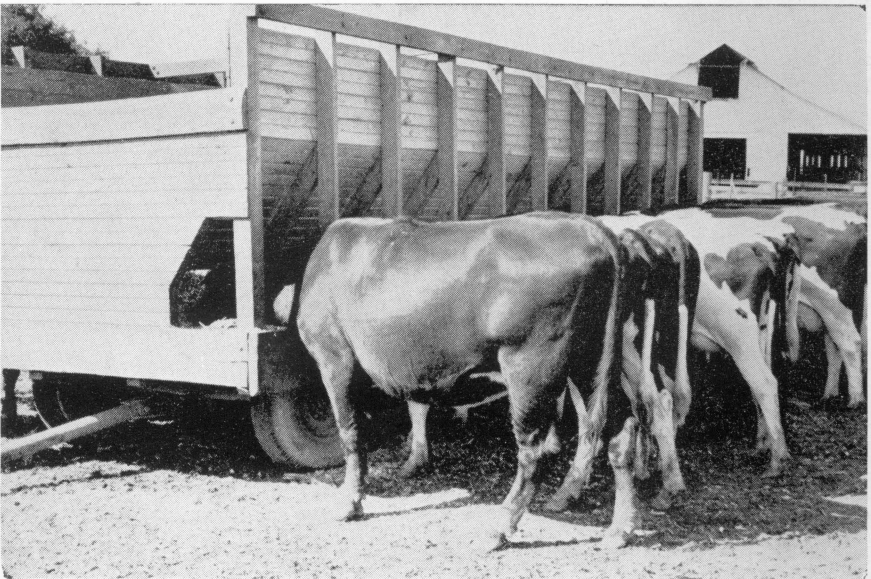


LABOR, EQUIPMENT and COSTS of USING ROTATIONAL GRAZING and GREEN CHOP PASTURE SYSTEMS in OHIO

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INTRODUCTION

Permanent bluegrass, long a major source of pasture, requires large acreages to adequately support a dairy herd. Pasture needs are about constant for each month of the season. However, bluegrass yields its maximum growth during the early part of a season. Most farm operators, in the past, attempted to stock at a level below the peak carrying capacity. Part of the ample early growth was wasted, and in the latter part of the season, animals were usually underfed.

In recent years, dairy farmers have experimented with different grazing systems in an attempt to more fully utilize the growth available and to minimize the drop in milk production later in the season. Higher land values, inability of many to increase land area, and the need for greater volumes of business have stimulated interest in more efficient pasture utilization. In these more intensive systems, more labor, capital, and managerial effort are being combined with each acre of forage to carry more livestock and carry them better for the entire pasture season. However, for these systems to succeed, production costs must be kept low, or increased yields and carrying capacities will add little to net returns.

The need to make each acre produce more caused farmers to improve pastures with lime, fertilizer and reseeding. Improving permanent pasture enables farmers to carry more livestock but does not bring forage growth and livestock needs into balance. Yields during the late summer and early fall months are still lower than those during the early part of the pasture season.

Some bluegrass pastures have been shifted to rotation cropland. Part of these rotation meadows are then used to supplement bluegrass pastures during the late summer and early fall. The system of using bluegrass early and making hay or silage from first crop rotation meadow, then pasturing the second and third crops, has become widespread. However, cows tramp and contaminate an acreage of either bluegrass or rotation meadow pasture which is to sustain them for

several weeks or for the entire season. Part of the growth usually becomes overripe and a significant portion is wasted. These newer systems of pasture utilization are designed to reduce or eliminate this waste.

SYSTEMS OF PASTURING

Five distinct grazing systems are in use on Ohio farms. These are: (1) conventional grazing, (2) rotational grazing, (3) rationed grazing, (4) green chopping, and (5) summer feeding.

Conventional grazing is the system of pasturing typically used by Ohio farmers today. Either permanent bluegrass pastures or rotation meadows (or both) are used in this system. The animals are permitted to graze over an area that will carry them six weeks to several months. The extent to which this first pasture area is supplemented varies from farm to farm. Usually the livestock are moved to a field of second growth meadows or new seedings, then back to the first field. A disadvantage is that animals grazing unrestricted over large areas, contaminate and trample large quantities of the forage growth reducing the total potential carrying capacity.

In a **rotational grazing** system, a meadow is divided in three to six small fields or paddocks which are grazed in sequence. As one paddock is grazed down in 5 to 10 days, livestock are moved to the next. During the pasture season, the same area may be grazed three or four times. Clipping after the cattle are moved to the next lot results in a more palatable and uniform growth during the following period. Paddocks not needed because of heavy growth early in the season are generally harvested for hay or silage for later feeding.

Rationed grazing is more intensive than rotational grazing but less than green chopping. Temporary fences are used to confine livestock to an area sufficient to meet the pasture requirement for one day. The animals are forced to consume the plant growth on this area. They are then moved to a fresh area the next day. When meadows recover the sequence can be repeated.

In a **green chopping** system, the forage is harvested mechanically once or twice daily and hauled to the cattle. A field forage harvester is used to chop forage which is fed from self-feeding wagons or in conventional feed bunks in a small lot or yard. More complete utilization of the forage growth is possible than with rotational or conventional grazing. Trampling and contamination are entirely eliminated. Excess forage growth, early in the season, is usually harvested as hay or silage to be used later.

Summer feeding is practiced by some farmers. All of the forage is harvested as silage or hay to be fed during the year. Cattle are not grazed. They consume only hay and silage in a dry lot or small exercise area. With this plan, more of the total forage growth can be harvested at the desired state of maturity. With the other systems, a large portion of the forage is either immature or overmature when fed.

ABOUT THE STUDY

Objectives of this study were to obtain information on (1) carrying capacity, (2) costs of labor and equipment used and (3) managerial problems involved in using intensive grazing systems.

This study was confined to two intensive pasture systems, rotational grazing and green chopping. Costs, as presented here, are based on a selected sample of farmers using these systems. Difficulty was experienced in obtaining reliable information on conventional grazing. An attempt was made to locate dairymen who were doing conventional grazing, but in practically every case, these farmers greatly modified their pasture programs toward a more intensive grazing system during the season. Thus, the records were unreliable. Farmers intending to practice conventional grazing used other pastures and provided other feeds, such as sudan, green corn and silage before the season was over.

Information was collected from 59 farmers during 1956 and 1957. The farm records used were clearly defined as to the system followed.

Farms were selected from a list of dairymen known to be using intensive grazing systems. The list was obtained from dairy extension specialists, county agents, soil conservation planners and farmers. Farms were located in 14 important dairy counties. Thirty-three of these dairy operators, 14 in 1956 and 19 in 1957, used rotational grazing and 26 operators, 7 in 1956 and 19 in 1957, used a green chopping system. Five of the farms practicing rotational grazing were used both years. None of the farms using green chopping in 1956 were included in 1957.

TABLE 1.—Characteristics of 59 Dairy Farms, by System of Grazing Used, Ohio, 1956 and 1957

Item	Rotational grazing	Green chopping
Number of farms	33	26
Acres per farm	185	224
Acres of rotation meadow	55	81
Cows per herd	30	46
Average years of experience with system	4	2

RESULTS

Rotational Grazing

Rotational grazing, the system of dividing a rotated meadow area into small fields or paddocks grazed in sequence, was studied on 33 dairy farms. On most, each paddock was grazed during four periods.¹ In addition, all of the farmers fed some hay and one in four fed silage.

Two-thirds acre per cow was grazed during the first period (May 10 to June 19). During the second and third periods, about four-fifths of an acre was grazed per cow. More supplementary feed, hay and silage were fed during the third period. Farmers intending to plow up the meadows the following year usually grazed during September and early October or what has been referred to as the fourth growth period. However, only a part of the forage needs could be obtained from the pasture this late in the season.

¹The grazing period does not necessarily coincide with conventional hay harvest dates.

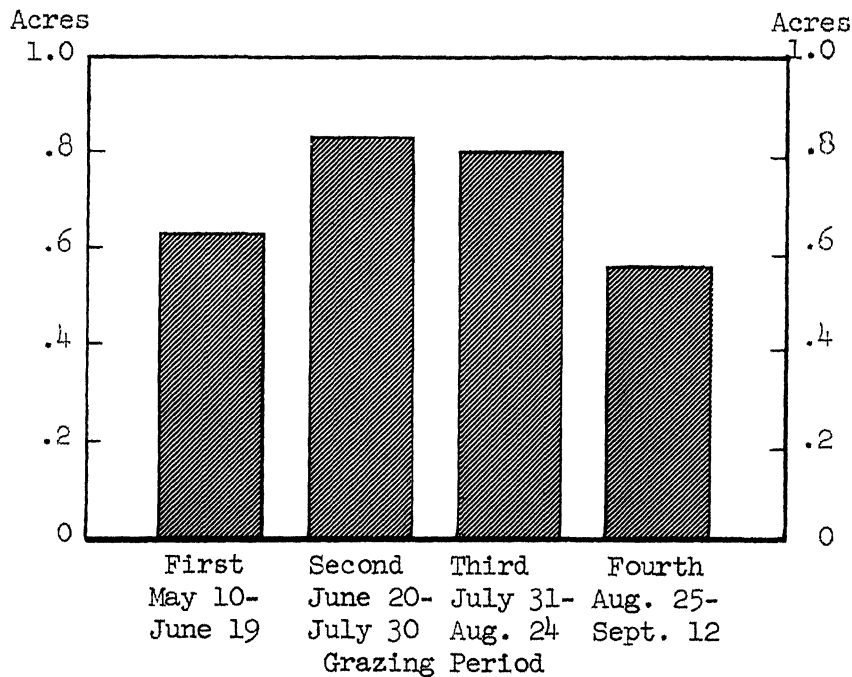


Chart 1.—Acreage Grazed per Cow, by Grazing Periods, 33 Ohio Dairy Farms, 1956 and 1957.

Some hay was fed throughout the pasture season. Part was fed for bloat prevention and part to supplement the pasture during the dry season. Most of the hay was fed in August and September. An average of eight tons of hay was fed per farm or 0.25 ton per cow. If first crop meadows had been used to provide this hay, 0.12 of an acre per cow would have been needed.

TABLE 2.—Acres Grazed per Cow, by Grazing Periods, Rotational Grazing, 33 Farms, Ohio, 1956 and 1957

Period	Acres per cow	Average date start	Number of days	Range in days
First	.65	May 10	42	19-53
Second	.85	June 20	40	22-60
Third	.83	July 31	37	20-65
Fourth	.56	August 25	18	9-49
Supplemental*	.59	-----	--	-----

*Supplemental forage consisted of silage, sudan grass, green corn, etc.

Twelve of the 33 farmers fed silage as a supplementary measure during August and September. Four times as much silage was fed during 1957 as in 1956 because of a drier season. Between 30 and 35 tons of silage were fed on each of these farms. Regardless of the form in which forage was fed, a similar acreage was used to produce supplementary forage. Supplementary sudan grass was pastured on a number of the farms. Only one-fifth of the farms grazed pastures during October.

Carrying Capacity—The use of three paddocks for a rotational grazing system was most common on the farms included, but the number ranged from two to five. The number of paddocks decreased, but size increased as the season progressed. During 1957, 9 of the 19 farms used a 3-paddock system averaging 0.75 an acre per cow for the season. Herds averaging 35 cows were provided with 7.2 acres per paddock for the first growth period, 9.0 acres for the second and 9.3 acres for the third. This increase in average size of paddock was the result of combining two or more lots after the first growth period. The 14 farms studied during 1956 had smaller herds averaging 28 cows and used smaller paddocks ranging from 5.6 to 7.0 acres. However, about the same acreage was provided per cow both years.

Added Investment Costs—The basic added investment necessary for making a rotational grazing system function is for fence. On most farms, temporary fences were used to divide the pasture areas into the size paddocks desired. Information on the cost of the added facilities needed was obtained from 14 farmers. The regular line and field fences in existence before rotational grazing was initiated were not included. These were needed when other systems of grazing were used.

Eight of the 14 farmers used electric fences. Three farmers added a semi-permanent fence. One of these was actually constructed with wood posts and woven wire, but they were erected and removed every other year. Others used two strands of barbed wire as temporary fences.

TABLE 3.—Added Fence Investment per Farm for a Rotational System, 11 Ohio Farms, 1956 and 1957*

	Number per farm	Value
Post		
Wood	14	\$ 8.81
Steel	47	56.72
Fence charger	.6	12.73
Wire		
Barb	205 rods	16.62
Copper	30 rods	1.91
Total	-----	96.79

*Three farms erected the equivalent of a permanent fence; these were not included in this analysis.

The average added fence investment was just under \$100 per farm. In addition, most farmers used a hay feeding rack worth about \$45.

Annual Costs—The feeding of supplementary hay and silage was one of the largest labor consuming jobs in a rotational grazing system. Farmers feeding hay and silage used about four times as much labor (1.6 hours per cow) as farmers feeding only hay (.4 hour per cow). Shortage of pastures during the late summer months of 1957 resulted in farmers using about double the labor required for this purpose as they did in 1956.

Clipping of meadows was done for two reasons, weed control and pasture improvement. Clipping for pasture improvement (palatability and quality of following growth) after the cows were moved to a new lot was done on 5 of the 14 farms in 1956 and 9 of the 19 farms in 1957. The remaining farmers clipped for weed control. This was done only

once during the pasture season. More than twice the amount of labor per cow was used when clipping for pasture improvements was practiced, as for weed control. How much increase was realized from clipping for improvement was not ascertainable.

No labor was required for moving cattle where pastures were adjacent to the barn. Farmers with pasture areas some distance from the barn used about 1.25 hours per cow to move cattle during the season. In some instances, lanes were arranged to permit the cows to come to the barn by themselves. The mean distance of the rotation pasture from the barn was 32 rods. On some farms, cattle were moved a mean distance of 175 rods.

Additional labor was used on a third of the farms for erecting and removing the temporary fences each year. On the rest, the same fences were used two years and occasionally longer. Most of the additional labor required for green chopping is periodic rather than daily. This permits more flexibility in labor use.

TABLE 4.—Labor Used and Costs for Using a Rotational Grazing System, by Selected Operations, Ohio, 1956 and 1957

Operation	Number of farms	Hours of labor per cow	Cost per cow
Labor for supplementary feeding			
Hay	18	.4	\$.37
Hay and silage	12	1.6	1.57
Clipping			
Weed control	19	.3	.64†
Improvement	14	.8	1.57†
Moving cows to and from barn			
Lots adjacent to barn	15	0.0	0.0
Lots distant from barn*	18	1.2	1.22
Fence (temporary)			
Build	26	.6	.68†
Remove	20	.2	.35†

*Average distance from barn was 32 rods.

†Includes charge for equipment.

NOTE: Man labor was valued at \$1.00 per hour. Tractor and mower for clipping was valued at \$1.10 per hour. Tractor or truck for erecting or removing temporary fence was charged at 57 cents per hour.

Most farmers used steel posts spaced at two rod intervals for temporary fence. Single strands of smooth or barb were used if the fence was electrified or two strands of barb when it was not. Very few wooden posts were used for the temporary fences.²

The lowest cost pasture program followed on the 33 farms included supplementary hay feeding, clipping for weed control, and using temporary fences for two years with the grazing area located near the barn. Feeding silage, clipping for pasture improvement and moving the cows long distances greatly increased the costs.

Herd size also had an effect on the additional cost of using a rotational grazing system. Smaller herds had higher costs per cow than large herds. The 33 herds included in this study averaged 30 cows and ranged from 19 to 55 cows.

Typical Rotational Grazing Programs—Added costs of using four typical rotational grazing programs found in operation follow:

	Added costs per cow (costs above conventional pasture)
Program I	
Supplementary hay was fed, pastures were clipped for weed control, temporary fences were used for two years, and the pastures were located adjacent to the barn.	\$2.37
Program II	
Supplementary hay and silage were fed, pastures were clipped for weed control, temporary fences were used in the same location for two years, and the pastures were located some distance from the barn.	\$3.07
Program III	
Supplementary hay was fed, pastures were clipped for improved growth and palatability, temporary fences were erected and taken down each year, and the pastures were located some distance from the barn.	\$4.97

²Steel posts valued at \$1.20 with 12-year life, barb wire at 8 cents per rod with 10-year life, copper wire at 6 cents per rod with 5-year life and a charger at \$20 with a 10-year life; battery cost for charger averaged \$6.00 each year. Annual use costs were determined by straight line depreciation and interest of 5 percent on the midvalue.

Program IV

Supplementary hay and silage were fed, pastures were clipped for improved growth and palatability, temporary fences were erected and taken down each year, and the pastures were located near the barn.

\$5.17

Availability and Use of Forage—There was an average of 55 acres of rotation meadow on the 33 farms practicing rotational grazing. On a cow basis, the hay, silage and pasture were produced on 1.85 acres for the year. During the three growth periods, 40 to 50 percent of the forage acreage was grazed. The remaining 50 to 60 percent of the forage could be harvested for hay, silage or used by other livestock.

Milk Production—The total pounds of milk produced by the 33 herds varied little each month during the pasture season. More cows freshened during the late summer and early fall period. Almost one-third of the cows in the herd freshened during August and September. Fewer cows per month freshened during the May-June period of ample

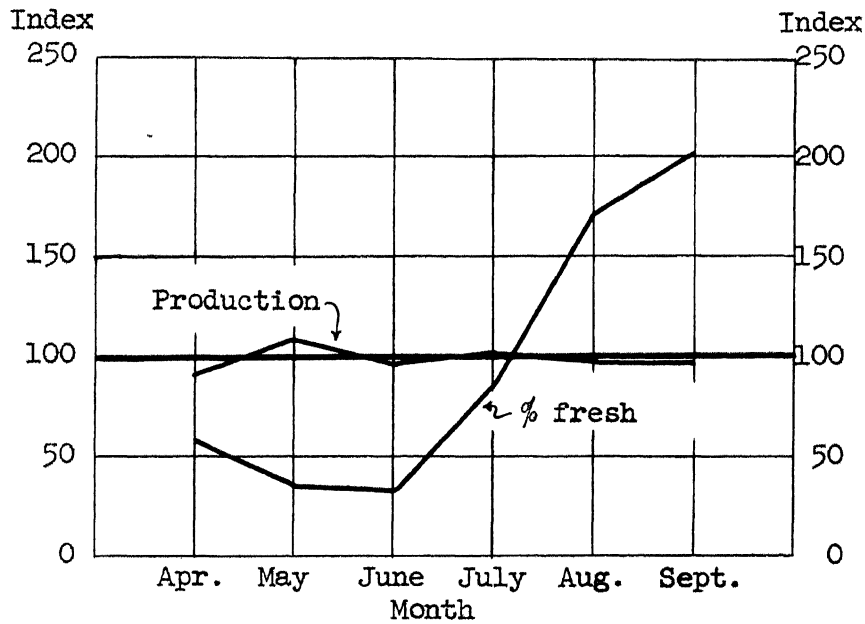


Chart 2.—Index of Production and Cows Fresh on 19 Farms Practicing Rotational Grazing, Ohio, 1957.*

*Percent of average.

forage growth. These farmers did an excellent job of maintaining a uniform production of milk each month. However, there is evidence that pasture and supplemental feed during the August and September period were inadequate. Otherwise, with the high proportion of fresh cows, total herd production should have been higher. Thus, the added impetus of more fresh cows was needed to maintain the same herd production throughout the season.

Green Chop

In a green chop system, the forage is harvested mechanically with a field forage harvester and hauled to the cattle. The cattle do not graze over the pasture area, instead they eat the chopped forage from self-feeding wagons or from bunks. A farmer must have a field chopper, convenient wagons and power that can be used once or twice each day for the chopping operation.

More of the total forage grown is consumed by the livestock, thus increasing the carrying capacity of the meadow area. Green chopping was studied on seven farms during 1956 and 19 farms during the 1957 season. The experience of the 1957 year is reported in these findings. With a green chop system, immature forages were fed early and over-mature forages were fed late during each growth cycle. On most farms, prior to chopping, early season pasture was provided by bluegrass for about three weeks or from May 5 to May 30. Starting dates for chopping ranged from May 5 to June 15 with the average May 24. The early grazing period permitted the meadows to reach a more mature stage and thereby prevented damage from cutting too early. However, forage growth is usually too mature for optimum digestibility of dry matter by the 24th of May in Ohio. Following the prechop grazing period, forages were harvested from three growth periods paralleling

TABLE 5.—Farms on Which Green Chopping was Practiced Classified by Selected Methods of Feeding, Ohio, 1957

Method	Farms
Chop three periods	5
Chop three periods and supplementary forage*	9
Chop four periods	4
Chop four periods and supplementary forage*	1
Total	19

*Some sudan, ryegrass, oats and corn were chopped in addition to meadows.

hay crops. One-fourth of the farmers chopped during a fourth growth period.

Rain and breakdowns gave some difficulty. A small pasture area was reserved as an insurance policy, or silage and hay were fed. Farmers reported no adverse effect from changing to pasture or preserved forage for a one- or two-day interval.

All of the farmers fed some hay during the grazing season for bloat control and as supplementary feed. In addition, supplementary forages such as sudan, ryegrass, oats and chopped corn were used on 10 of the 19 farms. Grass silage was fed on a few farms to supplement the green chop during the latter part of the season.

Carrying Capacity—Acreage of forages chopped increased as the season progressed. Supplementary forages, such as oats or sudan grass, were used mostly during the second and third chopping periods. Sudan grass was chopped in August and corn during September.

Chopping periods were extended to include more immature and more mature forage than generally cut for hay. Chopping each day developed different stages of forage maturity.

Bluegrass was chopped or pastured until the rotation meadows had enough growth to chop. Variation in forage available was responsible for a wide range in the chopping periods. Rotation meadows were chopped an average of 111 days and supplementary forages, 19 days.

TABLE 6.—Acres per Cow, by Chopping Period, Green Chopping, 19 Farms, Ohio, 1957

Period	Acres per cow	Average date start	Number of days	Range in days
Prechop	.33	May 5	20	6-35
First	.57	May 24	36	19-49
Second	.78*	June 30	44	25-68
Third	1.00*	August 20	31	16-48

*Includes 0.14 acre during the second period and 0.21 acre during the third period of sudan grass, ryegrass, oats and chopped corn. Small amounts of first crop hay and silage were fed throughout the season.

The termination of green chopping depended on meadow use during the next year. A meadow stand to be plowed next year could be cut in October; however, one to be kept was not cut after early September.

Thirteen of the 19 farmers fed an average of 280 pounds of hay per

cow during the season. Most of the farmers kept some dry hay available at all times. A few farmers fed hay when meadows were too wet for chopping.

An average of 2,300 pounds of grass-legume silage was fed per cow during August and September on the 19 farms. Silage was used to supplement inadequate late season meadows. The dry fall experienced in 1957 was partly responsible for this heavy feeding of silage.

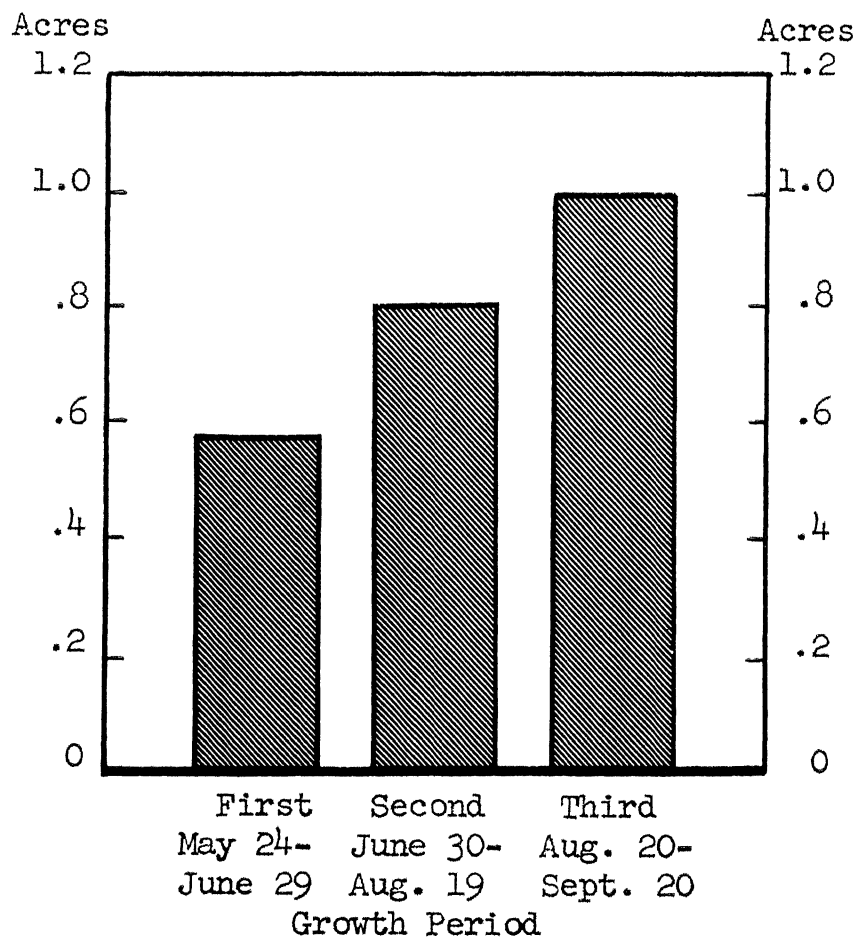


Chart 3.—Acreage Chopped per Cow, by Periods, 19 Ohio Farms, 1957

Added Investment—The chopper, wagon, feed bunks, tractor and labor are additional costs of a green chop system. Part of the equipment cost is shared with other activities. The chopper on many farms is also used to fill silos and chop hay. Farmers estimated the proportion

of the chopper use for green chop and for other uses. On these farms, approximately three-fourths of the chopper use was for green chopping. On 5 of 19 farms, a chopper was used only for green chopping. These farmers either owned two choppers or did not use a chopper for other purposes. No auxiliary engine choppers were in use.

Fence is one basic item of cost not required in a green chop system but is needed for systems where the livestock graze over the land. Actually, boundary line fences will still be needed but cross fences could be eliminated. This reduction in cost, although small, is an off-setting factor.

When prorated, the average added chopper investment for the green chopping system was \$1,070. This ranged from \$435 to \$2,150. Wagons equipped with self-feeding racks or sides to hold chopped forage cost \$325 and feed bunks about \$40 each. Any additional tractor investment because of the green chopping system should be charged against it. However, for this study, it was assumed that the farms had adequate power. Only an hourly charge was made for the tractor use. Even so, the added investment needed for the average green chop system was \$1,400 per farm.

Annual Costs—Direct cut power take-off choppers were used by most farmers. When a windrow chopper was used, twice the amount of labor was required since mowing and raking had to be completed prior to chopping. Flat wagons with self-feeding racks were used to transport the green chopped forage to the cows. One man handled the job. Choppers were left attached to the tractor most of the season by eight of the farmers.

Forage was chopped and hauled to the cows an average of 1.4 times each day for the season. Information on the daily chopping pattern was obtained from 19 farmers. Eight of these men chopped once per day, six chopped twice per day and the remaining five farmers chopped once per day part of the season and twice a day the remainder.

Labor required to chop, haul and feed the forage decreased with an increase in the size of herd. An average of 36 minutes was required for a 20-cow herd or 1.8 minutes per cow. About 90 minutes were required to feed 60 cows or 1.5 minutes per cow.

Chopping time per cow increased as the season progressed. This resulted from the larger areas that had to be cut to obtain similar amounts of feed. A faster rate of travel partially offset the larger area covered during the shorter second and third growth periods. Supplemental feeding labor was small when only hay was fed; however, the feeding of silage required considerable labor. Three operators fed hay

**TABLE 7.—Hours of Labor for Harvesting and Feeding Green Chop,
by Selected Operations, 19 Farms, Ohio, 1957
(Average of 45 cows per farm)**

Operation	Number of farms	Hours of labor per cow	Costs per cow
Chop and haul	19	3.2	\$12.84*
Self-feeding wagon	16	.0	1.21*
Hand feed in bunks	3	1.2	2.58*
Supplementary feeding			
Hay	11	.3	.25
Hay and silage	3	1.1	1.10
Clipping†	13	.2	.42*

*Includes charge for equipment.

†Clipped for weed control of feeding lots.

and silage and used four-fifths of an hour more per cow for the season than when hay was fed alone. The availability of more forage to chop would eliminate the need for supplementary silage feeding.

Typical Green Chop Programs—The basic program included chopping and hauling the forage to the cows. Power, labor, wagons and a chopper were required to perform this operation. In addition, a small lot where the self-feeding wagon or bunk could be placed for easy access by the cows was used.

Three typical green chop programs used by Ohio farmers follow:

	Added costs per cow (costs above conventional pasture)
Program I Chopped forage was self-fed from wagons. Dry hay was available in a feed rack to the cow during the summer season.	\$14.72
Program II Chopped forage was hand unloaded from wagons to bunks. Dry hay was available in a feed rack to the cows during the summer season.	\$16.09
Program III Chopped forage was hand fed from the wagons to bunks. Dry hay and silage were available in racks or bunks during the summer season.	\$16.94

Chopper, wagon and feed bunk costs can be divided into investment and operating costs. Depreciation was computed at 10 percent, interest at 5 percent of midvalue, insurance at \$4.00 per \$1,000 on 80 percent of midvalue, taxes at 20 mills on 40 percent of midvalue and repair at four percent of original cost. All labor was charged at one dollar per hour.

Costs per cow decreased as herd size increased. The cost of using a green chopping system averaged \$15.75 per cow with 20 cows in the herd. With a herd of 60 cows, there was an average cost per cow of \$12 for the season.

Farmers self-feeding green chop from wagons experienced the lowest costs. Supplementing the green chop with hay or feeding hay and silage and hand feeding chopped forage increased the cost about \$2 per cow for the season.

Availability and Use of Forage—Rotation meadows on the 19 farms doing green chopping averaged 81 acres per farm or 1.77 acres per cow in 1957. About 35 percent or 28 acres of the first and second growth meadows were green chopped or fed as hay or silage during the season. The remaining two-thirds of the meadow (53 acres) was available for winter feed or for other livestock. Approximately half of the third growth meadow was green chopped.

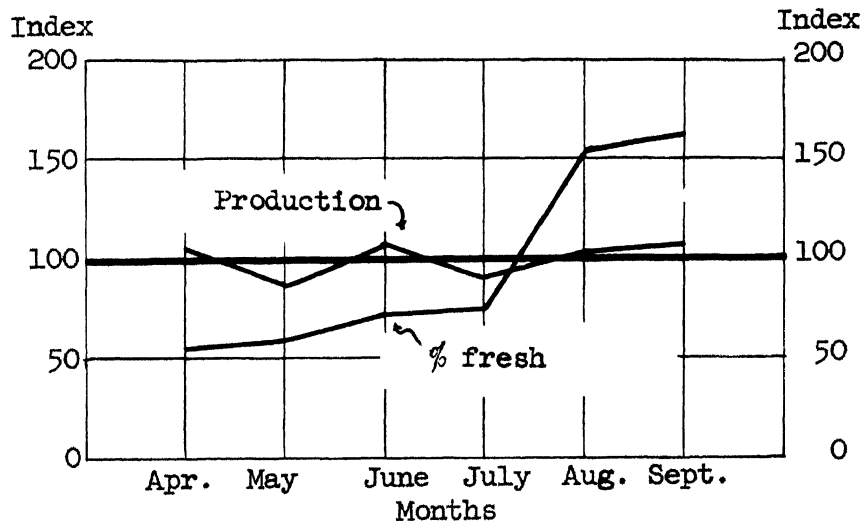


Chart 4.—Index of Production and Cows Fresh on 19 Farms Practicing Green Chopping, Ohio, 1957.*

*Percent of average.

Supplementary forages tended to reduce the amount of third growth meadows needed for green chop. A few men chopped a limited amount of their fourth growth meadow.

Milk Production—Production per herd remained fairly stable during the chopping season. A slight increase in milk was realized when the green chop was first fed to the cows. More cows were freshened during August and September than during the early part of the season. However, the total herd production increased only slightly. Insufficient or low quality forages during these fall months may have contributed to low milk output which was barely balanced by more fresh cows.

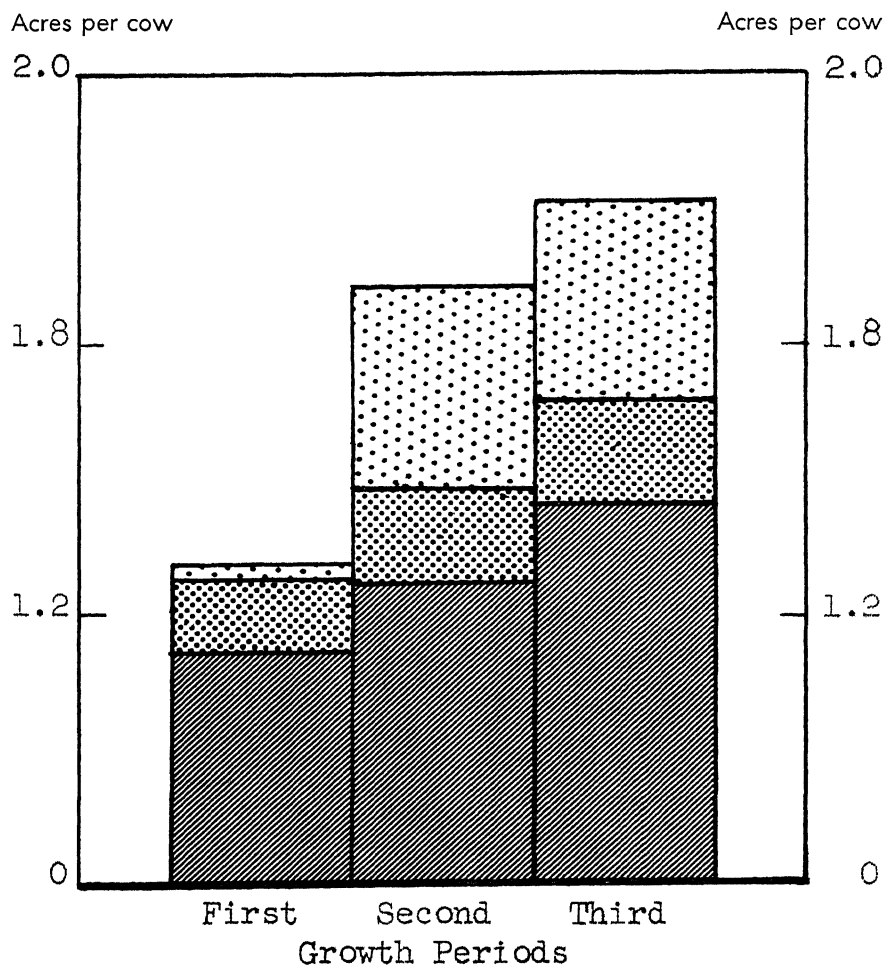
SUMMARY AND CONCLUSIONS

Livestock need approximately the same amount of nutrients each month during the pasture season. Variations in the growth patterns of forage plants and climatic conditions result in wide fluctuation in growth or production of nutrients. Consequently, the carrying capacity of most pastures is much greater during early summer than during the latter half of the season.

Rotational grazing and green chopping are two methods employed by farmers to achieve greater efficiency in utilizing forages during the growing season. Rotational grazing involves dividing a pasture area into a series of paddocks grazed in sequence. In a green chop system, the forage is harvested mechanically and hauled to the cows for feeding. More labor and capital are needed to use a green chopping system than a rotational grazing system. Offsetting this is the possibility of greater carrying capacities. Based on the acreage required per cow with each system and assuming similar yield, between a third and a fourth more area was needed to maintain the same size herd with rotational grazing than with green chopping. The added capital investment for rotational grazing was about \$150 per farm or \$5.10 per cow, whereas the additional capital investment for a green chop system averaged \$1400 per farm or over \$30 per cow.

Depending on the program followed, the annual added costs of typical rotational grazing systems ranged from \$2.37 to \$5.17 per cow. The added annual cost of typical green chop systems ranged from \$14.72 to \$16.94 per cow.

Farmers' experience indicated either system will work satisfactorily, but the added costs must be weighed against the possible returns. An increased annual cost of approximately \$12 per cow for a green chopping system over rotational grazing necessitates a sizeable increase



 Conventional grazing (estimated)
  Rotational grazing
  Green chop

Chart 5.—Acres per Cow of Summer Forage Used for Three Grazing Systems, by Growth Period, Ohio, 1957.

in milk production to be profitable. Two possible ways exist for an increase in production to take place. These are more milk per cow or

more cows. If the cows have been well fed with the previous pasture system, an intensive grazing system will increase income only if more cows are added to utilize the available forage growth.

Higher returns from other crops and land values make it necessary to use pasture lands more profitably. The first step is to improve the productivity of the pasture or meadows. On many farms, greater returns will be obtained from dollars spent for improving the quality and yield of meadows than from installing more intensive pasturing systems. The second step is the use of a rotation grazing system. With a limited investment of labor and money in facilities, about one-fourth more cows can be carried with rotational grazing than with conventional grazing. A third step might be either a move to rationed grazing as explained in the early section of this publication or to the use of a green chopping system. Green chopping is demanding of labor and capital but will permit more intensive use of forage growth.

On the farms in this study, milk production was maintained at a nearly constant level. However, more cows freshened during the late summer months. In general, farmers using a green chop system were able to maintain the production of milk with a smaller deviation from a monthly average of freshening than those using rotational grazing systems. From the study, it appears that more fall freshened cows were required to maintain constant production in herds using rotational grazing systems than when green chopping was used. This difference may have been because the cows were receiving a more adequate level of feeding with green chopping than with grazing during August and September. But, in both cases, some supplemental feeding was required on most farms in the latter part of the season.

On an acreage basis, farm operators using a rotational grazing system were able to increase the carrying capacity about 25 percent over a conventional grazing system. This 25 percent increase in carrying capacity was obtained at an average annual increased cost of \$4.20 per acre. This would require an increase of 100 pounds of milk per acre to offset the cost over conventional grazing.

Farmers using green chopping increased their forage carrying capacity about 40 percent over conventional grazing per acre. To do this increased the average annual cost \$17.50 per acre. To offset this added cost, milk production would need to be increased 350 to 400 pounds per acre.