Grasses and Legumes on Michigan Farms
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Grasses and Legumes

on Michigan Farms

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PREPARED AND EDITED

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Grasses and Legumes on Michigan Farms

The increased emphasis on the use of grasses and legumes on Michigan farms has given rise to the use of a new term, "grassland farming".

Grassland farming means different things to different persons. For some it means going to 100 percent grass and small grain crops. For others it simply means that grass and legumes are included in the rotation. Undoubtedly some entire farms, because of slope and erosion, are best adapted to grass and small grains. There are some farms that may be maintained without using grass or a legume as a harvested crop.

For the great majority of farms, however, a grassland farming program somewhere in between the two extremes of all grass and legumes or no grass and legumes as a harvested crop is for the best interest of the farm and farm family. The twin goals to strive for are maximum farm income and soil conservation. The wider use of the better adapted and more productive legumes and grasses is essential to the maintenance of Michigan's soils and agriculture on a permanent basis. These legumes and grasses may be used largely as green manure crops, cover crops, or as hay and pasture on livestock farms.

The use of inferior grasses and legumes such as Junegrass and lespedeza, when better adapted ones such as brome grass and alfalfa are available, leads to lowered income and poorer farms. Using the best grasses and legumes in their proper place with respect to good farming practices and managing them so as to get the greatest continuous benefits may be considered as good "grassland farming".

The Present Situation

About 4 out of every 10 tillable acres on Michigan farms are in hay or pasture. The amount has not changed much in recent years. With respect to acreage, feed and soil conservation, grasses and legumes are our most important crops.

The proportion of tillable land in hay and pasture varies greatly within Michigan. In Wayne, Monroe and Berrien counties about 20

percent of the tillable land is in hay and pasture. In most of the southern part of the state the range is from 30 to 40 percent. In most counties in the northern part of the lower peninsula the range is from 60 to 70 percent. In the upper peninsula the range is from 65 to 85 percent. Thus while hay and tillable pasture are important crops throughout Michigan there is much variation in their importance and also in the problems related to the most efficient production and use of grasses and legumes.

On a large proportion of Michigan farms poor yields and poor quality of hay and so-called permanent pasture are major factors causing low farm earnings. In addition, most Michigan farmers do not make the best use of winter-cover and of green manure crops. Much can be done to improve fertility and to increase crop yields and farm earnings through the more effective production and use of these crops.

The Problem

The question is really one of "what is a sound grassland program for each Michigan farm?" Naturally the answer will be different for a farmer in southern Michigan near the Ohio-Indiana border than it will be for the northern Michigan farmer near Lake Superior. It will also be different for the cash crop farmer than for the dairy or general livestock farmer. It may also be different for two adjoining dairy farms. It will be different for the fruit grower than for the potato grower.

Some of the specific problems confronting Michigan farmers are:

1. How much grass and legume acreage to include in a good farm plan?
2. On what part of the farm should more emphasis be given to grass and legumes?
3. How to produce high quality forage?
4. How to improve yields of forage?
5. How to produce and harvest grass and legume seed profitably?
6. How to best utilize forage crops, both as pasture and as harvested crops?
7. How to best use grass and legumes in a soil conservation and soil building program?

How Much Hay and Pasture?

One of the first problems in a grassland farming program is, how much forage is best for my farm? Each farmer must answer that question for himself after taking into consideration, 1) the soil type, slope, and degree of erosion on his farm, 2) size of farm, 3) kinds of livestock he now has or could have, 4) his building facilities, 5) the machinery and equipment available, 6) his labor supply, 7) his markets and 8) his need for maximum farm earnings.

In general, a farmer should be conservative in making major changes in the acreage of forage crops as well as in methods of harvesting and storage. Before making such changes he should study the effect on his entire farm business and also should learn the "know-how" involved in a changed program. Through improvements in the quality and in the yields of forage crops and by using green manure and cover crops, an even smaller acreage of hay and pasture may be needed on some farms.

The most important thing is to emphasize **quality** rather than **acreage** of forage crops. Most farmers in Michigan can improve the quality of their forage programs. Certainly not all farmers should increase their acreage of forage crops. It seems easy to become too enthusiastic about putting the farm into grass and thereby hope to greatly improve the farm and farm earnings. It is better to first put forage on land that should be in forage and produce quality crops on our present acreages.

Most farmers will want to go as far as they can in putting their crop acres into forage and still keep up their farm income over a period of years. However, they will not want to have more hay and pasture on their farm than they need for a sound farm program.

Is It "Grass" Versus Corn?

Some folks think in terms of grasses and legumes largely replacing corn in a farm program. Others think in terms of grass, legumes and small grains as replacing corn in the rotation. It should be emphasized, however, that in general in our feeding program forage does not replace grain. There are farms, however, on which corn should not be grown. Corn is necessary in most feeding programs, but on farms where it should not be grown it will need either to be purchased or

to be replaced by small grains. Thus it is not a question of "grasses" replacing corn anymore than it is a question of a farmer's tractor replacing his wife. Both help greatly in making the farm successful.

On the basis of average yields on farm-account cooperating farms in southern Michigan, corn and alfalfa (alfalfa-brome) are the leading harvested feed crops. However, the total digestible nutrients (T. D. N.) in corn are not comparable with T. D. N. in alfalfa. Research by Dr. C. F. Huffman and Prof. C. W. Duncan, of the Michigan Agricultural Experiment Station, in alfalfa-corn trials with dairy cows show that corn grain supplies an unidentified factor or factors needed to balance alfalfa hay for milk production. Milk production rose about 20 percent in a typical experiment when a ration containing corn and alfalfa replaced a ration of only alfalfa, the daily intake of total digestible nutrients being kept the same in each ration.

Dr. Huffman further states that after the unidentified grain factors are supplied by the initial feeding level of grain, for example 7 or 8 pounds a day for the average cow, it makes little difference in milk production whether the silage fed is corn or "grass" silage.

On some farms the decision may well be grass and small grains instead of corn. The major factors in this decision are 1) land capability, 2) comparative crop yields, 3) the kind of livestock kept and 4) the farmer's need for high farm earnings.

The land capability is determined largely by the soil type, slope and erosion. The most important of these are soil type and length and steepness of slope. The better corn lands are the more level heavier types of soils. Land with slopes from 0 to 2 percent (that is a rise of 0 to 2 feet per 100 feet) are of course the best suited to row crops. As the degree and length of slope increases, special management practices are required and in addition corn or other row crops should not be grown as often as on the more level ground.

Corn yields are affected not only by the capability of the land but also by the length of growing season. Length of growing season and the yields decrease as one goes north from the southern border of Michigan. Thus, in the regions with the shorter growing season and the limited acreages of land adapted to corn most farmers will find it to their financial advantage to put major emphasis on grasses and legumes. Improvement in both quality and yields of forage crops in such areas is of first importance.

The amount of forage crops (hay and pasture) required per roughage consuming animal unit (i.e. 1 cow, 2 yearling heifers, 7 ewes, etc.) varies much depending on the yield and quality of the forage. In 1948, a study of this problem was made by the agricultural economics department of Michigan State College of 26 farms in southern Michigan. These 26 farms had no non-tillable pasture. The acreage of hay and tillable pasture per roughage-consuming animal unit ranged from a low of 1.2 acres to a high of 11.3 acres. Half of the farms averaged 2.1 acres and half averaged 4.8 acres of forage per roughage-consuming animal unit. These figures are in addition to the acreage used for corn silage.

One interpretation that could be made from this study is that by improving the quality and yields of hay and pasture 13 farmers needed only 2.1 acres of hay and tillable pasture per roughage-consuming animal unit, thus freeing more land for other crops. These 13 farmers used more commercial fertilizer per tillable acre, they purchased about $3 an acre more feed, their crop yields were higher, their dairy sales per cow were higher and they kept more livestock.

In a Barry County study (Michigan Agricultural Experiment Station Special Bulletin 356, "Success in Farming Rough Land in Southern Michigan"), 65 farms averaged 3.7 acres of hay and tillable pasture and 2.3 acres of non-tillable pasture per roughage-consuming animal unit. Figures for the four different land classes, No. 1 being best, in this area are presented in Table 1.

TABLE 1—*Forage crop acreage per roughage consuming animal unit on 65 Barry County, Michigan farms in 1946*

Item	Area average	Land class			
		I	II	III	IV
Number of farms	65	8	17	29	11
Acres per farm, total	162	126	177	164	158
Percent of tillable land in					
Hay	25	17	25	26	27
Pasture	24	21	18	27	31
Row crops (mostly corn)	18	20	19	19	12
Small grains	23	35	28	19	15
Forage crop acreages per roughage consuming animal unit					
Hay	1.9	1.3	2.1	1.8	2.5
Pasture: Tillable	1.8	1.4	1.5	1.9	2.8
Non-tillable	2.3	0.4	2.2	2.8	3.1
Total	6.0	3.1	5.8	6.5	8.4
Dairy sales per cow	$213	$272	$211	$213	$159

Is Grassland Farming Profitable?

Some degree of grassland farming is essential on all farms. Many folks ask the question, however, *is grassland farming profitable?* There is no yes or no answer to that question. Much depends on one's definition of the term grassland farming and also of the term profitable. On the steeper slopes, on some of the poorly drained areas and on some other spots on the farm grasses and legumes are usually the only profitable crops for the conditions. They have little competition. On the more level areas, however, grasses and legumes usually have to compete with a wider diversity of crops.

Grasses and legumes are feed crops. On land that is suited to a variety of crops, the best profits will be obtained by growing those crops that will produce the largest amount of digestible nutrients and at the same time fit in best with the livestock feeding program and with soil conservation.

Grasses and legumes may also serve as soil builders. Thus it is necessary to include them in the rotation either as a hay or pasture crop or as a green manure or cover crop. The indirect values of grasses and legumes in the rotation in improving the soil and thus the yields of other crops is of first importance.

FORAGE CROPS—VARIETIES AND ADAPTATION

Pasture Mixtures and Practices Recommended for Michigan

Alfalfa at 6-8 pounds and smooth bromegrass at 2-4 pounds per acre have given the best meat and milk production of any mixture tried on upland soils suited to alfalfa. Drouth resistant, these plants produce when other upland pastures fail.

Reed canary grass, sown at 5 pounds per acre on wet muckland, makes a highly productive pasture on areas too wet for other crops. These areas, unsuited for pasture with their native vegetation such as cattails, swamp grass and swamp weeds, can become fine pasture when plowed, fitted and reseeded to reed canary grass.

Alfalfa 6-8 pounds, **bromegrass,** 2-4 pounds and **ladino** at 1 pound have been used with fair success. Ladino on the drier upland soils competes unfavorably with the alfalfa, is shallow rooted, dries up in

midsummer and tends to kill in the spring of the second productive year.

Ladino at 2-3 pounds and **bromegrass** 3-5 pounds are recommended on wet clay soils with a high water table where alfalfa kills out because of poor drainage.

Alsike clover at 3-5 pounds and **bromegrass** at 3-5 pounds can be used on creek bottom flats subject to periodic flooding with periods up to two weeks of ponded water.

Junegrass and **white clover** on heavy, poorly drained clay soils is encouraged north of the Bay City-Muskegon line. Seeding is seldom necessary as seed is in the ground.

Sweet clover at 12-15 pounds per acre makes a one-season pasture crop in short rotations. Will usually die out in August of the second year.

Sudan grass—Common or sweet sudan seeded at 20-25 pounds per acre makes excellent summer pasture on land suited to corn. Sweet sudan is ready to pasture a week to 10 days later than common and is considered no better.

Balbo rye. Seed about 1 bushel per acre in Mid-August. Do not pasture too close that fall. Pasturing can start earliest of any grass next spring. Balbo rye pasture does not taint milk.

Junegrass is an early season pasture and soon becomes dormant and unproductive with the advent of hot dry weather in July and August. Season-long dependance on such pastures makes for many of the problems associated with uneven supplies of dairy products during the grazing season. Too many acres and too much reliance on these so-called native or permanent pastures is our number one pasture mistake.

Species Not at Present Recommended

Alta fescue—Likewise called Kentucky Wonder grass, Kentucky 31 and tall fescue. This grass is highly competitive and is unpalatable in our dry summers. This grass is recommended for air fields, road shoulders and athletic fields where it produces a coarse but usable sod.

Birdsfoot trefoil—As yet difficult to establish, probably due to faulty inoculation. Not so good as alfalfa or red clover where they

are adapted. Research is under way to find out how and where to use this plant to advantage.

Lespedeza—An annual which must reseed before frost to give any appreciable amount of pasture from year to year. Very little grown north of the Ohio river valley.

Hubam—An annual sweet clover which seldom makes as much growth as the biennial sweet clovers in the seeding year.

Blue Lupine, Crotalaria and Kudzu—Southern forage and green manure crops not adapted to Michigan.

Hay Crops

Alfalfa at 6-8 pounds and **bromegrass** or **timothy** at 2-4 pounds per acre are considered our best hay crop. Bromegrass is more productive in the second cutting season. Both mixtures are palatable. Alfalfa and bromegrass rather than alfalfa alone is generally recommended because of 1) winter killing losses of alfalfa, 2) the wilt disease of alfalfa which cuts down its period of use to 1-2 years where severe and 3) the bloat problem is more serious when straight alfalfa is pastured. The stand should be plowed up when the alfalfa has largely disappeared.

Red clover at 6-8 pounds and **timothy** 2-4 pounds are used in short rotations on soils of lower fertility than that necessary for alfalfa-brome but it is not as productive even the first year as alfalfa-brome where soil conditions are favorable for either mixture.

Alsike clover at 1 pound per acre is frequently included in either of the two preceding mixtures where wet spots are prevalent in the field.

Red clover with alfalfa is not recommended except when alfalfa is scarce or particularly high priced. Where properly handled, alfalfa is much more productive than red clover and any appreciable amount of red clover with alfalfa is quite apt to lower the productivity of the stand.

The foxtail millets, Hungarian, German or Japanese can be used as emergency hay. The hay quality is inferior to legume or to a legume-grass hay.

Soybeans of the Earlyana, Lincoln and Manchu varieties are good hay varieties for emergency use.

Green Manure and Cover Crops

Rye at 1½ bushels or rye at 1½ bushels and vetch at 15 pounds per acre make good green manure or winter cover crops.

Sweet clover seeded at 12-15 pounds in wheat or oats or barley and plowed down for beans or corn the following spring is the best green manure crop.

Sweet clover at 10-12 pounds and **domestic ryegrass** at 10 pounds per acre are at present the recommended mixture, for green manure seedings made in the last cultivation of corn.

Oats, barley or **Sudan grass** may be seeded in late summer as cover. These crops usually die with cold weather and are not as good as a crop which lives over winter. However seed is available on nearly every farm and dead cover is better by far than bare soil.

Waterway and Ditchbank Seedings

The easiest and quickest method of establishing a waterway is to leave the waterway when plowing up a sod field. To establish a waterway on bare soil sow bromegrass 10 pounds, bluegrass 5 pounds, redtop 2 pounds and domestic ryegrass 3 pounds per acre mixed.

Ditchbank seedings in muck areas—Poa trivialis, (rough stalked meadow grass) at 15 pounds or Chewings fescue at 20 pounds or redtop at 5 pounds per acre have shown promise. Reed canary grass has been used but tends to grow in the ditch proper, ultimately plugging it. Further research is under way to find out more and better ways of handling this problem.

Ditchbank seedings on mineral soils—These vary with soil type. On soils high in organic matter use redtop 5 pounds, or bluegrass 10 pounds per acre. On lighter soil types, bromegrass at 15 pounds or Chewings fescue at 15 pounds should be used.

Sand Stabilization—On shifting sand areas, vegetative segment planting of the two big beach grasses at 3-foot spacing has proven as satisfactory as any along lake shore areas. On sandy areas inland, the fescues at 15 pounds per acre or sand drop-seed at 3-5 pounds per acre have given best results.

Orchard cover—Chewings fescue at 10-15 pounds per acre for sandy soils.

For the Lighter Soil Types

The forage problem remains unsolved for many of the lighter soil types such as Coloma, Granby, Grayling, Newton and Kalkaska. When bromegrass will not grow, there is no answer at present for a grass; and the legume for such soils is still not available. Forage growth and livestock maintenance on these lighter soil types is still an unsolved problem. Exceptions can be found to this general statement but it is only through extreme care and excellent soil management that these soil types can be kept productive.

New Varieties of Forage Crops

The U. S. D. A. Plant Introduction Division, as well as numerous plant breeders, is at work to develop or introduce new forage varieties. Ranger and Buffalo alfalfa are such new varieties as are Tift sudan and Kenland clover. None of these new varieties has as yet shown any particular promise over the older varieties now in use in Michigan. Chances are good, however, that newer and better varieties will be produced.

Forage Establishment

Liming where tests show a need for lime is essential to establishment of legumes. Any form of lime is usable if used at recommended rates. Spread at least the season ahead of seeding if possible.

Fertilizer should be applied prior to or at seeding time; 400-600 pounds per acre of a recommended grade and analysis will do much to insure a seeding and a vigorous, productive stand of either legume or legume and grass.

Seed shallow—Seed all grasses and legumes at or near the surface. Garden hose or other extensions of the short seed hoses to direct the seed back of the drill will aid materially.

Spring seedings—On moisture retentive soils seedings can be made with small grains which are later harvested. On lighter soils that tend to dry out, the small grain crop should be grazed off; or the seeding should be made alone in June after fallowing the land.

Late summer seedings—Can be made between August 10-25. Later seedings are likely to be hurt by fall freezes before root growth is sufficient for over-wintering.

Seeding with wheat—Drill bromegrass or timothy with the wheat in the fall and top seed alfalfa or red clover in early spring. Alfalfa is less hardy than red clover and should be seeded later, preferably with a drill. Red clover can be seeded by hand in early spring with more success than alfalfa.

Ditchbank seedings—Any pure grass seedings can be made for ditchbanks, waterways and orchards much more favorably in late summer, August 10-25. Fall rains are much more favorable for establishment and annual weed competition is far less at this time.

Seeders other than grain drill—Cultipacker seeders are excellent. Satisfactory equipment to seed after the last cultivation in corn is largely homemade. There is not sufficient demand to warrant commercial manufacture.

Reed canary grass—Because of the wet nature of muck areas recommended for pasture, these areas are usually plowed and fitted in the dry part of summer. A marsh breaking plow, followed by disk and roller will generally suffice. A muck fertilizer at 400-600 pounds of 0-9-27 or 0-20-20 is recommended. Seed in period from August 10-25 or November 1-15. November seedings lie dormant until early spring. September and October seedings are quite apt to heave out.

Pasture Renovation

White clover pastures on moisture retentive and poorly drained soils of **northern** Michigan can usually be established by topdressing with phosphate at 400 pounds of 0-20-0 per acre followed by close grazing. Seeding is not necessary because the crop is present in the ground. To maintain the clover the pasture must be phosphated with 200 pounds per acre per year or 400 pounds every other year.

Junegrass pasture—Attempts to renovate Junegrass pasture on uplands, that is reseeding and fertilizing without seedbed preparation, are usually wasted effort. To establish a seeding, plow in June; fallow, lime and fertilize in summer and seed alfalfa-brome mixture in August 10-25. Attempting to prepare a seedbed with field cultivator is more

time consuming but can be done. Spring-tooth, disc and sub-surface tillers as renovation machinery have been largely unsuccessful.

PASTURE MANAGEMENT

A Pasture Calendar – One of the important pasture management problems is to set up a sequence of crops that will provide good grazing throughout the entire season. Table 2 shows such a sequence. The figures indicate the average number of days of pasture that one acre will provide for one cow. For example, in June an average acre of reed canary grass will provide pasture for one cow for 30 days and another cow for 10 days.

TABLE 2–*A pasture calendar which indicates a good sequence of crops as well as the average number of cow days of pasture provided per crop acre.*

Crop	Cow days of pasture per acre						
	May	June	July	Aug.	Sept.	Oct.	Total
Junegrass (good—permanent)	15	30	.....	.....	2	3	50
Alfalfa-brome (average—3 years)	15	30	30	30	.....	15	120
Sweet clover 2nd-yr. (average)	15	30	30	15	.....	.....	90
Red Clover-Timothy (average)	15	30	20	15	15	.....	95
Junegrass-white clover (permanent)	15	30	15	15	10	5	90
Reed Canary grass (average—10 years)	20	40	40	40	40	20	200
Sudan grass (average)	.....	.....	30	45	30	10	115
Oats (average)	.....	40	20	.....	.....	.....	60
Balbo rye	.....	.....	.....	.....	.....	.....	.....

Rotational grazing – This is the fencing of any one field of a given kind of pasture into three or four fields, and then moving livestock from one field to another in sequence. The system is best adapted to regions where rain and climate maintain an even pasture growth. In Michigan where rainfall is adequate in spring and early summer, and inadequate in midsummer, a rotational grazing system fails because we have too much growth in spring and too little in July and August. In testing continuous versus rotational systems with both dairy cows and sheep at the Kellogg Farm, a continuous system proved easier to handle and produced as much if not more milk and meat than a rotational system.

Pasture Costs – Estimated pasture costs per acre and per day for the major pasture crops of Michigan are shown in Table 3. Both the cost of establishing as well as the annual charges are shown. In judging the costs per day it should be kept in mind that some pastures with low

TABLE 3—*Estimated Pasture Costs Per Acre and Per Day*

Kind of pasture	Establishment cost					Expected life	Annual charge				Days pasture per acre	Cost per day
	Seedbed preparation, seeding	Seed	Fert.	Lime	Total	Years	Seedbed preparation, and seed*	Fertilizer and lime**	Interest, taxes and overhead	Total		
												cents
Junegrass	.....	.....	$5.80	.....	$5.80	.....	.....	$1.45	$2.00	$3.45	50	6.9
Junegrass-white clover	.....	.....	3.20	.....	3.20	.....	.....	1.60	2.00	3.60	90	4.0
Reed Canary grass	$21.70	$5.00	8.40	.....	35.10	10	$2.67	3.64	3.50	9.81	200	4.9
Alfalfa-brome	1.53	5.69	12.00	$8.00	28.22	3	2.74	7.60	4.75	15.09	120	12.5
Sweet clover 2nd-Year	1.53	3.00	6.00	8.00	18.53	1	4.53	7.60	4.75	16.88	90	18.8
Red clover-timothy	1.53	4.00	6.00	8.00	19.53	1	5.53	7.60	4.75	17.88	90	19.9
Sudan grass	5.59	3.25	6.00	.....	14.84	1	8.84	6.00	4.75	19.59	115	17.0
Oats	3.92	1.50	3.20	.....	8.62	1	5.42	3.20	4.75	13.37	60	22.3

*Annual share of seedbed preparation and seed cost.
**Annual share of fertilizer application upon establishment plus subsequent application on alfalfa-brome and Reed Canary grass. Lime application prorated over five years.

Rates used in estimating pasture costs: Man labor 75 cents an hour; two-plow tractor 60 cents an hour; alfalfa 8 pounds per acre at 60 cents and brome 3 pounds at 63 cents a pound; June clover 8 pounds at 50 cents a pound; sweet clover 12 pounds at 25 cents; sudan grass 25 pounds at 13 cents; reed canary grass 5 pounds at $1 a pound; oats 64 pounds at 75 cents a bushel; lime spread on the field $4 a ton; and commercial fertilizer averaging 200 pounds per acre per year at $60 a ton.

acre and day costs provide grazing when there is lots of pasture Other pastures which are more costly may furnish grazing during the dry season of the year when pasture is normally short and scarce.

Alfalfa-brome only – Using a small acreage of first cutting alfalfa-brome for the period of May and June, followed by two to three times this acreage of second cutting works well. Going from Junegrass, instead of alfalfa-brome, to second cutting hayfields leaves a gap of poor production from June 15 to July 15. The Junegrass is unproductive after June 15 and second cutting hayfields are seldom ready for grazing before July 15.

Balbo Rye – Under favorable conditions, Balbo rye has a very high carrying capacity for a period of about a month in the spring, usually from April 15 to about May 15. It can also be pastured lightly from about the middle of October to the middle of November.

Seedings may also be made in Balbo Rye where it is desirable to establish a pasture for several years. The Michigan State College dairy department has used the following plan at East Lansing for the past three years. The seed bed was plowed and prepared in July. From August 1 to 15, Balbo rye was planted at the rate of one-half bushel per acre. At the same time the following small seed mixture was seeded–alfalfa 6 pounds, bromegrass 3 pounds and ladino one-half pound. In the southern two tiers of counties in Michigan, the rye should be seeded a little later than in the counties to the north.

After the spring pasture season, the remaining rye on reaching maturity could be harvested for seed. In any event, it should be cut and removed from the field in order to give the new seeding a chance.

Reed canary grass – When well fertilized and properly managed on wet muck lands this grass makes for the longest season pasture. Managing the number of head per acre is hard, but enough stock must be kept on the grass to *keep it eaten to about a foot in height.*

Annual clipping – Clipping of pastures for other than weed control is a mistake. They may be unsightly if unclipped, but a lot of mature growth may of necessity be eaten by livestock during dry summers. Certain classes of livestock do quite well on mature grass. Clipping does not influence the amount of new growth–it only looks that way. It is similar to burning old dead grass–after burning only the green grass can be seen and the color is not masked by the dead grass. Burning does not result in more grass growth as many persons believe.

Closeness of Grazing – Pastures containing white clover must be closely grazed to keep the white clover productive, otherwise grasses take over and crowd out the clover. All other commonly used pasture plants such as alfalfa, red clover, timothy, bromegrass and reed canary grass should not be grazed closer than 6-10 inches. Close grazing of these upright plants results in lowering the production of new growth, and makes them more susceptible to disease, drouth and winterkill injury. Junegrass can be grazed close as it will not last season-long as productive pasture in Michigan.

Do not Pasture Late – To insure an early spring growth on a pasture field, pasturing no later than September 1 will help materially. Late fall pasturing weakens plants which must have time to recover in the spring before grazing starts.

Prussic Acid Poisoning on sudan grass is over-emphasized in Michigan. If grazed when 18 inches to 2 feet high, little danger is present. Sudan is dangerous only when short regardless of what may cause a short growth—young plants, drouth or a light freeze which may start suckers from the crowns. To date, no one has any knowledge of an authentic case of sudan poisoning which resulted in death of an animal in Michigan, and a lot of it has been grazed when short. To avoid any possible danger, refrain from grazing sudan when it is short.

Irrigation – As yet, no real evidence is available on irrigation of hay and pasture crops in Michigan. During 1949, an irrigated ladino field at Michigan State College, in comparison to one not irrigated, gave slightly higher but not significant increases in meat production on sheep. Research is under way to find an answer to the management and economics involved. If irrigation equipment is available on the farm however, it would certainly be desirable to try irrigation of hay and pasture.

Fertilizing when seeding – A productive pasture needs about 200 pounds of high analysis fertilizer annually, of a type recommended for the soil type involved. The total amount of fertilizer needed can be applied when seeding, or part can be applied each year. On mucks and sandy soil use 0-20-20 or 0-9-27, on clay soils use 0-20-0 or 0-20-10.

Fertilizing on Established Pasture – The use of fertilizers on grasses where the kind of grass and the fertilizer used react favorably results in an increase in quantity rather than quality of the forage. Observations on reed canary grass indicate the need for more critical work,

and such an experiment on muckland is under way cooperatively between the soils, farm crops and animal husbandry departments at Michigan State College. Fertilizing Junegrass does not pay—the period of use is too short.

Fertilizing with Nitrogen – Any young grass is high in protein. The application of nitrogen to grass delays maturity somewhat, resulting in a larger growth. This larger growth may actually be younger in terms of maturity where nitrogen is applied than some short grass of the same variety to which no nitrogen was applied. Applications of nitrogen to grass may frequently double or even treble the amount of protein per acre, but does so largely through an increase in volume of growth.

Fertilizing for White Clover – On the heavy clay soils of northern Michigan where the water table is high and drainage poor, applications of superphosphate at 200 pounds per acre per year followed by close grazing has resulted in the volunteering of white clover. This has materially increased both the quantity and quality of pastures on this type of land.

Wilt – This is our most important legume disease attacking alfalfa. The "leaf spots" are the most important grass diseases. Treatment is too costly and the only real solution is development of resistant varieties. Buffalo and Ranger alfalfa are wilt resistant, but are not adapted to Michigan's climate. Research to develop new varieties that are both resistant and hardy is getting special attention at a number of the northern college experiment stations.

September Damage – In order to keep forage fields of alfalfa and red clover as vigorous as possible, they should be neither cut or pastured during September. At this time alfalfa and red clover are storing food in the roots for winter use and spring recovery. Grazing or cutting during September tends to weaken the plants resulting in damage to or outright death of stands.

Insect Pests of Hay and Pastures

Grasshoppers—Here is the main insect menace in Michigan to grass and legume crops. With everybody working at it, in a community effort, it is possible to kill off grasshoppers in those years when they become a problem. Chemicals, such as Toxaphene and Chlordane are the principal insecticides being used at present. Warnings of "grass-

hopper years" are given by the entomology department of Michigan State College, together with current recommendations as to control procedure.

White Grubs—These beetle larvae which live in sod crops are less numerous in legumes than in grasses. No chemical control of white grubs is feasible. Plow up the affected area and get it into rotation. Do not plant crops susceptible to grub damage, such as potatoes or strawberries, on land that has been in sod crops for several years.

Spittle Bugs and Leaf-Hoppers—There is no practical chemical control for these insects on forage crops. The material that kills the insects leaves a poisonous residue on the leaves. In the case of seed production, where the forage is not to be used by livestock, chemical control can be used if the seed is valuable enough to warrant the expense.

SEED PRODUCTION PRACTICES

Legumes

Alfalfa—There is no known set of rules for growing a seed crop of alfalfa in Michigan. Seed frequently sets on first crop alfalfa from the second or third crop of blossoms which develop in the leaf axils after the first blooms fall off. In Michigan wild bees such as bumblebees are of primary importance. Honeybees may work alfalfa for nectar but seldom for pollen because competing flower pollen sources are much easier to work. Honeybees placed in alfalfa fields have failed to increase seed yields.

Killing of harmful insects with D.D.T. may be helpful but without the beneficial wild bees, little seed is set. So seed production seems to be closely tied up with alfalfa blooming, and the work of beneficial wild bees. Certain areas of the state where nesting sites of wild bees in fence rows, old pastures, and brush areas are still numerous seem to be most favorable for seed production. The first crop of alfalfa is the one most likely to set and mature seed. The second crop frequently blooms too late for best insect activity, and frost often comes before the seed is ripe.

Red Clover—Red clover seed is produced in the second crop—mammoth in the first crop. A cutting of mammoth for hay reduces seed yields of the second crop drastically, whereas red clover cut at

early bloom produces the most seed in the second crop. Here again, bumblebees and other wild bees are the most efficient pollinators, although honeybees may be important where other pollen sources are restricted. Much red clover seed is produced over a large share of the area south of the Bay City-Muskegon line.

Sweet Clover, Alsike, Ladino and **White Clover** are all pollinated by honeybees. Bee yards close to seed fields of these crops may double or treble seed yields. Bee yards less than a mile from seed fields are desired, and those over two miles from seed fields are not of much benefit.

Harvesting Legume Seed

Recent studies show that farmers manage to harvest only about 40 percent of the seed actually present on the field at harvest time. Losses are due to handling, unfavorable weather, inefficiency of harvesting machinery, and lack of knowledge on the part of operators in operating the machinery. No given method of procedure seemed to show any consistently better recovery. More care should be given to handling seed material. Threshing the material two or three times gave highest returns when done in one place with canvases placed on wagons and at strategic places around and under the threshing equipment.

Any handling of seed material in curing should be done when the material is tough rather than dry. More attention to sieves, speed of threshing, and setting of concaves will increase efficiency of operation. Losses in threshing small seed are not usually observed because no one knows how much seed was on the field at the start of harvesting and a few bushels of small seed unthreshed or run over the machines in field threshing is not noticeable on the field. Ladino and white clover seed can best be harvested with a vacuum harvester. These machines will pick up shattered heads and seed and blow material collected into a covered forage wagon. The material can then be run through a stationary huller or thresher at least twice to separate seed from other material, such as dirt and stems.

Grasses

Bromegrass—For best results, bromegrass for seed production should be sown in rows and cultivated. Nitrogen applications in early spring have given increased yields. Seed may be harvested from old

alfalfa-brome stands but any fields with a trace of quack grass should not be harvested. The brome and quack seed cannot be separated. Harvesting can be done with combines cutting the field high so as to leave all green material below the cutting height. Cleaning of seed is difficult and should be done by operators with machinery designed for such work. A rotating brush under the screens is almost a necessity to prevent plugging of screens.

Reed Canary Grass—Reed canary grass is a difficult seed crop to harvest because it ripens unevenly and shatters easily. Yields have run from 25-600 pounds per acre. Seed is usually combined when 15-20 percent of the seed is brown, the remainder green. Seed should not be stripped of the seed coat as may happen when concaves are set too close and speed of operation is too high. The seed will be mostly green when harvested and a lot of husks, leaves and pieces of green material will be present along with the seed. This green material will heat rapidly, resulting in low germination. Thus the seed should be spread out in a thin layer on a clean, well-ventilated floor as soon as threshed. It should be shoveled or raked over two or three times a day to speed up drying and prevent heating. Running the seed material through a fanning mill will remove much of the greener material and facilitate curing.

Most grass seeds can be harvested with combines if they are set and operated correctly. Grass and legume seeds are scarce, high priced and difficult to harvest. More care in harvesting will pay big dividends.

SOIL CONSERVATION AND SOIL BUILDING

Cash Crop Rotations

Maintaining Soil Productivity where Cash Crop Rotations are Followed: Careful attention to the use of green manures and liberal use of commercial fertiilzer of an analysis recommended for the given soil type make it possible to maintain fertility of a good soil where a cash crop rotation is followed. This is indicated by results obtained in the rotation experiment being conducted on the Ferden farm in Saginaw County. In one rotation in that experiment, a sweet clover-mammoth clover mixture is seeded twice in a 5-year rotation. The rotation is as follows: Barley (sweet clover-mammoth clover), beans, wheat (sweet clover-mammoth clover), corn, sugar beets. Results during the past

few years indicate that such a rotation does very well in soil fertility maintenance.

It is suggested that fertilizer applications for the preceding rotation be as follows: With the barley, 300 pounds per acre; with beans, 200 pounds; with wheat, 400 pounds; with corn, no fertilizer and with sugar beets, 600 pounds per acre. A still greater chance of maintaining fertility would be possible if a legume seed crop were substituted for one of the green manure crops and/or if some grass such as timothy were included in the green manure mixture.

Strictly cash crop rotations, without the inclusion of leguminous green manure crops, will not maintain fertility unless legume seeds, such as alfalfa, sweet clover, or June or mammoth clover are considered as cash crops. A rotation such as beans, barley, and legume seed, with liberal applications of fertilizer, should result in soil building. The substitution of wheat for barley might be better because of the winter cover provided by the wheat; or wheat or rye could be seeded as a green manure crop, to be plowed under for barley or oats. In that case the green manure crop should be liberally fertilized.

Cover Crop Management—Cover crop management must vary with the soil type and with the cash crops being grown. Generally, the small-seeded legumes are particularly adapted to heavy soils. This is because on such soils it is possible to seed them with a small grain companion crop. This is also possible on sandy loams in a good state of fertility, but is not possible on lighter sands.

On sandy soils it is possible to make good use of rye at 1½ bushels, or domestic ryegrass at 10-15 pounds per acre, as green manure crops. They can be planted in corn or after corn, and after early potatoes or early vegetable crops.

Cover crops should always be planted where soil would otherwise go through the winter bare. Nutrients are lost by leaching from a bare soil, and erosion losses may be severe if the soil is hilly or if it is sandy enough to blow during the winter. Cover crops should be liberally fertilized, with phosphate and potash in the case of legumes, and with complete fertilizer running heavy in nitrogen for non-legumes. Straight nitrogen fertilizers may be desirable at the time of plowing under non-legumes.

Fertilizer Application Rates—It is recommended that fertilizers be applied at the rate of 200 pounds per acre per year of the rotation. For example, if a grain crop is to be seeded to alfalfa which is to be har-

vested two years for hay, and the fourth year's crop is also one which responds to fertilizer, such as beans, the amount to be applied with the grain would be 600 pounds per acre. This quantity should be sufficient on most soils for the three-year period. Where new seedings are to be made without a companion crop, fertilizer should be applied at the rate of 600 pounds per acre, with an additional application if the crop is harvested more than two years.

Green Manure Crop Management—The management of green manure crops depends upon what cropping system is being followed. If sweet clover is to be plowed under for a current year's row crop such as corn or beans it should be plowed when young, before excessive quantities of water have been removed from the soil.

Where livestock are not included in the total farm enterprise, it is a good idea to allow sweet clover to reach the full blossom stage before it is plowed under. In that case, of course, another crop could not be produced that year. Wheat could be seeded in the fall.

Rebuilding Soil Fertility—When the fertility is low and the soil is acid, it is good economy in land use to replace the depleted mineral nutrients and then grow the best available legumes.

Grasses, Legumes and Orchards

Contour Plantings, Trashy Cultivation and Sod Mulches—The use of contour plantings with clean cultivation probably would not control soil losses as much as orchards planted in the usual manner and grown with sod-mulch or trashy cultivation. This of course depends upon the slope of the soil and probability of torrential rains. In areas where heavy downpours are frequent, the use of a sod is perhaps the best method of checking soil losses. Trashy cultivation should not be used in orchards having more than a 5-10 percent slope without employing contours. This also implies that contours need not be used in orchards having less than a 5 percent slope. (5 feet in 100)

Regardless of slope, a good sod cover is the best known means of preventing soil losses. However, since sod depresses tree growth for several years a crown mulch of straw or similar material should be used around the trees. Mechanical structures such as contours and other barriers to reduce soil losses should be used only in emergency cases and even then as sparingly as possible because of increased management costs and problems.

Grasses and Legumes for Small Fruits—The use of grass cover crops in small fruit enterprises, especially raspberries, should be developed with available soil moisture as a prime consideration. Grasses such as rye grass, rye and wheat which may be planted in late summer and would stand over winter may be successfully used without seriously competing with the small fruits for moisture. These grasses should then be disced in the spring before they set seed and after sufficient growth as been made. Tall growing grasses, and grasses that grow throughout the summer should be used with caution because of their competition for soil moisture, and increased management problems.

Cover Crops, Tree Growth, Fruit Size and Maturity—With nearly all cover crops in orchards there is, initially at least, a reduction in tree growth and size of fruit, and earlier maturity of fruit. These effects may be observed whenever a soil management program is changed to include a greater growth of cover crops or sods. The effect of cover crop growth appears to be in direct proportion to the amount of growth. Should the increase in cover crop growth be combined with an extreme shortage of water, tree growth may be reduced too much and result in winter killing because of the weak condition. If, however, an excessive growth of cover crops is supplemented with irrigation there should be little influence upon tree performance during the first couple years. After a period of 5 to 10 years the production of large amounts of cover crop growth in an orchard should result in improved tree performance.

Chewings Fescue in Orchards—Chewings fescue is not unlike most other sod covers in regard to moisture utilization. In soils having low fertility the fescue makes very little growth and does not draw heavily upon the soil moisture. In fertile soils, however, the fescue may be deep rooted and use large amounts of soil moisture. Mulching is the best means of allowing the tree to compete with the fescue for soil moisture. A tree growing in fescue sod with a crown mulch of straw or similar material should produce as much if not more than a tree in clean cultivation.

Chewings fescue appears to be different from most other types of sods in its rate of decay. The leaves and roots of fescue appear to decay more slowly than the leaves and roots of grasses such as Kentucky bluegrass. This decay is necessary before the nutrient-elements utilized in producing sod growth can be used by the tree or sod. Fescue, because of its slower rate of decay, appears to tie up certain

nutrient-elements and can result in a shortage for trees growing in fescue without mulch. Several growers are using the practice of discing fescue sods lightly each year. This is done in hopes of partially destroying good sods and thus combating the two objectionable features mentioned above.

HARVESTING AND STORAGE OF FORAGE CROPS

When to Cut Hay

To maintain the stand and to get the largest possible yields in two cuttings, alfalfa should be cut when about half in bloom. At this time the field should be blue with flowers. If a period of two weeks is to be used in harvesting, cutting should start earlier, in order to finish the job not much later than in full bloom. This will avoid much of the overmature, woody hay, and will conserve moisture to grow a second crop.

Timothy, clover, quack grass and smooth bromegrass should also be cut when in bloom, but before late bloom or seed stage.

The Best Week to Harvest Hay

The weather is an important factor to which both farm operations and production are closely related.

Thirty-one years of records reveal that the occurrence of weather often falls into a fairly dependable pattern. This pattern may be used to show the weather most likely to occur for a given period. For example, records for south central Michigan show that farmers may expect to encounter greater difficulty harvesting forages for hay during the last two weeks in June than in the first two weeks. During the last two weeks rainfall occurs in greater amounts and more frequently.

Chances are that a farmer may expect from two to three consecutive days of no rainfall during each of the first two weeks of June, compared to only one to two good days in each of the last two weeks, (Table 4). Generally speaking, the customary farming practice in this area is to undertake hay harvesting operations during the last two weeks in June. This in part probably explains why the hazards of weather are often mentioned as the reason for much of the poor quality or damaged hay being harvested each year in this area.

TABLE 4—*Average consecutive days without rainfall, 1918-1949 (Central Michigan)*

Weeks	Consecutive days of no rain
Last week in May	3 plus
First week in June	2—3
Second week in June	2—3
Third week in June	1—2
Fourth week in June	1—2
First week in July	3 plus

Hay Quality and Color

If a farmer has an abundance of cheaply-grown grain, lack of hay quality may be offset with grain in the ration—thus early haying that is unduly troublesome may not be justified. On the contrary, if a farmer expects fair to good production per animal on a ration composed mostly of hay, he must provide good hay, even if it might be somewhat more convenient to delay harvest until the hay is dead ripe and the weather warm and dry.

Good color in hay usually indicates freedom from weathering and reasonably early cutting, but such hay is not necessarily high in feeding value.

Curing Early Cut Hay

Curing hay at the early end of the season is ordinarily so difficult that mow-driers or some form of curing on racks are almost necessary. Putting the hay up as grass silage also gets away from most of the difficulties due to poor curing weather. If the hay on a farm can be gotten up before the full bloom stage, and if there is a good supply of grain available to supplement this mature hay in the ration, early cutting may not be worth the trouble. But if a mow-drier is needed to avoid cutting hay in the seed stage, it certainly should be considered where any amount of hay is to be put up.

Using Mow-Drier or Silo

A mow-drier or a silo permits putting hay into storage before it is dry and thus helps greatly in getting the job done at the proper season, without a lot of weathered hay and without a lot of wasted time and effort. With a mow-drier or a silo you can—

a) Get started haying early and get the job done before the hay is overmature.

b) Save the leaves and get more tons of hay.

c) Produce a better average quality of leafier and unweathered hay when cut at an earlier date.

d) Get a better second cutting by getting the first crop off on time.

If the haying operation is a small one and can usually be performed on time without hiring much help and without spoiling the hay, the investment in a mow-drier is of doubtful justification. Hay put up with the assistance of a mow-drier, however, saves more of the leaves, more of the dry matter and also more of the protein of the hay crop. Mow drying of hay is also a protection against fire from spontaneous combustion. If the weather prevents doing a good job on time, a mow-drier is probably justified even in small operations. Obviously, in a small operation, a small mow-drier is all that is required. A field chopper, cutting hay in about 4-inch lengths is very desirable for the best use of a mow-drier.

Baling hay before mow-drying greatly increases the difficulty of uniform drying, since the air flows more readily through the open spaces between bales and through dry bales than it does through the wet, heavy bales that need drying worst.

Curing Immature Grass or Legumes

Young, soft hay such as ladino clover and early-cut fertilized grasses have a very high feeding value, but are hard to cure even in an ordinary mow-drier. This is due to the low air temperature at that season of the year. Avoidance of tramping helps. With heated air in the mow-drier, they can be cured readily enough. For grass silage, these young hays need a lot of wilting, and with such valuable material, molasses is recommended as a preservative.

Desirable Moisture Content for Hay and Silage

For dry hay, about 20 percent moisture, a sample of the hay shaken up in a tight container with common crystal table salt should leave the salt dry.

For a mow-drier, the tough hay should not be excessively heavy. It should be down to about 30 to 35 percent of moisture as compared to

20 percent of moisture content hay for the conventional mow storage. This difference in moisture content usually represents one day of good hay drying weather. When ready for putting up in the mow-drier the hay should handle much like ordinary hay, altho heavier and tougher. It is not as green as would be used in putting up grass silage. The leaves should stick to the stems. Depending upon the rate of filling the barn, and on the capacity of the mow-drier, there is a good deal of leeway in the moisture content permitted. A few loads of too-wet hay can be balanced off with a few loads of dry hay. The hay need not be uniform in dryness.

For grass silage, the moisture content should be between 65 and 70 percent.

A study of Michigan farmers with 2 or more years of experience in harvesting grass silage revealed that two-thirds of these farmers relied on the "grab test" for determining the moisture content of chopped forage. Some were obtaining good results and some not too good. After a farmer gets the "feel" of forage with the right moisture content, he can make a fairly accurate estimate of the moisture content of chopped forage.

The "grab test" is illustrated in the May, 1950 Quarterly Bulletin of the Michigan Agricultural Experiment Station. To make the "grab test", grab a handful of the chopped forage as it comes from the chopper, squeeze tightly. If water squeezes out of the roll, the forage is too wet to put in the silo—let the crop wilt longer. If the chopped forage cannot be squeezed into a roll, it is too dry—mix in some more freshly cut forage. If the roll squeezes together, then *slowly* springs apart the crop is at the right moisture content to ensile without any preservative.

Farmers with more experience have learned about how long to allow the forage to wilt before putting it into the silo. Those who are starting in with grass silage can obtain some idea of the amount of wilting necessary with different crops by comparing the approximate moisture content of growing forage crops, as set forth in Table 5.

The amount of wilting required will depend on the kind of crop, stage of maturity, and the weather. A forage mixture most commonly reported by farmers putting up grass silage was alfalfa-bromegrass. For best results, this mixture should be cut when the alfalfa is in the one-fourth blossom stage. At this stage the forage usually contains around 75 percent moisture, and requires from 1 to 3 hours of wilting (sunshine) before ensiling.

TABLE 5—*Moisture content of standing forages. (Information gathered by Dr. S. T. Dexter, M.S.C., shows the approximate average moisture content of standing forages at East Lansing on the dates indicated)*

Crop	June 1	June 10	June 20	June 30	July 5
Alfalfa* (alone)	80%	78%	75%	72%	70%
Bromegrass "	80	75	69	65	62
Ladino clover "	87	85	84	82	80
June clover "	81	78	74	70	67
Timothy "	81	77	72	65	60

*First year alfalfa is likely to be higher in moisture than these figures show. If soil is dry, or season is early, moisture content may be lower.

Experience and care in getting the forage into the silo at the proper moisture level is a major factor in successful harvesting of forages for grass silage.

With the proper moisture content, no preservative such as molasses is ordinarily required, but using a preservative is recommended for the beginner, at least in the making of a high-protein, early-cut hay into silage. A preservative may be molasses, at least 40 pounds per ton of green cut crop, or it may be starchy grains, such as 200 pounds of corn and cob meal.

How Much Silage Per Acre?

In reasonably stalky corn, figure 1 ton silage for each 5 bushels of shelled corn it would yield if ripe. Thus, 50 bushels corn, 10 tons silage; 40 bushels corn, 8 tons silage. In northern Michigan, silage yields of 6 or 7 tons may accompany grain yields of almost nothing—10 bushels or less, because there may be but little grain on the stalks.

Alfalfa or alfalfa-brome will produce approximately 3 tons of silage per ton of dry hay.

Haying Machinery

Baler: Convenient if hay is to be sold. Custom baling simplifies operations, leaving only the hauling and storing to the farmers. A custom crew provides extra men to help at haying time, and thus may help get the job done on time (if you can get the machine when you want it). Saves storage space. The high investment necessitates a large annual use, probably 100 tons of hay a year should be a minimum.

Field Chopper: Good on well organized large farms, where capital investment is not too critical a matter. For greater convenience in use,

a mow-drier is strongly advised. Convenient for chopping material such as straw or corn silage.

Hay Crusher (Bean Hay-maker): Cracks stems open and speeds drying. Often can save one day in curing. Probably investment not justified for a small operation, but useful in well-organized large haying operation.

The hay crusher makes possible more rapid drying of stems with the possibility that the hay can be put up before the leaves become overdry and drop off. By shortening the field curing time it is possible to save more nutrients and preserve color. The crusher is suitable for use with hay that is going to be put up as loose hay, chopped hay or baled hay.

The Best Length to Cut Chopped Hay

The best length to cut chopped hay is from 3 to 4 inches, with 4 inches preferred. This length of cut provides the best results from the standpoint of palatability, storage and keeping quality. Shorter cut lengths are not as desirable as the longer lengths.

HARVESTING METHODS AND COSTS

Grass Silage, Methods and Costs

The wilting method of harvesting grass silage is used by most Michigan farmers. With this method the forages are wilted to about 65-70 percent moisture before ensiling. Not all of the forage has to be at this moisture level, but the silo contents should average near this level.

TABLE 6—*Cost of harvesting a ton of grass silage on farms in South-Central Michigan, 1949*

Cost item	Hay loader and Silo filler	Field chopper	
		Owned	Custom hired
Number of farms	6	67	48
Tons of silage per farm	77	96	57
Mowing and raking	$0.63	$0.42	$0.40
Filling costs:			
Labor	1.63	.89	2.75
Power	.90	.76	
Chopping and filling equipment	.94	.99	
Hauling equipment	.64	.28	
	$4.74	$3.34	$3.15

Hay loaders and silo fillers have been used for grass silage but are not very popular. The average cost of harvesting a ton of grass silage with this equipment was $4.74 (Table 6). The charge for labor was the largest cost item, making up over one-fourth of the total harvesting cost. This points out the major reason why farmers do not like to handle grass silage with this type of equipment. It takes a lot of time and work to handle the grass forage. The hardest job is pitching the forage from the load into the silo filler.

The average cost per ton of harvesting grass silage with field chopping equipment was $3.34, or 30 percent below the cost of harvesting with hay loaders and silo fillers. The labor charge was only about one-half as great as where hay loaders and silo fillers were used.

No preservative is needed when forages are wilted to between 65-70 percent moisture before ensiling. Thus these cost figures do not include any charge for preservative. If a preservative had been included the cost would have been increased about $1.50 to $2 per ton of silage.

The investment in field chopping equipment varied with the type of equipment. One group of farmers had smaller equipment with an investment of $1500 in the field chopper and blower at the barn. The other group had larger equipment with an investment of about $2500 in the chopper and blower. Analysis of the cost records indicates that farmers should have about 75 hours or more of use each year (roughly about 50 to 60 tons of hay, 60 tons of silage and about 25 tons of straw or 15 to 20 dairy cows and accompanying young stock) before they can afford to own the small chopping equipment. A farmer should have not less than 125 hours of use (roughly about 150 tons of hay, 170 tons of silage and about 40-50 tons of straw) for the large field chopping equipment. The alternative for farmers with less than this amount of work is to hire the job done on a custom basis.

To obtain the full advantage of the capacity and labor saving possibilities of field chopping equipment the work must be carefully organized. A well organized crew can do an easier and faster job of harvesting silage with field choppers than wtih hay loaders and silo fillers. This fact enables the farmer to do a more timely harvesting job, and this frequently results in a better quality silage.

Comparative Costs, Corn and Grass Silage

The cost of harvesting a ton of corn silage is less than the cost of harvesting a ton of grass silage. This holds true for both stationary silo filling and field chopping equipment, (Table 7).

TABLE 7—*Cost of harvesting a ton of corn and grass silage by different methods, in South-Central Michigan in 1949*

Method	Corn silage			Grass silage		
	Number of farms	Cost per ton	Tons silage per farm	Number of farms	Cost per ton	Tons silage per farm
Silo filler and hay loader	0	.....	0	6	$4.74	77
Silo filler and corn binder	15	$3.47	72	0	.....	0
Field chopping equipment:						
Owned	13	1.74	118	67	3.34	96
Custom hired	27	2.15	58	48	3.15	57

Part of the difference in cost is due to the added work of mowing and raking the grass silage material. With a field chopper or a corn binder and bundle loader, the corn is cut directly from the standing row. Another reason for the lower cost with corn silage is the greater tonnage that can be handled in a given time. Farmers can handle from 1 to 2 tons more of corn than grass silage per hour with the same equipment.

Field chopping equipment reduces harvesting costs when acreages are large enough to warrant the use of such equipment. There was a reduction in the labor required where this equipment was used. In addition, the farmers with field choppers used the equipment for harvesting several crops (hay, straw, and silage). Using the equipment more days per year reduced the cost of the equipment for each ton.

On the farms in this study, the corn binders and silo fillers were high cost pieces of equipment. This was chiefly due to the fact that half of the farmers used their binders less than 20 hours per year and their silo fillers less than 40 hours. The cost of depreciation and interest, as well as operating expense, made a high cost per hour of use.

Comparative Costs, Harvesting Hay and Grass Silage

The cost of harvesting a ton of hay as hay is less than the cost of harvesting the same ton in the form of grass silage. The cost of harvesting a ton of hay by various methods ranged from $3.67 to $5.39, (Table 8). The cost of harvesting the same ton in the form of grass silage ranged from $9.76 to $14.69. Thus with similar types of equip-

TABLE 8—*Comparative cost of harvesting one ton of hay as hay or its equivalent as silage, South-Central Michigan, 1949*

Method	Cost of harvesting*	
	1 ton of hay	3.1 ton of silage
Hay loader and slings	$4.64	.....
Buck rake	3.67	.....
Field baler:		
One man baler	5.39	.....
3 man baler	5.01	.....
Hay loader and silo filler	4.87	$14.69
Field chopper:		
Owned	4.24	10.35
Custom hired	.....	9.76

*Includes all operations from hay standing in the field until it is stored.

ment the cost of making grass silage was two to three times as great as the cost of harvesting the crop as hay.

Experimental evidence has shown that harvesting forage as grass silage conserves from 15 to 20 percent more of the dry matter in the crop than does harvesting as field cured hay. In addition to conserving more dry matter, making grass silage reduces the risk of serious damage, or complete loss of the first cutting of hay due to inclement weather.

Feeding Nutrients Saved by the Different Methods of Harvest

Results of a 3-year study, 1945-47, from the U. S. Department of Agriculture Experiment Station at Beltsville, Maryland indicate that the dry matter content loss of alfalfa from the time of cutting to time of feeding is 3 percent when dehydrated, 15 percent as silage, 16 percent when barn cured and 28 percent when field cured. The loss in protein content of alfalfa when dehydrated is 16 percent, as grass silage 16 percent, in barn cured 23 percent and in field cured hay 36 percent from time of cutting to time of feeding.

Thus, according to these tests, 10 acres of the same field of grass and legumes put up either as silage or barn cured would have the same amount of dry matter at feeding time as would 11.8 acres put up as field cured hay. Likewise, the 10 acres put up as silage would have the same protein content as would 10.9 acres of barn cured hay or 13.1 acres put up in the usual manner of field curing.

LIVESTOCK, THE GRAZING AND FEEDING ANGLES

Grasses and Legumes for Dairy Cattle

The dairy cow is adapted by nature to use forage. Pasture is her natural feed. She is built to use bulky feeds like hay and silage, and should be fed all the forage and roughage she can consume.

"Lactation factors," (as yet unidentified) that promote milk secretion and are most prevalent in grass when it is young, are more apt to be found in legumes in early maturity. But, in dry growing seasons they may be present in legumes in late maturity.

Ensiling grasses and legumes or mow drying them, may preserve more of these factors because the crop can be gathered, despite the weather, in early maturity. The higher cost of machinery involved limits such harvesting methods to larger operators.

Grain and grain by-products and corn silage, always supplied with these lactation factors, offer a "balance wheel" to a ration where the roughage part may be low in the factors.

Grass Silage in the Ration—

"Grass" or "hay-crop" silage can be a valuable addition to the cow's ration. It can replace part of the hay. Best results are obtained when hay makes up one-fourth to one-third of the roughage fed, on a dry matter basis.

For Summer Feeding—Hay-crop silage is excellent to supplement pasture. The crop should be put in without wilting, so as to pack well in the relatively small volume ensiled. Any obnoxious acids will not develop in the short period before the silage is fed out.

For Winter Feeding—There is a danger that an evil smelling acid, butyric, will taint milk. Such acid develops when the crop is put in too high in moisture content. Preservatives such as corn and cob meal help prevent the development of butyric acid. Wilting the crop will also reduce the moisture content to a safe level. Until the dairy farmer learns how to put up hay-crop silage so as to prevent the formation of this acid he should not risk converting too much of his hay crop into silage.

What Grass or Legume Crop to Ensile—

Legumes, as a group and on a dry matter basis, may average 50 percent more protein than do the grasses. No comparison is available as to the feeding value of the various grasses and legumes. Such factors as time of cutting and method of ensiling may result in greater difference in feeding value than the kind of hay crop ensiled. In general, a crop such as alfalfa-brome is advised.

Feed Value of Hay-Crop Silage and Hay—

It is questionable if there is any difference in the feeding value if the same crop is cut at the same time and properly preserved. A hay crop cut early and made into silage will provide more protein in the ration than the same crop cut later and made into hay.

Feed Value of Hay-Crop Silage and Corn Silage—

If grain is fed according to rules such as those recommended by the Michigan State College dairy department, there should be no difference in milk production whether the silage fed is corn or grass.

Quality Is the Important Factor in Hay—

The higher the content of legume in the hay, the greater the value for milk production, is an old story. Recent experiments indicate the presence of a "lactation factor" in hay. This factor is generally more abundant in hay cut in early stages of maturity. A new finding, based on feeding trials at Michigan State College, is that the kind of season, the weather, has more to do with the presence of absence of the lactation factor than does the stage of maturity. Hay made during a season of less rainfall produced more milk when it was cut late than when it was cut early.

Mow Curing of hay will conserve more dry matter, thus making possible a saving of grain in the ration. The cost will often exceed the value of the grain replacement.

Loose Hay, Baled and Chopped Hay—Any difference in feed value depends on the success achieved in preserving the hay quality, not in the method used.

Carotene is lost in storage, after the first year, but nutrients for milk production are retained.

Amount of Roughage and Pasture to Provide—

If hay is fed as the only roughage, 3 tons per cow should be provided for the year. If hay is fed in combination with silage, each cow should have 1-1½ tons of hay and 5 tons of either grass or corn silage.

Providing Properly Planned Pasture—

Pasture to be good must be planned. A table on page 16 shows the kinds of pasture available, the seasonable use, and some indication is given as to the number of acres required. Pounds of seed and amount of fertilizer to use are discussed on pages 10 to 20.

The hardest point to decide is how many acres to provide in order that the pasture will neither be grazed into the ground, or allowed to grow too rank. With rainfall normal and fertility of the land good, the carrying power usually expected is: alfalfa-brome, one head per acre; sudan, 3; Balbo rye, 6; and reed canary, 1½.

Reed canary can be depended on as the sole pasture where the needed wet land is available for its growth.

Alfalfa-brome is used by more dairymen, and as the sole pasture, than is any other crop. A good system is to devote for pasture a field to carry one head per acre, supplementing if needed by "second cutting" hayfields for July and August.

Poor Versus Good Pasture—

A good dairy pasture has been described as a place where a cow can eat her fill in a few hours and then lie down in the shade and chew her cud. It takes good land and good pasture to provide such a condition. A 1200-pound dairy cow producing 40 pounds of 3.5 butterfat milk on good pasture and eating 8 pounds of grain per day would require 100-120 pounds of green pasture grass per day to meet her nutrient requirements.

On pasture which is both short and thin on the ground it becomes increasingly difficult for the dairy cow to get enough to eat to meet her daily requirements. She must spend most of her time traveling about in search of feed. Where pasture is very poor it may take most of the feed she obtains to maintain her body and provide energy to continue her search for food. Little is left for milk production.

From an economic approach, more grain is usually fed in an attempt to keep up production on poor pasture. Costs of building and equipment use, investment in the herd and other operating expenses

continue on poor pasture even though production drops. After all other charges have been met, the dairyman receives little or no return under poor pasture conditions for the labor he expends on the dairy enterprise. It is difficult to determine just how poor a pasture may be before it becomes unprofitable or just how far a dairyman can go in providing good pasture. Indications are that too many dairymen are using fields for pasture which are little better than a dry lot during a third to one-half of the pasture season, and few farmers have an adequate all-season pasture program.

What Is Good Pasture Worth for a Dairy Herd?

The importance of pasture in the dairy ration has long been recognized by good dairymen. The milking qualities of good pasture and its economy in the dairy ration are quite generally accepted as two of its greatest virtues.

Many methods have been used to determine the value of pasture. Most of them have some merit but many of them are inadequate. One approach to this problem is to assume that pasture replaces most of the barn feed which would have to be fed if dairy cows were confined to the barn and dry lot. Recent work (Journal of Dairy Science, October, 1949) by the dairy department at the University of Illinois indicates that for each acre of legume-grass pasture there was a savings of 3,739 pounds of silage, 2,017 pounds of hay, 175 pounds of beet pulp and 510 pounds of grain mixture. Valued at spring 1950 prices, this feed saving would amount of $47.93 for each acre of pasture.

TABLE 9—*Average cost and net return per acre from different classes of pasture (using dairy cows) on 50 Ionia County fields, 1949*

Type of pasture	Gross return per acre grazed	Feed cost other than pasture	Herd cost per acre grazed	Annual pasture cost per acre grazed	Net return (residual)
Rotation	$82.02	$10.16	$29.16	$15.15	$27.55
Native—upland	43.49	8.46	20.31	2.00	12.72
Lowland and reed canary	102.01	14.07	44.46	8.12	35.36
Combination	81.11	10.27	28.91	9.93	32.00

Pasture, feed and production records with dairy cows on 28 Ionia County Michigan farms during the 1949 grazing season provided the information presented in Table 9. The residual net returns left after all costs, except for management, had been deducted from the gross returns from the sale of milk averaged $27.55 for alfalfa-brome pas-

ture; $12.72 for native upland pasture; $35.36 for lowland and reed canary; and $32 per acre for combinations of the different pastures. Under good conditions the residual net returns from alfalfa-brome pasture were from $50 to $60 per acre. Some pastures particularly native-upland and thin or run out rotation pastures failed to have a residual net return.

The cost items deducted from the gross returns in Table 9 were (1) cost of feed other than for pasture; (2) herd costs such as labor, interest on investment in the herd, cow depreciation, building and equipment use, bull costs, veterinary medicine, electricity and other cash costs including D. H. I. A. fees, and bedding and (3) the annual pasture costs such as the cost of establishing the pasture distributed over the life of the pasture plus annual charges for maintenance, taxes, interest on land, and for overhead.

Returns from Sudan Grass for Midsummer Pasture—

Results on three Ionia County dairy farms, where records of costs and returns were kept on sudan grass pastures during the 1949 pasture season, indicate that dairy farmers can afford to use sudan grass in areas where it is adapted to supplement regular pastures during the generally hot and dry midsummer period. Records were kept on a total of 37.1 acres of sudan grass which furnished pasture for 73 head of Guernsey and Jersey cows for an average of 47 days per farm during July and August. On two of the farms, however, the herd continued to graze the sudan grass during the entire month of September, but in conjunction with other types of pasture.

During the July-August period, milk production averaged 2,222 pounds of 4 percent fat-corrected milk per acre grazed. With 4 percent milk valued at $4 per cwt., total returns were $88.88 per acre. Feed purchases amounted to $8.28. Annual pasture costs including cost of establishing, maintenance, taxes and interest on land values were $17.99 per acre. Other deductions were made to take care of costs connected with the dairy herd. These include such items as use of buildings and equipment, labor, depreciation on cows, interest on herd investment, bull costs, and veterinary medicine. These herd costs totaled $37.95 per acre grazed. Net returns amounted to $24.66 per acre of sudan grass grazed on these three farms.

Such a return compares very favorably with that which might be expected from other crops, even though 1949 was not an exceptionally favorable year for sudan grass.

Hay and Pasture for Beef Cattle

Hay, as the Only Feed for Wintering Beef Cattle, will not produce large gains. Yet good hay contains the vital nutrients for health and maintenance. Thin cattle may gain up to 25 pounds per month, while fleshy cattle are likely to lose fat and may even lose weight. Experimental steer calves required 1,850 pounds of hay for 100 pounds gain, while as yearling steers the next winter, they required 4,400 pounds of hay for 100 pounds gain. Dry beef cows winter well on hay. In fact, some straw, stalkfields and other roughage may be substituted.

Silage Made from a Grass-legume Mixture has been fed much the same as similar crop hay to both wintering cows and steers. The silage-fed steers gained more rapidly than the hay-fed steers only when fed heavily on corn near the close of the feeding period.

Pasture Gains are determined to a large extent by the fatness of the cattle. Big, thin 2-year old steers have gained 2.2 pounds daily after wintering on hay alone at the high feed cost described in the first paragraph of this section. Fat yearling steers have sometimes not gained anything for 3 months when turned to pasture. Between these extremes we find gains ranging from 1 to 2 pounds daily, or 30 to 60 pounds per month.

Weanling Calves that are wintered so as to lose some fat, but grow and gain 30 pounds a month or less, may be expected to gain around 50 pounds monthly on good pasture. Similar calves gaining 50 pounds monthly in winter and fattening some in the process, may be expected to gain 40 pounds or less on pasture. Yet the heavier and fatter cattle, as they go to grass, tend to stay ahead of the others in finish and weight and may be fattened sooner with less corn.

Fertilized Pastures, Varieties and Feeding Values. Not enough evidence is available to evaluate accurately the nutritional value of fertilized pastures, nor that of different varieties of grasses and legumes for beef cattle. Generally speaking, effects of fertilizer on yield and tonnage of pasture and hay may be more pronounced than is the effect of fertilized forage on growth rate and fattening of livestock. Short pastures and dry, woody pastures do not afford a good supply of nutritious feed.

Legumes tend to produce more quantity of pasture than do grass crops, as well as pasture richer in protein and other nutritive factors. Alfalfa especially produces more good green forage throughout the

season than do other crops. Including at least some legumes in the pasture mixture shows definite beneficial effects, especially after the first stimulating effects of fresh, green, spring grass. Observations and some data indicate that the best use of the usual limited acreages of legumes available in the summer and fall may be to supplement existing grass pastures, rather than by changing pasture completely for a short time.

Feeding Grain on Pasture is a method of preparing for an early market, or of finishing cattle that are already well started. Cattle that will be ready for slaughter with less than 60 days' grain feeding usually should not be turned to pasture. Thin steers grazing on good pasture for the summer will gain in flesh and will require less grain to reach a given finish than will be necessary if fed grain all summer.

Little Gain, or even loss in weight and flesh occurs *after hard frosts* and freezing in the fall of the year. Many Michigan cattle would bring more money if sold in September rather than in November.

Pastures and Hay for Swine

Hogs are concentrate-consuming animals and are unable to consume large amounts of roughage. However, good pasture is one of the most important phases of successful swine management. An acre of good pasture will supply forage for four sows and litters through weaning time, or for approximately 20 growing-fattening hogs. Green pasture will furnish nutrients at low cost, insure against vitamin deficiency, is a source of certain minerals and is rich in good quality protein.

Pasture is recommended for hogs for the following reasons: 1) Pork can be produced with 10 to 15 percent less grain and up to 50 percent less protein rich feeds, 2) Faster gains are made on pasture, 3) It saves labor and maintains soil fertility, 4) Sanitation is more easily practiced than in dry-lot feeding, 5) There are fewer runts in pasture-fed pigs and 6) Pastures help eliminate worm infestation and swine diseases.

Good pasture crops for hogs are rye and bluegrass for spring and fall, alfalfa-brome for summer. Rape at 3 to 6 pounds and oats at 1 bushel per acre sown early in the spring provide good pasture for midsummer and fall. Sudan grass pasture is also good for midsummer.

Hay and Grass-legume Silage for Hogs: Winter and dry lot rations for pregnant sows should contain 10 to 15 percent good quality legume

hay. When self-fed, the hay should be ground and could be increased to about 33 percent of the ration. Dry lot rations for growing-fattening pigs should contain about 5 percent of good sun-cured hay. Although there is very little recorded experience of the feeding of grass-legume silage to hogs it is believed that it could well replace part of the hay.

Hay, Grass Silage and Pasture for Sheep

Sheep are one class of livestock that can make profitable gains on pasture alone. When pasture is not available in July and August or during the winter, either dry hay or hay ensilage properly supplemented with grain makes a good ration for sheep or lambs.

Grass silage is good insurance of saving a maximum supply of roughage for feeding the sheep. Fattening lambs will make fair gains with grass-legume silage and corn. Better gains are obtained if dry hay is used along with the silage and corn ration. The addition of one-fourth pound per day of protein will produce gains equal to any other good ration.

No class of livestock can so successfully be carried over the winter months on roughages only, as can sheep. Early cut grass or legume hay will provide all the feed necessary for wintering the breeding ewe flocks. Lambs can be grown and fattened to marketable weights on their dam's milk and green succulent pasture, if parasites are controlled.

Pasture Recommendations for Poultry

Pastures can be used advantageously for the growing of pullets during the months of June, July and August in Michigan. As much as 20 percent of the mash and grain feed can be saved where pasturage is properly used.

A good pasture for poultry, under Michigan conditions, is a mixture of alfalfa and bromegrass. Ordinarily, chickens are poor grazers but they can be forced to consume more pasture by restricting their mash and grain. This can be done by using a type of feeder that can be closed during the morning and opened in the afternoon. The feeding of a low protein mash with grain will also force chickens on range to consume more pasture.

It should be remembered that poultry have no capacity for digesting fiber, and therefore a range which contains mature plant growth, which is mostly fibrous material, will have little food value. Mowing at frequent intervals during the summer will stimulate the growth of new

and highly nutritious plant tissue for the chickens to graze upon. For best grazing the chickens should be held off the mowed areas until 2 weeks after mowing.

The carrying capacity of a good pasture is about 450-500 pullets per acre where the birds are not on restricted feed. Where feed is restricted it will be reduced to about 250 birds or less per acre because of heavier grazing.

Saving of concentrate feed is not so evident with laying hens on pasture as it is with growing pullets, because any attempt to conserve on mash and grain feed in this case is usually met with lowered egg production. Eggs from hens on pasture contain darker colored yolks which many markets dislike. This, coupled with the probability of a higher percentage of dirty eggs ocurring in the flock, especially during rainy weather, usually discourages the ranging of laying hens on pasture.