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CIRCULAR NO. 151

FOUR SYSTEMS OF DAIRY FARMING AND THE PROFIT ON EACH

BY

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AND

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The systems produce 991, 1475, 2025, and 3150 pounds of milk per acre and return $2632, $3890, $5312 and $8263 respectively from the 160 acres of land.

The most intensive system shows 1616 times the profit of System No. 1.

SUMMARY OF CIRCULAR NO. 151

1. General plan for figuring the relative returns under four different systems of cropping on a 160-acre dairy farm, comprising acreage, crops and digestible nutrients produced per acre.

Page 3 to 9

2. System No. 1. A rotation of corn, oats, corn, oats, timothy, pasture, pasture, pasture, producing 245,182 pounds total digestible nutrients and supporting a herd equal to 38 cows producing 991 pounds of milk per acre at a profit of approximately $2.43.

Page 9 to 12

3. System No. 2. A rotation of corn, corn, corn, oats, clover, clover and timothy, pasture, pasture, producing 322,359 pounds total digestible nutrients and supporting a herd equal to 51 cows producing 1475 pounds of milk per acre at a profit of approximately $780.

Page 12 to 15

4. System No. 3. A rotation of corn, corn, corn, oats, clover, pasture, pasture, alfalfa, producing 379,126 pounds total digestible nutrients and supporting a herd equal to 65 cows producing 2025 pounds of milk per acre at a profit of approximately $1947.

Page 15 to 17

5. System No. 4. A rotation of corn and alfalfa, producing 617,730 pounds total digestible nutrients and supporting a herd equal to 100 cows producing 3150 pounds of milk per acre at a profit of approximately $3928.

Page 17 to 20

6. Conclusions. A concise comparison of the four systems and their returns, showing that the intensive methods of the fourth return 1616 times the profit of the first and that a dairy farm, even tho all the milk is sold, may be conducted so as to make not only a permanent agriculture, but an accumulative agriculture which at the same time is highly remunerative,

Page 20 to 24

FOUR SYSTEMS OF DAIRY FARMING

BY

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The amount of milk and butter fat produced per acre is, generally speaking, the final test of profitable dairying where all feed is raised on the farm. The final resultant depends not only on efficient cows but also on raising crops that contain a maximum amount of digestible nutrients, and especially protein, which is so essential for dairy cows. This circular explains and compares four different systems of cropping for dairy farms. The first will make 991 pounds; the second, 1475 pounds; the third, 2025 pounds; and the fourth, 3150 pounds of milk per acre. The poorest system of cropping returns $15.20 per acre in milk, and the best system returns $48.30 per acre. The first system will give an annual return of $2,632 from a 160-acre farm, and the last, $8,263, or more than three times the first.

But this is not all. The fertility of the farm is diminished by the first system, as there is an annual loss of 1900 pounds of nitrogen. The second system shows 110 pounds, the third, 2280 pounds, and the fourth, 5830 pounds increase of nitrogen in the soil. These differences are due entirely to the kind of crops raised and their adaptability to the feeding of dairy cows, for the cows are figured as of the same natural efficiency and the soil equally productive, in each of the four systems. It is certainly worth while to consider crop plans that make such differences in the returns and in the maintenance of the soil.

SEVERAL REASONS FOR POOR RESULTS

The investigations of the Department of Dairy Husbandry during the past dozen years show plainly that the dairy farmers are not getting the profits they should and could get for the investment of their time and money. There are several reasons for the poor results so frequently obtained. One is inefficient cows, and the Department has done much investigating to show the difference in efficiency of individual cows, and has published the striking results. Another reason is the great waste in raising crops that do not yield anything like the maximum amount of digestible nutrients per acre. This is especially true in regard to the protein contained in the crops commonly raised on the dairy farm and so essential in the ration for dairy cows. For

example, an acre of timothy hay does not contain more than one-tenth as much digestible protein as an acre of alfalfa hay. Notwithstanding this fact, timothy hay is still extensively grown on many dairy farms and fed to dairy cows.

Conditions Found in Dairy Sections

A few examples may help to bring out the conditions existing in the dairy sections of Illinois. Not long since the writer visited a large dairy farm in the Elgin district, where the tenant had been on the farm for 14 years without sowing clover or other legume seed during this time, thus showing the same defect as in System No. 1. Just across the road was a large dairy farm on which ten acres of clover were grown. In March this man still had the clover hay in his barn and was inquiring for a market where he might dispose of it, as he said he had so much corn stover he could not feed it out before time to turn the cows to pasture. He made a gross mistake in not feeding this legume hay, which would have taken the place of much of the high-priced bran which he had been buying in large quantities all winter in an attempt to balance the ration for his dairy herd.

Why This Circular is Written

Since there are many dairy farms in Illinois that approach these conditions, where the farmers attempt to go into dairying by simply putting cows on the farm without changing the crops raised, and continue indefinitely without attempting to adapt the crops raised to the best ration for a dairy herd, it has been thought wise to show a comparison of results—the relative efficiency—of different systems of cropping on dairy farms. This has been done by comparing the amounts of nutrients produced annually by the different crops in the various systems. From the results thus obtained has been determined the average amount of milk that can be produced by feeding the crops to good dairy cows under ordinary farm conditions. Four different systems of cropping have been compared, using, in each case, 160 acres of good land and producing all of the feed on the farm, as this is the only way to make the four systems comparable.

To indicate actual tested results as found by the Experiment Station in a full year's record, six dairy farms in the Elgin district of from 151 to 350 acres, carrying from 43 to 80 cows which were much alike in production, yielded the following respective amounts of milk per acre: 994 pounds, 1137 pounds,

1341 pounds, 1382 pounds, 1412 pounds and 2145 pounds. Only one of these farms compares favorably with the third best of the four systems described in this circular, and it produced only about two-thirds as much milk per acre as the corn and alfalfa system. It must also be considered that on these farms large amounts of commercial feeds were purchased.

The Four Systems of Cropping

Four acres of every quarter section as called for in the deed are used for public highways, and another four acres is allowed for buildings and yards, leaving 152 acres for actual cultivation. If this were in eight equal fields, each would contain 19 acres, hence the unusual numbers of acres in this division of the farm. There would of course be some change in the position of the crops each year. The crops raised and the rotation practiced under each system are as follows:

System No. 1.—Corn, oats, corn, oats, timothy, pasture, pasture, pasture.

System No. 2.—Corn, corn, corn, oats, clover, clover and timothy, pasture, pasture.

System No. 3.—Corn, corn, corn, oats, clover, alfalfa, pasture, pasture.

System No. 4.—Corn, corn, corn, corn, corn, alfalfa, alfalfa, alfalfa. The comparisons to be made here in detail show what one going into the dairy business may reasonably expect to accomplish from each of these systems, and they should be of even greater value to established dairymen by pointing out the great advantage of raising the proper crops and adopting a good system of rotation, especially one containing a large acreage of legumes, preferably alfalfa, and also a large acreage of corn for the silo.

Figuring the Same Yields in Four Systems

The entire farm in each case has been figured as tillable, and all the land of good quality and well-drained. However, the larger the proportion of untillable land in a farm, the more important it is that the tillable area be devoted to intensive systems of cropping. In order to have the systems of farming on the same basis, the crop yields are the same for all systems. No attempt is herein made to exhibit phenomenal or impossible results, as the yields have been fixed as nearly as possible at the average production per acre on the better class of farms in Illinois, as

follows:

TABLE 1.—YIELDS OF CROPS RAISED, BUSHELS, POUNDS AND DIGESTIBLE NUTRIENTS PER ACRE *

Crop	Yield per acre		Digestible nutrients						Total per crop
	Amount	Pounds	Prot.	Total	Carbo.	Total	Fat x 2.25	Total	
Oats (grain).....	50 bu.	1600	147		757		151		1055
Oat straw	1600 lb.	1600	19		618		29		666
				166		1375		180	1721
Corn (grain).....	55 bu.	3080	240		2054		297		2591
Corn stover	2 T.	4000	68		1296		63		1427
				308		3350		360	4018
Timothy hay.....	1½ T.	3000		84		1302		95	1481
Clover hay.....	2½ T.	5000		340		1790		191	2321
Alfalfa hay.....	4 T.	8000		880		3168		216	4264
Pasture §.....	.....	....		160		585		101	846

From the compositions as given above is derived the comparative production of food value of the four systems of cropping for dairy purposes, as tabulated in Table 2.

TABLE 2.—RELATIVE AMOUNTS OF AVAILABLE DIGESTIBLE NUTRIENTS PRODUCED ANNUALLY ON A 160-ACRE FARM BY EACH OF THE FOUR SYSTEMS

System	Protein	Carbohydrate	Fat × 2.25	Total nutrients
No. 1	26,804	192,460	25,918	245,182
No. 2	35,024	255,479	31,856	322,359
No. 3	48,850	296,204	34,072	379,126
No. 4	80,237	491,249	46,244	617,730

* Dairymen who have farms less productive, or who for any reason get smaller yields, must scale down the final results in proportion to the crops obtained, and those who can produce greater yields should raise the results proportionally.

§ The amount of digestible nutrients produced per acre by pasture grass was determined by averaging all of the available data upon this subject.

This shows in a striking manner the inefficiency of System No. 1, because of the comparatively large acreage devoted to crops yielding a small amount of nutrients per acre. In striking contrast to this is the great amount of nutrients produced by system No. 4, devoted to corn and alfalfa, the protein being three times, and the total nutrients 2½ times that produced by System No. 1. Systems No. 2 and No. 3 are intermediate between these and show how a dairyman may by a mere change of cropping gradually work his way from the first to the fourth system if a sudden change is thought too radical. System No. 4 requires more labor, but where this can be obtained and used to advantage this system will be increasingly profitable as land becomes higher priced.

The figures here shown do not tell the full story; for the poorer rotation will gradually run down the land so that it will produce smaller yields, while with the better rotations the land will tend to increase in producing power, growing larger crops than are here estimated and thereby increasing the pounds of milk and profit per acre year after year.

Poor Feed Lowers Production; Just Basis

As the main object is to show approximately the amount of milk which can be produced per acre under each of the different systems, it is essential that a definite basis of production per cow be used, and for this purpose in all cases there are taken good grade cows, weighing 1100 pounds, that will produce an average of 6000 pounds of 4-percent milk a year when well fed on a balanced ration such as can be produced by Systems No. 3 and No. 4. Under System No. 1 cows of this efficiency would produce only approximately 5000 pounds of milk in a year when fed on the unpalatable and unbalanced ration inevitably furnished by this system. This is not only because the cows would be in poorer physical condition, but because they would consume less of these feeds. Cows of this efficiency would produce approximately 5500 pounds of milk in a year when fed on a ration made of feeds raised under System No. 2. It must be borne in mind that in figuring the amount of milk produced per acre under Systems No. 1 and No. 2, the cows are in each case charged with only the amount of feed required to produce the respective amounts of milk, and that the cows are not all fed the same amount of nutrients regardless of their production.

In each system the cows are allowed to go dry 60 days,

which covers the time until the milk is good. To make allowance for the nutrients required to grow the fœtus, the ration as figured for the last four months of milk production is continued during the time dry.

All Feed Produced on the Farm; Other Conditions

To put the systems on the same basis, all the feed is produced on the farm, and nothing but milk, old cows, and surplus calves are sold. Good pure bred sires are kept and the herds are made self-sustaining by raising enough heifers from the best cows to keep up the milking stock. As cows will produce, on the average, for six years, this means that one-sixth as many heifers must be raised each year as there are cows in the herd. In the calculations that follow it is figured that the feed for one cow for one year will be sufficient to raise a heifer from birth to freshening at 2½ years of age.

One-sixth of the cows in the herd are to be sold each year and these would bring an average price of twenty-five dollars. The surplus calves to be sold at three dollars each, for veal, would number ninety percent of the cows in the herd minus heifers that must be raised to supply the herd with cows.

No allowance is made for transporting the product. At the present time milk or cream is frequently gathered by haulers, but where the product is transported by the producer, the distance varies greatly, and it is best for each one hauling his product to make this allowance to suit the individual case.

The farm is figured as rectangular, with the buildings centrally located. If the farm is ill-shaped, so that the work cannot be done so conveniently, more horses than here figured will be required.

Horses Required for Each System

Four 1300-pound horses will be required in System No. 1; five, in System No. 2; five, in System No. 3; and six, in System No. 4; and a certain amount of land will be needed in each case to support the horses. In the first three systems an allowance of one-fourth of an acre of pasture is made for each horse. The horses are all fed grain 10½ months and roughage 12 months in the year—15 pounds of grain and 13 pounds of hay per horse per day.

How Many Cows Can be Kept; Their Rations

To determine the number of cows that can be kept on the farm under each of the separate systems, the first step is to know

the amount and kind of rations needed and the length of time each should be fed. Under ordinary conditions cows give a greater yield of milk per year when freshening in the fall, and the management of the herds under all these systems of cropping is based upon cows freshening at this season of the year. The winter rations are therefore figured for the first portion of the lactation period. If some cows freshen in the spring, a portion of the grain here allowed for the winter ration of such cows will not be needed at that time and can be fed during the summer, as those freshening in the spring will be giving less milk during the winter.

SYSTEM NO. 1, 32 COWS, 991 POUNDS OF MILK PER ACRE

System No. 1 is an eight-year rotation of corn, oats, corn, oats, timothy, pasture, pasture, pasture, with 38 acres each of corn and oats, 19 acres of timothy and 57 acres of pasture.

Feeding each of the four horses 6⅔ pounds of oats and 8⅓ pounds of corn for 10½ months, and 13 pounds of hay per day for 12 months, it is found that they require 5.24 acres oats, 3.4 acres corn, 6.24 acres timothy and one acre pasture—15.88 acres in all. When this and the 8 acres in roads and yards are taken from the farm, 136.12 acres are left available for dairy stock —34.6 acres corn, 32.76 acres oats, 12.76 acres timothy and 56 acres pasture.

On a ration composed of the feeds available on this farm, the cows will produce approximately 5000 pounds of milk each per year. To do this, the cows would have to produce, on the average, 20 pounds of milk per day during the winter six months and 11 pounds of milk per day during the summer six months.

During the 182 days from May 10, when the cows are turned to pasture, to November 10, when given a full winter ration in the barn, they should receive digestible nutrients as follows:

REQUIRED NUTRIENTS FOR AN 1100-POUND COW PRODUCING 11 POUNDS OF MILK PER DAY

		Protein	Carbohydrate	Fat
Pounds nutrients	1 day	1.29	10.08	.29
Pounds nutrients	182 days	235.	1835.	53.

The pasture must be supplemented with green oats and corn from about July 1 to November 10, making 130 days feeding. Allowing 50 pounds of green oats per day for 30 days, requires 1500 pounds of oats, or .1 of an acre of oats per cow, and allowing 60 pounds of green corn or its equivalent per cow per day for 100 days, requires 6000 pounds of green corn, or .25 of an acre per cow. With this supplementary feed 56 acres of pasture will support approximately 38 head of cows and allow each animal 1.47 acres.

TABLE 3. AREA OF DIFFERENT CROPS AND DIGESTIBLE NUTRIENTS REQUIRED TO SUPPORT A COW THE SUMMER SIX MONTHS

Crop	Pounds	Digestible nutrients			Acres required	
		Protein	Carbo-hydrate	Fat	For one cow	For 38 cows
Pasture		235	860	66	1.47	56.
*Green oats	1500	15	106	7	.1	3.8
†Green corn	6000	54	678	42	.25	9.5
Corn (grain)	182	15	122	8	.06	2.28
Total	....	319	1766	123	1.88	71.58
Nutrients required for one cow producing 11 lbs. milk daily for 182 days		235	1835	53	....	...

It will be noted that the protein allowed in the feed exceeds that required, but where the cows are kept on mixed pasture during the summer the protein is in excess unless the cows are giving a large flow of milk.

In this system 1.47 acres of pasture are allowed per cow, and the 56 acres available will support 38 cows. Since it requires .1 of an acre of oats and .31 of an acre of corn per cow to supplement the pasture, to support 38 head of cows will require 3.8 acres of oats and 11.78 acres of corn, making a total of 71.58 acres of land to support the herd during the summer six months.

There are 32.76 acres of oats available for dairy stock, 3.8 acres of which are used for soiling and 28.96 acres for winter feeding. There are 34.6 acres of corn available for dairy stock, 11.78 acres of which are used for soiling and 22.82 acres for winter feeding.

TABLE 4. ACRES AND POUNDS OF EACH CROP AVAILABLE FOR DAIRY STOCK DURING THE WINTER SIX MONTHS

Crop	Acres		Pounds
Corn	22.82	Grain	70,285
		Stover	91,280
Oats	28.96	Grain	46,336
Timothy	12.76	Hay	38,280

During the winter six months, when the cows are on dry feed, they should produce, on the average, 20 pounds of milk per day. Most dairymen who practice this rotation feed all cows in milk practically the same ration, so that for 183 days on winter feed but one ration, which is given below, has been figured to cover the average production of 20 pounds of milk per day for that period.

RATION NO. 1

Feed	Pounds		Digestible nutrients			Nutritive ratio
	Fed	Eaten	Protein	Carbohydrate	Fat	
Corn stover	14	8	.14	2.59	.06	
Timothy hay		5.5	.15	2.38	.07	
Corn meal		9.5	.75	6.34	.41	
Oats		6.5	.60	3.07	.27	
Total	....	...	1.64	14.38	.81	1:9.8
Nutrients required for 1100-lb. cow producing 20 lbs. milk daily		....	1.70	12.02	.43	....

*Green oats are figured as yielding 15,000 pounds per acre. The digestible nutrients are figured as including all grain and one-half straw consumed, the analysis of the dry grain and straw being the basis.

†Green corn and corn silage are figured as yielding 12 tons per acre, and the digestible nutrients are figured from the average composition of silage given in Henry's Feeds and Feeding.

TABLE 5. POUNDS AND ACREAGE OF CROPS FOR 183 DAYS WINTER FEEDING

Crop	Pounds fed	Pounds per cow	Acres per cow	Acres for 58 cows	Acres available	Surplus or shortage
Corn stover	14	2562	.64	24.32	22.82	—1.50
Timothy	5.5	1006	.33	12.54	12.76	.22
Corn meal	9.5	1739	.57	21.66	22.82	1.16
Oats	6.5	1190	.75	28.50	28.96	.46
Total acres required for the winter six months		....	1.72	65.36	....	.. .

As before stated, it takes 1.88 acres to keep a cow during the summer six months and 1.72 acres during the winter six months—a total of 3.60 acres per cow per year. Thus 135.42 acres will support a herd of 38 cows.

TABLE 6. ACRES OF EACH CROP USED FOR DIFFERENT PURPOSES

	Corn	Oats	Timothy	Pasture
Horses	3.40	5.24	6.24	1.00
Cows—Green	9.5	3.8		
Cows—Stover	24.32		12.54	56.00
Cows—Grain	(23.94)	28.5		
Total	37.22	37.54	18.78	57.00
Available	38	38	19	57
Surplus stover	.88	.46	.22	
Surplus grain	1.16			

This sized herd would require one bull, and an average of 5.3 heifers must be raised each year to replenish the herd. There could then be supported 31.7 milk cows after deducting the feed consumed by the bull and heifers. This number, producing an average of 5000 pounds of milk per year, would make a total of 158,500 pounds, or an average of 991 pounds of milk per acre.

SYSTEM NO. 2, 43 COWS, 1475 POUNDS MILK PER ACRE

The rotation and crops raised in this system are corn, corn, corn, oats, clover, clover and timothy, pasture, pasture, with 57 acres of corn, 19 acres each of oats, clover, clover and timothy, and 38 acres of pasture. The feed per horse is exactly the same

as in System No. 1, except that only 1.17 acres of clover and timothy are needed; the five horses consume the crops from 17.90 acres, and there remains available for dairy stock 52.75 acres corn, 12.45 acres oats, 19 acres clover, 13.15 acres clover and timothy, and 36.75 acres pasture.

Cows that would produce 6000 pounds of milk on a ration composed of corn silage and legume hay with grain, would not produce over 5500 pounds on the feed available on this farm. During the summer six months, or 182 days, from May 10 to November 10, the cows would have to produce, on the average, 12 pounds of milk per day for 122 days, allowing 60 days to be dry.

During this time they should receive digestible nutrients as follows:

REQUIRED NUTRIENTS FOR AN 1100-POUND COW PRODUCING 12 POUNDS OF MILK PER DAY

		Protein	Carbohydrate	Fat
Pounds nutrients...	1 day	1.33	10.29	.30
Pounds nutrients	182 days	242.	1873.	55.

The pasture must be supplemented with green oats and corn from about July 1 to November 10—70 pounds of green oats per cow per day for 30 days, and 70 pounds of green corn or its equivalent per cow per day for 100 days. With this supplementary feed 36.75 acres of pasture will support approximately 51 head of cows and allow each animal .72 of an acre of pasture.

TABLE 7. AREA OF DIFFERENT CROPS AND DIGESTIBLE NUTRIENTS REQUIRED TO SUPPORT A COW THE SUMMER SIX MONTHS

Crop	Pounds	Digestible nutrients			Acres required	
		Protein	Carbohydrate	Fat	For one cow	For 51 cows
Pasture.....		115	421	32	.72	36.72
Green oats.....	2100	22	149	10	.14	7.14
Green corn.....	7000	96	946	51	.35	17.85
Corn meal	274	21	182	12	.09	4.59
Clover hay.....	364	25	130	6	.07	3.57
Total.....	....	279	1828	111	1.37	69.87
Nutrients required for one cow 182 days.....		242	1873	55	....	....

The protein and fat allowed in the feed exceed that required and the carbohydrate is slightly deficient.

A total of 69. 87 acres is required to support the herd during the summer six months. During the winter six months, when the cows are on dry feed, they should produce an average of 22 pounds of milk per day and the one ration given below must be fed for this 183 days.

RATION NO. 2

Feed	Pounds		Digestible nutrients			Nutritive ratio
	Fed	Eaten	Protein	Carbohydrate	Fat	
Corn stover	12	6	.10	1.94	.04	
Clover hay		8	.54	2.86	.14	
Clover and timothy hay		5	.27	2.18	.09	
Corn meal		9.5	.75	6.33	.41	
Oats		1.5	.09	.47	.04	
Total nutrients	....	....	1.75	13.78	.72	1:8.8
Nutrients required for 1100-lb. cow producing 22 pounds milk daily		....	1.79	12.45	.46	....

There is some waste in carbohydrate, but this cannot be prevented with the crops grown in this rotation, and it is in keeping with the practice on many of our dairy farms during the winter. The acreage in crops per cow for the winter six months will then be as follows:

TABLE 8. POUNDS AND ACREAGE OF CROPS FOR WINTER SIX MONTHS

Feed	Pounds fed	Pounds per cow	Acres per cow	Acres 51 cows	Acres available	Surplus or shortage
Corn stover	12	2196	.55	28.05	30.3	2.25(bedding)
Clover hay	8	1464	.3	15.3	15.43	.13
Clover and timothy hay	5.5	1006	.25	12.75	13.15	.40
Corn meal	9.5	1738	.56	28.76	30.3	1.54
Ground oats	1	183	.11	5.61	5.3	—.31
Total acres required for winter six months	....	....	1.23	62.73	....	....

As shown in the tables, it requires 1.37 acres to support a cow during the summer six months and 1.23 acres during the winter six months, or 2.6 acres to support a cow a year, and 134.1 acres will support a herd of 51 cows.

A herd of this size would require one bull, and an average of 7.1 heifers must be raised each year to replenish the herd. There could then be supported by this system 42.9 milch cows producing an average or 5500 pounds of milk per year, or a total of 235,950 pounds for the farm averaging 1475 pounds of milk per acre.

SYSTEM NO. 3, 54 COWS, 2025 POUNDS MILK PER ACRE

The rotation and crops raised in this system are corn, corn, corn, oats, clover, pasture, pasture, with alfalfa in the rotation once in eight years, giving 57 acres to corn, 19 acres each to oats, clover and alfalfa, and 38 acres to pasture, with an additional 19 acres, corn ground, sown to rye for pasture.

Feeding each of the five horses needed under this system 13 pounds of corn per day for 10½ months and 15 pounds of clover hay per day for 12 months, it is found that they require 6.65 acres of corn, 5.4 acres of clover and 1.25 acres of pasture—13.3 acres in all. When this and the 8 acres in roads and yards are taken from the farm, 138.7 acres are left available for dairy stock—50.35 acres corn, 19 acres oats, 13.6 acres clover, 19 acres alfalfa and 36.75 acres pasture. Cows fed on rations grown in this system should produce their maximum yield, or 6000 pounds of milk per year.

During the summer six months, or 182 days, from May 10 to November 10, the cows would have to produce, on the average, 13 pounds of milk per day for 122 days, allowing 60 days to be dry.

During this time they should receive digestible nutrients as follows:

REQUIRED NUTRIENTS FOR AN 1100-POUND COW PRODUCING 13 POUNDS OF MILK PER DAY

		Protein	Carbo-hydrate	Fat
Pounds nutrients.....	1 day	1.38	10.51	.32
Pounds nutrients.....	182 days	251.	1913.	58.

The pasture must be supplemented with green oats and corn silage from about July 1 to November 10: 70 pounds of green oats per cow per day for 30 days, 40 pounds of silage per cow per day for 125 days, three pounds of corn meal per cow per day for 182 days and six pounds of clover hay per day for 182 days. With

this supplementary feed 36.75 acres of pasture will support approximately 65 head of cows and allow each animal .57 of an acre of pasture.

TABLE. 9. AREA OF DIFFERENT CROPS AND DIGESTIBLE NUTRIENTS REQUIRED TO SUPPORT A COW THE SUMMER SIX MONTHS

Crop	Pounds	Digestible nutrients			Acres required	
		Protein	Carbohydrate	Fat	For one cow	For 65 cows
Pasture	...	91	333	26	.57	37.05
Green oats	2100	22	149	10	.14	9.10
Corn silage	5000	45	565	35	.21	13.65
Corn meal	548	43	370	24	.18	11.70
Clover hay	1092	74	393	19	.22	14.30
Total	....	275	1810	114	1.32	85.80
Nutrients required for one cow 182 days		251	1913	58	....	....

The protein and fat allowed in the feed exceed that required and the carbohydrate is deficient, but the total nutrients exceed the requirements.

During the winter six months the cows should produce an average of 24 pounds of milk per day. The one ration given below must be fed for the winter five months, or 153 days, the cows being on green rye for an average of 30 days, when they get in addition 2 pounds of corn meal and 6 pounds of alfalfa hay per day.

RATION NO. 3

Feed	Pounds	Digestible nutrients			Nutritive ratio
		Protein	Carbohydrate	Fat	
Silage	40	.36	4.52	.28	
*Corn stover	1	.02	.32	.01	
Corn meal	2	.16	1.33	.09	
Oats	1½	.14	.71	.06	
Alfalfa	14	1.54	5.54	.17	
Total nutrients	....	2.22	12.42	.61	1 : 6.2
Nutrients required for 1100-lb. cow producing 24 lbs. milk daily		1.88	12.88	.49	...

*No allowance made for corn stover as it is produced on the same area that grew the corn meal.

The carbohydrate is a little low, but the protein and fat are both high, making the total digestible nutrients in this ration in excess of the requirement.

TABLE 10. POUNDS AND ACREAGE OF CROPS FOR THE WINTER SIX MONTHS

Feed	Pounds fed	Days fed	Pounds per cow	Acres per cow	Acres 65 cows	Acres available	Surplus or shortage
Corn silage.....	40	153	6120 + 5 % waste	.27	17.55	17.55	
Corn meal.....	2	183	366	.12	7.8	7.45	—.35
Oats.....	1.5	153	229	.14	9.1	9.9	.8
Alfalfa.....	(14	153	2142				
.....	(6	30	180	.29	18.85	19.	.15
Total acres required for winter six months	....	....	....	.82	53.30	....	....

Since it requires 1.32 acres to support a cow the summer six months and .82 acres the winter six months, it requires 2.14 acres to support a cow a year, and 138.7 acres will support a herd of 65 cows.

A herd of this size would require two bulls, and an average of 9 heifers must be raised each year to replenish the herd. There could then be supported by this system 54 milch cows producing an average of 6000 pounds of milk per year, or a total of 324,000 pounds for the farm averaging 2025 pounds of milk per acre.

SYSTEM NO. 4, 84 COWS, 3150 POUNDS OF MILK PER ACRE

The only crops raised in this system are corn and alfalfa with rye as a catch crop for pasture, there being 95 acres of corn and 57 acres of alfalfa. The yards into which the cows are turned are included in the four acres allowed for buildings and yards.

Six 1300-pound horses will be required to do the work under this system. If each horse is fed a daily ration composed of 13 pounds of corn and 15 pounds of alfalfa hay, with the exception of a six weeks' rest period during the winter, when no grain is fed*, they will consume 7.98 acres of corn and 4.05 acres of alfalfa, or 12.03 acres in all. To this 12.03 acres add 8 acres required for roads, yards, etc., making 20.03 acres to be taken from the farm for these purposes. This leaves a total of 139.97 acres—87.02 acres of corn and 52.95 acres of alfalfa—available for dairy

*It has been demonstrated at the University of Illinois that this is a practical ration to feed horses.

stock.

During the summer six months, or 182 days, the cows should produce an average of 13 pounds of milk per day, and would require the following ration:

RATION NO. 4

Feed	Pounds	Digestible nutrients			Nutritive ratio
		Protein	Carbohydrate	Fat	
Silage	40	.36	4.52	.28	
Alfalfa hay	13.5	1.49	5.34	.17	
Total nutrients	....	1.85	9.86	.45	1 : 5.9
Nutrients required for 1100-lb. cow producing 13 pounds of milk daily		1.38	10.51	.32	....

TABLE 11. FEED AND ACREAGE FOR ONE COW FOR THE SUMMER SIX MONTHS

	Pounds fed per cow	Acres per cow
Corn silage	7280 + 5% waste = 7644	.32
Alfalfa	2457	.31
		.63

This shows that it takes .63 of an acre to supply the feed for one cow during the summer six months.

During the winter six months the cows should produce, on the average, 24 pounds of milk per day, and would require the following ration:

RATION NO. 5

Feed	Pounds	Digestible nutrients			Nutritive ratio
		Protein	Carbohydrate	Fat	
Silage	40	.36	4.52	.28	
Corn meal	5.5	.43	3.67	.24	
Alfalfa hay	11	1.21	4.36	.13	
Total nutrients	.....	2.00	12.55	.65	1:7.0
Nutrients required for 1100-lb. cow producing 24 lbs. milk daily		1.88	12.88	.49	

57 acres of the corn ground is sown to rye as soon as the corn is cut, and the cows are on rye pasture two weeks in the fall and 40 days in the spring. The ground will be too wet a portion of the time during the rainy weather to turn the cows to pasture, and only 33 days of rye pasture are counted during the year. While on rye the cows are given only one-third of a ration of silage and hay with no grain. Ration No. 4 would therefore be fed only five months, and a ration composed of 15 pounds of silage and 4 pounds of alfalfa hay is fed the remaining 33 days while on rye pasture.

TABLE 12.—FEED AND ACREAGE FOR ONE COW FOR THE WINTER SIX MONTHS

	Pounds fed per cow	Acres per cow
Corn silage	6495 + 5 % waste = 6820	.28
Corn meal	825	.27
Alfalfa	1770	.22
		.77

This shows that it takes .77 of an acre to support a cow during the winter six months, with the catch crop of rye used for pasture.

As it requires .55 of an acre of corn for the winter six months and .32 of an acre for the summer six months, it follows that .87 of an acre of corn would supply the corn ration for a cow for one year. Since it takes .22 of an acre of alfalfa for the winter six months and .31 of an acre for the summer six months, .53 of an acre of alfalfa would be sufficient to supply the alfalfa part of the ration for a cow for one year. The 87.02 acres of corn available for dairy stock would support 99.9 cows, and the 52.95 acres of alfalfa which are available for dairy stock would support 100.3 cows. It necessarily follows that by this system 100 cows could be kept on the 139.97 acres available for this purpose, which means 1.4 acres per cow per year. A herd of this size would require two bulls and the raising, on an average, of 14 heifers a year to replenish the herd. This system would then support 84 milch cows producing an average of 6000 pounds of milk per year, or a total of 504,000 pounds for the farm averaging 3150 pounds per acre.

CONCLUSIONS

Comparing actual results obtained on practical dairy farms in the intensive dairy region of northern Illinois with each of these systems, we find the following results:

TABLE 13.—PERCENT OF LAND IN DIFFERENT CROPS AND RETURNS PER ACRE

Crop	System No. 1	Farm No. 1	System No. 2	Farm No. 2	System No. 3	Farm No. 3	System No. 4	Farm No. 4
Corn	25	25	37.5	23.5	37.5	35	62.5	56.5
Oats	25	21.5	12.5	10	12.5	14	.....	.....
Timothy	12.5	16	.....	.....	.....	.....	.....	.....
Clover	.....	.....	12.5	19.5	12.5	14	.....	.....
Clover and timothy	.....	.....	12.5	19.5	.....	.....	.....	.....
Pasture	37.5	37.5	25	27.5	25	37	.....	.....
Alfalfa	.....	.....	.....	.....	12.5	.....	37.5	43.5
Lbs. milk per acre	991	994	1475	1341	2025	2145	3150	4185
Amount feed purchased		$400		$500		$1100		

Farm No. 1 produces 994 pounds of milk per acre, or 3 pounds more than System No. 1, but at an outlay of $400 for feed. Farm No. 2 falls short of System No. 2 by 134 pounds of milk per acre and an annual expenditure of $500 for feed. Farm No. 3 spends $1100 annually on concentrated feeds, which System No. 3 supplies from the 12.5 percent of its area devoted to alfalfa. The excess in pounds of milk in farms No. 3 and No. 4 over Systems No. 3 and No. 4 may be accounted for by the fact that but few calves are raised on farm No. 3 and none at all on farm No. 4. These farms compare so closely to the systems in percentage of acres devoted to the various crops and the returns received per acre, that they may well be taken as examples of the systems in actual practice.

Many think that alfalfa cannot be grown successfully in Illinois, but it is being grown to advantage in nearly every county in the state and meeting with but few failures where intelligently sown on well-drained land, if the soil has been properly prepared. We have had from 10 to 45 acres of alfalfa growing on the dairy farm at the University for the past eight years and but one piece has winter killed during this time.

Wonders of increased production have been worked on many dairy farms by getting better cows; and it is here shown that

Summary of The Four Systems

System	No. 1	No. 2	No. 3	No. 4
Acres corn	38	57	57	95
" rye in corn			(19)	(57)
" oats	38	19	19	
" timothy	19			
" clover		19	19	
" clover and timothy		19		
" pasture	57	38	38	
" alfalfa			19	57
" roads and yards	8	8	8	8
Total	160	160	160	160
Lbs. digestible protein available	26,804	35,024	48,850	80,237
Total digestible nutrients available	245,182	322,359	379,126	617,730
No. men required	3	4	4.5	6.5
No. horses required	4	5	5	6
Acres to support horses	15.9	17.9	13.3	12
Acres required per cow	3.6	2.6	2.1	1.4
Herd in cow equivalent	38	51	65	100
Bulls kept	1	1	2	2
Average No. heifers raised	5.3	7.1	9	14
No. old cows sold yearly	5.3	7.1	9	14
No. calves sold yearly	23.2	31.5	39.6	61.6
Average No. cows kept	31.7	42.9	54	84
Average production per cow	5000	5500	6000	6000
Total pounds milk produced	158,500	235,950	324,000	504,000
Pounds milk per acre	**991**	**1475**	**2025**	**3150**
Value milk per acre at $1.53 1-3 per 100 lbs.	**$ 15.20**	**$ 22.62**	**$ 31.05**	**$ 48.30**
Total value milk produced	$2430.33	$3617.90	$4968.00	$7728.00
Value cows and calves sold	202.10	272.00	343.80	534.80
Total value of products	$2632.43	$3889.90	$5311.80	$8262.80
Cost of labor at $450 per man per year	$1350	$1800	2025	$2925
Interest on land at $150 per acre @ 5% *	1200	1225	$1250	1310
Taxes	80	85	90	100
Labor, interest and taxes	$2630	$3110	$3365	$4335
Amount left for profit	**$2.43**	**$780**	**$1947**	**$3928**
Cost per acre to replace by rock phosphate, phosphorus removed	3.8c	5c	6.5c	10c
Total pounds nitrogen produced by legumes		2610	5420	10,830
Total pounds nitrogen removed in milk and lost in handling manure	1900	2500	3140	5000
Total pounds nitrogen gained or lost	—1900	110	2280	5830

The interest is computed on $150 land for system No. 1, and to make allowance for building for the larger herds, from $500 to $2200 are added to the investment for each of the other systems. The taxes are increased in proportion to the size of the buildings and herd.

amazing results may also be obtained by following a better system of cropping. It must be remembered that all results in this bulletin are comparative.

The value of the different commodities which the farmer receives from the farm without being charged to it, such as house rent, fruit, garden truck, chickens, eggs, milk, etc., are figured as balancing the general running expenses of the farm outside of the interest, labor, etc.

The most important portions of the foregoing table are the *pounds of milk produced per acre*, *money value of this milk*, *and amount left for profit in each system*, all of which are printed in bold-faced type to show the relative efficiency of the four systems.

Increased Protein and Digestible Nutrients Basis of Increased Production

As has been noted, the digestible nutrients increase 77,177, 56,767 and 238,604 pounds respectively, from system to system, while the increase in protein is even greater, as System No. 4 produces 80,237 pounds digestible protein, or over three times that of System No. 1.

TOTAL DIGESTIBLE NUTRIENTS	
SYSTEM #1	245,182. LBS.
SYSTEM #2	322,359. LBS.
SYSTEM #3	379,126. LBS.
SYSTEM #4	617,730. LBS.

PROTEIN	
SYSTEM #1	26,804. LBS.
SYSTEM #2	35,024. LBS.
SYSTEM #3	48,850. LBS.
SYSTEM #4	80,237. LBS.

Increased Production Basis of Increased Returns

It will be noted that under System No. 1, 991 pounds of milk are produced per acre. By simply changing the crops raised,

but feeding to cows of the same quality, the amount of milk produced in System No. 1 is increased over three times in System No. 4, and the receipts from milk alone are increased from $15.20 per acre in System No. 1 to $48.30 per acre in System No. 4.

System No. 3 produces more than twice as much milk per acre as System No. 1, and is, perhaps, the system best adapted to the general conditions in the dairy districts of the state today.

System No. 4 is the most likely to meet the requirements of the dairyman with a small amount of productive land who wishes to practice intensive methods. Where the land is high-priced and sufficient help can be obtained, this system will prove the most remunerative if intelligently pursued. On a quarter section of land 84 cows can be kept just as well as 32 cows and yet have all their feed produced on the farm. It simply depends on whether System No. 1 or No. 4 is used to produce the feed.

Increased Returns Basis of Increased Profits

The small profit shown for System No. 1 means that after all labor is paid for at market prices and the incidental expenses figured as offset by the income from garden, orchard, etc., there is left for profit but $2.43. This means that the dairyman is just able to make a living by this system and the extras of life must come from the labor returns of the women and children, who receive no remuneration whatever. There are dairy farms in Illinois conducted in this manner that do not pay 5% interest on the investment. And this is not all: the farm is continually running down in producing power so that smaller and smaller yields are obtained year after year, making this deplorable condition grow gradually worse. System No. 2 has $780 profit, System No. 3, $1947, and System No. 4, $3928 profit above interest on the investment and pay for labor, including the proprietor's labor at common wages. If, as is likely to be done on more intelligently conducted farms, better methods of breeding were instituted under Systems Nos. 3 and 4, so as to increase the efficiency of the cows, there would be a much larger difference in the total returns than here indicated.

Increased Profits Not in Money Value Alone

It should also be noted that while System No. 1 reduces the nitrogen in the soil 1900 pounds per year and exhausts the humus, the other three systems increase the nitrogen 110, 2280 and 5830 pounds respectively, per year, besides increasing the humus. As

nitrogen and humus, because of their scarcity, are already the limiting factors in most soils, System No. 1 is a ruinous practice to pursue, while with Systems No. 3 and No. 4 the dairymen are not only making money, but the farm is gradually becoming more productive year after year, so that as time goes on their profits continually increase, provided only that attention be given to depleted mineral constituents. With System No. 4 there is an annual increase of 38 pounds of nitrogen per acre, while with the poorest system there is a loss of 12½ pounds per acre annually. Yet poor as System No. 1 is, it does not compare in depleting the soil with the practice of selling a 55-bushel crop of corn from the land and then burning the stalks, as is so frequently practiced thru the corn belt in this day of progressive agriculture. Few yet realize the full meaning of such practices to the future agriculture of our state.

Growing large quantities of legumes, as is done in Systems No. 3 and No. 4, not only increases the nitrogen, but if all manure is carefully preserved and applied to the soil, the humus will also be increased, and by paying special attention to good tillage the physical condition of the soil will without doubt be greatly improved, making the farm more productive year after year. Without the soil in good physical condition, no farm can do its best. There is scarcely a farm in Illinois on which the productive power cannot be greatly increased by the growing of more legumes, the intelligent use of manure and good tillage. Ten cents per acre will replace the necessary mineral constituents removed in the milk by System No. 4, and if twice this amount were applied each year the dairyman would be enriching his soil.

The marvelous differences in the profits derived from these four systems of cropping are best shown by a direct comparison of the profits left by each system. System No. 1 returns $2.43; System No. 2 returns $780, or 321 times the profit of No. 1; System No. 3, $1947, or 801 times that of No. 1; and System No. 4, $3928, or 1616 times the profit of System No. 1, besides adding 5830 pounds of nitrogen to the soil of the farm. These figures show that an intensive system of dairy farming will rapidly increase the profits and the producing power of the farm, even tho all the milk is sold, if the system includes the liberal growing of legumes, the careful saving and applying of all manure, and the addition of a few cents' worth of mineral constituents per acre annually, thus making *not only a permanent agriculture, but an accumulative agriculture which at the same time is highly remunerative.*