













# ADEQUACY OF PROTEIN IN SWINE RATIONS IN ILLINOIS

As related to areas within the state,  
phases of production, size of enter-  
prise, share of income from swine  
sales, soil association, tenure, and  
the market for protein supplements

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# ADEQUACY OF PROTEIN IN SWINE RATIONS IN ILLINOIS

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THE OBJECTIVES OF THIS STUDY WERE TWOFOLD. The first was to determine how much protein supplement would be required to bring rations fed swine by Illinois farmers up to recommended levels and how deficiency of protein in swine rations differed among areas and phases of production. The second was to determine whether deficiency of protein was associated with size of enterprise, percentage of income from swine sales, soil association, and tenure. Earlier studies for the United States had shown that rations fed swine were more deficient in protein than rations fed other classes of livestock.<sup>1</sup>

Information secured in personal interviews with farmers covered:

1. The quantities of different feeds — grain, commercially mixed feeds, protein ingredients or supplements, pasture, hay, skimmilk, and whey — that they fed in each phase of production (bred sows,<sup>2</sup> nursing sows, and growing hogs).<sup>3</sup>
2. The number of swine fed during each phase of production.
3. The estimated percentage that swine sales were of the operator's gross cash income.
4. The tenure status of each farm operator.

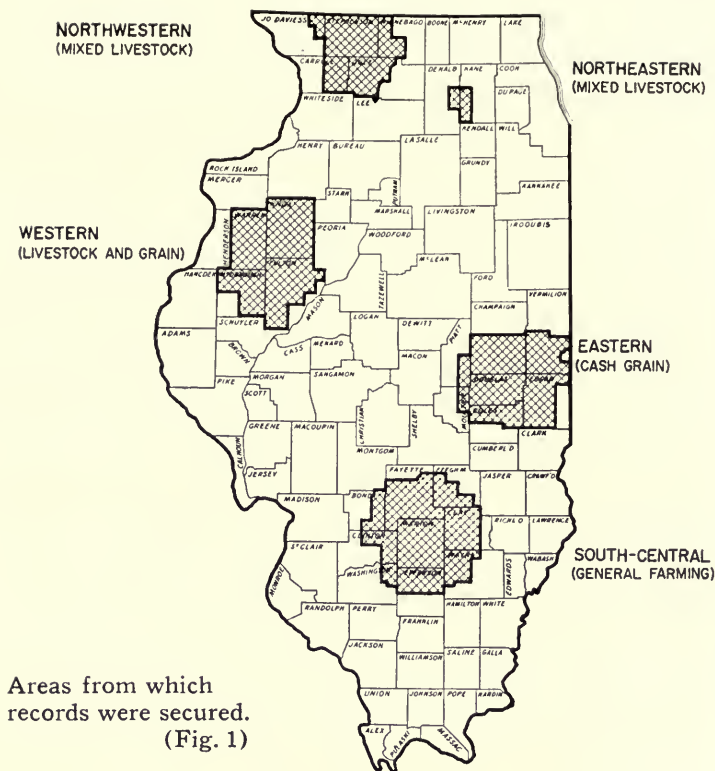
Most of the records covered the calendar year of 1951, but in some cases a 12-month production period for which data were secured began in the fall of 1950, and in some cases it ended in the spring of 1952.

Farms from which information was secured were located in areas representative of four important type-of-farming areas in the state (Fig. 1).

<sup>1</sup> These studies, made by R. D. Jennings and published by the U. S. Department of Agriculture Bureau of Agricultural Economics, are: *The deficit in protein for livestock: a quantitative estimate of needs based on feeding standards* (mimeograph, April, 1946); *Consumption of feed by livestock, 1909-47: relation between feed, livestock, and food at the national level* (Cir. 836, Dec., 1949); *A look at the protein situation for livestock* (mimeographs, March, 1950, and Sept., 1952).

<sup>2</sup> In this study, bred gilts were included with bred sows.

<sup>3</sup> Estimates of quantities fed during each phase of production were based on the most accurate data available, whether those data covered a day, a week, a month, or the entire phase. Feeding practices over a 12-month period were analyzed to include both spring and fall feeding programs.



The *western area* has the greatest density of swine in the state; the *northwestern* and *northeastern areas* have densities well above that of the state average; the *eastern area* is below the state average in density; and the *south-central area* much below that of the state average.

In all areas except the northeastern, the farms visited were located in sections chosen at random. Only sections of land lying entirely within a given soil association<sup>1</sup> were included in the universe from which the sample was drawn.

In the northeastern area, the northeast corner farm in every third section was visited, irrespective of soil association, and only data covering the spring production period were secured.

<sup>1</sup>In the western and northwestern areas, sections were selected from soil associations K and L; in the eastern area, from soil association H; and in the south-central area, from soil associations O and P. These five soil associations comprise 46 percent of the total farmland in the state. The productivity ratings in each of these areas under a low level of management ranged as follows: H: 65-100; K: 45-100; L: 5-45; O: 5-25; P: 20-35. For further information on soils, see *Illinois soil type descriptions*, by H. L. Wascher, J. B. Fehrenbacher, R. T. Odell, and P. T. Veale (Ill. Agr. Exp. Sta. AG-1443, 1950).

The number of records obtained from each area was as follows: western, 54; northwestern, 26; northeastern, 50; eastern, 24; and south-central, 78.

## PART 1: FEEDING PRACTICES AND ADEQUACY OF PROTEIN IN SWINE RATIONS

### Protein Supplements Fed

A protein supplement was fed at least part of the time on nearly all farms. About 5 out of every 11 farms used commercially mixed supplements only; 1 out of every 8 used ingredient supplements only;

Table 1. — Percentage of Farms in Five Areas Feeding Various Types of Protein Supplements and Pasture to Swine, 1951

Types of protein supplements fed	Western	Northwestern	North-eastern	Eastern	South-central
	(percent of farms)				
Commercially mixed supplement only	52	31	76	33	40
Commercially mixed supplement and:					
one ingredient supplement.....	24	19	10	42	29
two ingredient supplements.....	7	12	4	8	12
three or more ingredient supplements	6	15	2	4	5
Subtotal.....	(37)	(46)	(16)	(54)	(46)
Ingredient supplements only					
one ingredient supplement.....	3	12	0	13	9
two ingredient supplements.....	2	7	6	0	4
three or more ingredient supplements	2	4	2	0	1
Subtotal.....	(7)	(23)	(8)	(12)	(14)
No supplements.....	4	0	0	0	0
Total.....	(100)	(100)	(100)	(100)	(100)
Ingredient supplements					
Alfalfa meal.....	18	23	62	12	9
Bran or shorts.....	2	12	6	0	15
Condensed buttermilk.....	0	12	8	25	3
Cottonseed meal.....	0	4	2	0	0
Fish meal.....	2	0	2	0	0
Linseed meal.....	7	19	0	0	0
Meat scraps or tannage.....	11	27	14	4	10
Skimmilk.....	17	12	4	29	31
Soybean meal.....	20	15	24	12	17
Whey.....	0	15	0	0	1
Pasture					
Legume pasture only.....	52	46	70	8	13
Legume and grass pasture.....	26	31	22	50	29
Grass pasture only.....	15	11	8	38	45
Drylot only.....	7	12	0	4	13

and 2 out of every 5 used a commercially mixed supplement together with one or more ingredient supplements (Table 1).

About 7 out of every 8 farms used commercially mixed protein supplements. The northeastern and western areas had the highest percentages of farms feeding commercially mixed supplements only. The northwestern area had the highest percentage of farms using ingredient supplements only.

Alfalfa meal, meat scraps or tankage, skimmilk, and soybean meal were ingredient supplements fed in every area. The northeastern area had the highest percentage of farms using alfalfa meal, the northwestern area the highest using meat scraps or tankage, the eastern and south-central areas the highest using skimmilk, and the western and northeastern areas slightly higher percentages using soybean meal.

Of other ingredient supplements, these areas had the highest percentage of farms using them:

Bran or shorts . . . . .	northwestern and south-central
Condensed buttermilk . . . . .	eastern
Linseed meal . . . . .	northwestern
Whey . . . . .	northwestern

These variations reflect the availability and price of ingredient supplements in different parts of the state.

## Comparisons of Methods of Feeding Protein Supplements

### General comparisons

Comparisons in this section are based on averages computed from combined percentages for the phases of production shown in Table 2. Comparison of spring and fall production periods does not include the northeastern area, for which no fall data were secured. This exception applies to all subsequent discussion in which fall data are analyzed.

**Entire production period.** *Free-choice* feeding<sup>1</sup> of protein supplements was practiced by over three-fourths of the farms in the northeastern area, by over a half in the northwestern area, and by nearly a half in the eastern area.

*Rationing* supplements fed (limiting the amount) was practiced by

<sup>1</sup> Rations were considered as fed free choice if both grain and protein supplements were available so that the swine could choose as much of each as they wanted. Nearly all rations included as free choice were those put in self-feeders.

Table 2. — Percentage of Farms in Five Areas Using Different Methods of Feeding Protein Supplements to Swine, 1951

(By phases of production)

Methods of feeding supplements	Spring					Fall <sup>a</sup>			
	West-ern	North-west-ern	North-east-ern	East-ern	South-central	West-ern	North-west-ern	East-ern	South-central
	(percent of farms)								
<b>Bred sows</b>									
No supplements	4	9	2	10	18	8	33	25	18
Rationed.....	82	46	13	40	73	80	34	31	77
Free choice....	14	45	85	50	9	12	33	44	5
<b>Nursing sows</b>									
No supplements	2	4	0	0	0	2	14	14	7
Rationed.....	56	32	36	39	82	57	14	39	76
Free choice....	42	64	64	61	18	41	72	47	17
<b>Growing hogs</b>									
No supplements	6	0	0	0	0	5	10	6	2
Rationed.....	49	44	16	50	57	56	50	59	57
Free choice....	45	56	84	50	43	39	40	35	41

<sup>a</sup> No data for the fall production period were secured in the northeastern area. Differences shown in the northwestern area are less significant than in the other three areas because only a few records were obtained.

over two-thirds of the farms in the south-central area, and by five out of every eight in the western area.

Feeding *no supplements* was practiced by less than 12 percent of the farms in all areas. The range was from less than 1 percent in the northeastern area to 11.7 percent in the northwestern area.

**Spring and fall production periods.** A higher percentage of farms fed no supplements in the fall than in the spring. Conversely, a higher percentage fed free choice in the spring than in the fall. About equal proportions of farms rationed supplements in the spring and fall. This was also true for each phase of production — bred sows, nursing sows, and growing hogs.

**Phases of production.** A greater percentage of farms fed no supplements to bred sows than to either nursing sows or growing hogs. A slightly greater percentage also rationed supplements to bred sows than to either nursing sows or growing hogs. A greater percentage fed supplements free choice to growing hogs than to bred sows. The average difference in the percentages of farms using these methods of feeding supplements to nursing sows and growing hogs was slight.

## Comparison of areas by phase of production

**Sows bred for spring farrowing.** The south-central area had the highest percentage of farms feeding no supplements, the northeastern area for feeding free choice, and the western and south-central areas for rationing supplements (see Table 2).

**Sows bred for fall farrowing.** The northwestern and eastern areas had the highest percentages of farms both for feeding no supplements and for free choice. The western area had the lowest for feeding no supplements, the south-central area the lowest for feeding free choice. About equally high percentages of farms in the western and south-central areas rationed supplements.

**Nursing sows, spring.** A much higher percentage of farms in the eastern and two northern areas fed free choice than in the south-central or western areas. The south-central area had the highest percentage rationing supplements. Few farms in any area fed no supplements.

**Nursing sows, fall.** The south-central area again had the lowest percentage of farms feeding free choice as well as the highest for rationing supplements. The northwestern and eastern areas had the highest percentages both for feeding no supplements and for free choice.

**Growing hogs, spring and fall.** The percentages of farms feeding in different ways were similar in the western, northwestern, eastern, and south-central areas in both spring and fall. Differences in feeding between spring and fall were less for growing hogs than for either bred or nursing sows. The northeastern area in spring had by far the highest percentage of farms feeding free choice.

## Differences in Use of Pasture Among Areas and Phases of Production

Data in Table 1 show that the south-central and northwestern areas had the highest percentage of farms feeding swine in drylot the entire year. Table 3 shows the differences among areas in availability of pasture within the year.

A higher percentage of farms had no pasture available for sows bred to farrow in the spring than for any other phase of production. For these sows, none of the farms in the northwestern area had pasture, and only about two-fifths of the farms in the western, eastern, and south-central area had pasture for them.

Table 3.—Percentage of Farms With Different Kinds of Pasture Available, by Areas and Phases of Production, 1951

Area and kind of pasture	Spring			Fall		
	Bred sows	Nursing sows	Grow-ing hogs	Bred sows	Nursing sows	Grow-ing hogs
(percent of farms)						
<b>Western</b>						
Alfalfa.....	12	26	25	25	12	5
Ladino clover.....	2	4	4	2	0	0
Red clover.....	6	21	21	12	14	7
Mixed legumes.....	2	6	6	15	12	0
Mixed legumes and grasses <sup>a</sup>	10	26	21	10	9	4
Bluegrass.....	6	11	15	18	16	14
Other grasses.....	2	0	0	0	2	0
No pasture.....	60	6	8	18	35	70
<b>Northwestern</b>						
Alfalfa.....	0	18	20	30	34	9
Red clover.....	0	23	20	0	0	0
Mixed legumes.....	0	4	4	10	11	0
Alfalfa-bromegrass.....	0	9	16	10	11	27
Alfalfa-bromegrass-Ladino..	0	14	12	10	11	9
Mixed legumes and grasses <sup>a</sup>	0	5	4	0	0	0
Bluegrass.....	0	9	12	0	0	0
No pasture.....	100	18	12	40	33	55
<b>Eastern</b>						
Alfalfa.....	5	5	0	0	0	0
Ladino clover.....	0	4	4	6	6	6
Red clover.....	0	5	9	16	12	11
Mixed legumes.....	0	4	8	5	6	0
Alfalfa-bromegrass.....	0	0	0	0	6	0
Mixed legumes and grasses <sup>a</sup>	5	14	35	17	12	6
Bluegrass.....	28	36	31	39	41	22
Other grasses.....	5	18	9	11	5	0
No pasture.....	57	14	4	6	12	55
<b>South-central</b>						
Alfalfa.....	0	0	2	0	0	0
Ladino clover.....	2	14	10	8	7	10
Red clover.....	0	0	0	0	3	6
Mixed legumes.....	3	3	5	4	7	3
Mixed legumes and grasses <sup>a</sup>	8	20	24	32	28	19
Bluegrass.....	16	17	16	12	14	12
Other grasses.....	5	15	13	16	14	16
Woods.....	6	7	3	4	3	3
No pasture.....	60	24	27	24	24	31
<b>Northeastern</b>						
Alfalfa.....			24			
Ladino clover.....			2			
Red clover.....	(data not secured)		16	(data not secured)		
Mixed legumes.....			28			
Alfalfa-bromegrass.....			4			
Mixed legumes and grasses <sup>a</sup>			18			
Bluegrass.....			4			
Other grasses.....			4			
No pasture.....	76	22	0			

<sup>a</sup> Not alfalfa-bromegrass or alfalfa-bromegrass-Ladino

Another phase of production for which a high percentage of the farms had no pasture was growing hogs farrowed in the fall. Just as for sows bred to farrow in the spring, a big share of the feeding period occurs during winter. The percentage of farms having pasture for fall-farrowed hogs was higher in the south-central area than in other areas, a result in part of a little longer growing season and earlier farrowing.

A greater share of the farms had pasture available for hogs farrowed in the spring and for sows nursing in the spring than for other phases of production. For these two phases, the percentage of farms having no pasture was slightly higher in the south-central area than in the other areas.

Legumes as well as mixtures containing legumes were, according to the percentage of farms using them, much more important than grass pastures in the two northern areas. In the western area legumes alone were more important than either grasses alone or mixed legumes and grasses in five phases of production. In both the eastern and south-central areas a greater percentage of farms had grass pasture only than legume pasture only in all phases of production.

In the western area the most commonly used pasture was alfalfa, followed by mixed legumes and grasses and red clover.

In the northern areas alfalfa or a mixture including alfalfa was the dominant pasture, with red clover next in importance.

In the eastern area bluegrass was the most common pasture, followed by mixed legumes and grasses, other legumes, and other grasses. As shown in Table 1, this area had the highest percentage of farms using a mixture of legumes and grasses.

In the south-central area, bluegrass and other grasses combined were slightly more common than mixed legumes and grasses.

## Adequacy of Crude Protein in Rations

The adequacy of rations fed to sows in gestation and lactation, and to growing hogs of different weights, was measured by determining to what extent the crude protein content of the rations fed differed from recommendations (shown in Table 4)<sup>1</sup> for swine in these classes. In

<sup>1</sup>No attempt was made to adjust these recommendations to changing price relationships between protein supplements and grain. Since swine producers are primarily concerned with maximizing their returns from the swine enterprise, the feeding of these levels of protein would not be most desirable under *all* swine and feed-ingredient price relationships. It may be noted here that the period which these data covered was normal. During that period, for example, the average ratio of corn to soybean meal prices was almost the same as the average for the 7-year period, 1947-1953.



making these calculations, the kind, condition, and amount of pasture available were taken into account, as well as the grains and supplements produced on the farm. Among other things, it was recognized that grass pastures were lower in protein content than legumes except in their early growth period, and that weather and the number of animals using a pasture affect its condition.

**Table 4. — Recommended Percentages of Crude Protein in Swine Rations for Certain Classes and Weights of Swine<sup>a</sup>**

Class and weight of swine	Percentage recommended for—		
	Drylot or poor pasture	Fair pasture	Good pasture
Bred sows.....	14	13	12
Bred gilts.....	15	14	13
<b>Nursing sows</b>			
Young females.....	14	13	12
Mature sows.....	15	14	13
<b>Growing hogs</b>			
Weaning to 75 pounds.....	16	15	14
75 to 125 pounds.....	14	13	12
125 to 175 pounds.....	13	12	11
175 to 225 pounds.....	12	11	10
225 to 275 pounds.....	11	10	9
Average for growing hogs (125 pounds).....	13.5	12.5	11.5

<sup>a</sup> Adapted from data in *Your hog business*, by S. W. Terrill (Ill. Agr. Ext. Cir. 719, page 11, 1955 printing).

For farms that fed in self-feeders complete rations containing the recommended percentages of crude protein, or that made available all the protein supplement that swine could consume, no attempt was made to ascertain the quantity fed nor to determine whether more protein supplement was used than the recommendations called for. The assumption was made, in effect, that swine were able to balance their own rations if adequate supplement and grain were made available.<sup>1</sup> Nor was any attempt made to determine the adequacy of the rations in other nutritional requirements besides protein, or to estab-

<sup>1</sup> This assumption departs from the actual situation whenever swine did not in fact have access to adequate quantities of supplement, which might occur, for example, when the farmer neglected to keep the feeders supplied at all times, or when there was overcrowding of animals, or when feed did not flow from the feeders properly. Recent nutrition studies indicate that swine will not always balance their own rations properly.

lish deficiencies related to the quality of the purchased protein supplements fed.

**All areas.** Considering rations fed in all phases of production and in all areas, an average of about half the farms fed adequate rations, nearly one-third fed moderately inadequate rations, and nearly one-sixth inadequate rations.<sup>1</sup>

The range for farms feeding adequate rations was from only 25 percent in the south-central area (for sows bred to farrow in the spring) to 81 percent in the eastern area (for sows nursing in the spring). (See Table 5.)

#### **Comparison of the same production phases in spring and fall.**

Each area had a higher percentage of farms feeding adequate rations to growing hogs in the spring than in the fall, and all but the northwestern area had slightly higher percentages for nursing sows in the spring than in the fall.

The western and south-central areas had higher percentages of farms feeding adequate rations to sows bred to farrow in the fall than in the spring, but the northwestern and eastern areas had higher percentages for sows bred to farrow in the spring.

**Comparison of phases in the spring production period.** All areas except the northeastern area had higher percentages of farms feeding adequate rations to nursing sows than to either bred sows or growing hogs. The western, south-central, and northeastern areas had higher percentages feeding adequately to growing hogs than to bred sows.

**Comparison of phases in the fall production period.** All areas except the western area had higher percentages of farms feeding adequately to nursing sows than to either bred sows or growing hogs.

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<sup>1</sup> Rations were considered *adequate* if they contained sufficient crude protein to meet or exceed the standards recommended; *moderately inadequate* if they were within 3 percentage points of these standards; and *inadequate* if they were below 3 percentage points. For example, if the percentage recommended as adequate was 14 and the percentage fed was 13, a deficiency of 1 percentage point was recorded.

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<sup>a</sup> Variance in mean deficiency among areas was significant at the 0.1-percent level for bred sows and growing hogs farrowed in the spring, at the 1-percent level for bred sows in the fall, at the 20-percent level for nursing sows in the spring, but not at the 20-percent level for either growing hogs or nursing sows in the fall. Variance in mean deficiency among each phase of production within each area was significant at the 0.1-percent level in the northeast and the south-central areas in the spring, at the 5-percent level in the western area in the fall, and at the 20-percent level in the eastern (both spring and fall) and in the south-central areas. Variations within each phase of production were so great in the other areas (northwestern, spring and fall, and western, spring) that differences among them were not significant at the 20-percent level.

<sup>b</sup> Bred to farrow in this period.

<sup>c</sup> Farrowed in this period.

<sup>d</sup> Weighted by the number of swine on each farm.

<sup>e</sup> Differences shown in the northwestern area for the fall production period are less significant than in the other three areas because only a few records were obtained.

Table 5.—Percentage of Farms in Five Areas With Different Levels of Deficiency of Crude Protein in Swine Rations, 1951<sup>a</sup>

(By phases of production)

Deficiency of crude protein in rations	Spring			Fall		
	Bred sows <sup>b</sup>	Nursing sows	Growing hogs <sup>c</sup>	Bred sows <sup>b</sup>	Nursing sows	Growing hogs <sup>c</sup>
(Percentage points below recommended percentages)	(percent of farms)					
<b>Western area</b>						
None.....	37	54	49	50	43	33
.1-1.5.....	22	17	21	24	16	14
1.6-3.0.....	23	19	20	14	21	23
3.1-4.5.....	16	6	8	10	18	19
4.6 or more.....	2	4	2	2	2	11
Average weighted deficiency <sup>d</sup> .....	1.20	.97	1.03	.78	1.32	1.71
<b>Northwestern area<sup>e</sup></b>						
None.....	55	71	54	43	75	45
.1-1.5.....	18	10	17	0	0	19
1.6-3.0.....	18	5	25	14	13	18
3.1-4.5.....	9	14	4	43	12	18
4.6 or more.....	0	0	0	0	0	0
Average weighted deficiency <sup>d</sup> .....	.86	.64	.54	2.51	.69	1.20
<b>Eastern area</b>						
None.....	65	81	59	56	73	47
.1-1.5.....	10	14	9	19	14	6
1.6-3.0.....	15	0	23	6	0	6
3.1-4.5.....	0	5	9	19	13	35
4.6 or more.....	10	0	0	0	0	6
Average weighted deficiency <sup>d</sup> .....	.93	.26	.82	.47	.63	1.65
<b>South-central area</b>						
None.....	25	54	48	32	50	44
.1-1.5.....	8	17	12	8	5	11
1.6-3.0.....	19	20	13	25	26	16
3.1-4.5.....	21	7	16	15	17	20
4.6 or more.....	27	2	11	20	2	9
Average weighted deficiency <sup>d</sup> .....	2.28	1.00	1.12	1.51	1.55	1.21
<b>Northeastern area</b>						
None.....	26	56	72	(data not secured)		
.1-1.5.....	38	28	28			
1.6-3.0.....	30	14	0			
3.1-4.5.....	4	2	0			
4.6 or more.....	2	0	0			
Average weighted deficiency <sup>d</sup> .....	1.07	.51	.13			

(Footnotes appear on opposite page)

The western and eastern areas had higher percentages of farms feeding adequately to bred sows than to growing hogs, but in the south-central area the converse was true. In the northwestern area the difference was negligible.

**Comparison of weighted deficiencies.** When protein deficiencies in rations were weighted by the number of swine on each farm, the south-central area was found to be most inadequate in four of the six production phases, with the northwestern and western areas most inadequate in one phase each (Table 5). The average deficiency for the year was greatest in the south-central area, followed closely by the western area (Table 6).

If the estimates of weighted deficiency shown in Table 6 are representative of the entire state, there was an inadequacy of approximately 1 percentage point below recommended standards in Illinois in 1951.

**Comparison of weighted deficiencies in fall and spring.** The average weighted deficiency in each of the areas was greater for nursing sows and growing hogs in the fall than in the spring (Table 5). In three areas, rations fed sows bred to farrow in the spring were more inadequate than for sows bred to farrow in the fall. These differences can be attributed primarily to pasture: in periods when good pasture was unavailable, insufficient amounts of supplement were added.

**Comparison of the same farms within the year.** Data in Table 5 show the variations in inadequacy of rations in different phases of

Table 6. — Average Deficiency of Crude Protein in Swine Rations in Five Areas, 1951<sup>a</sup>

(For spring, fall, and yearly production)

Area	Spring	Fall	Year
	(percentage points)		
Western.....	1.04	1.56	1.25
Northwestern.....	.59	1.29	.80
Eastern.....	.77	1.41	1.03
South-central.....	1.27	1.30	1.28
Northeastern.....	.28	(data not secured)	(data not secured <sup>b</sup> )

<sup>a</sup> Percentage points below recommended percentages weighted by the number of swine on each farm and by the amount of feed required for bred sows, nursing sows, and growing hogs. The yearly average was determined by assuming the following weights for spring and fall: western and eastern: 0.6 for spring and 0.4 for fall; northwestern: 0.7 for spring and 0.3 for fall; south-central: 0.5 for spring and 0.5 for fall. No attempt was made to adjust rations with respect to the quality or excess of protein fed (note in Table 1 the various types of supplements used).

<sup>b</sup> If deficiency in the fall production period was 0.98 (assuming the same difference between spring and fall as in the northwestern area), the year's deficiency would be 0.49.

production for a group of farms. However, the same farms were not included in each group, because some farms did not have swine in all phases.

Table 7 presents the results of an analysis of feeding on each farm for the phases of production which were carried out on that farm. Nearly one-fourth of these farms fed adequate rations in every phase, over one-fifth had inadequate rations in every phase, and over one-half of the farms fed adequate rations only part of the time.

**Table 7.—Proportion of Phases of Production in Which Farms in Five Areas Fed Inadequate Protein in Swine Rations, 1951**

Proportion of production phase <sup>a</sup>	All areas <sup>b</sup>	West-ern	North-western	North-eastern	East-ern	South-central
		(percent of farms in each group)				
Not inadequate in any phase..	24	17	31	18	37	17
Inadequate in less than half the phases.....	25	23	23	38	25	18
Inadequate in half or more, but not in all phases.....	29	38	31	24	17	36
Inadequate in all phases.....	21	22	15	20	21	29

<sup>a</sup> The number of production phases varied from farm to farm. A few farms had only one production phase; many had the entire six production phases. The proportion for each farm was determined from the number of production phases which that farm had. For example, a farm feeding adequate rations in all phases of production in which it had swine was included in the category, *not inadequate in any phase*.

<sup>b</sup> Arithmetic average of the percentages given for the five areas.

The northwestern area had the lowest proportion of farms feeding inadequate rations in all phases, and the eastern area had the highest proportion feeding adequate rations in all phases.

The percentage of farms in each area which had swine in all six phases of production was as follows:

Western.....	74
Eastern.....	58
South-central.....	41
Northwestern.....	15
Northeastern.....	(fall data not secured)

In the western area, a higher percentage of the farms were on a two-litter-a-year program; of those that were not, many purchased feeder pigs and had no sows to feed while others were on a one-litter-a-year program. A two-litter-a-year program also dominated the east-

ern area, whereas farms in the northwestern area were mainly on a one-litter-a-year program. In the south-central area there was no clear-cut pattern; nearly one-fourth of the farms produced hogs in only one or two phases of production, and one-fifth had hogs in only three phases. Several farms in the south-central area sold weanling pigs.

### **Amount of Protein Supplement Required to Eliminate Protein Inadequacy**

The extent of the additional market for protein supplements among swine feeders can be estimated by calculating the percentage increases that would be required if all farms fed the amounts of crude protein recommended.

Assuming an overall inadequacy of 1 percentage point (based on data shown in Table 6) below a recommended protein level of 12.7 percent,<sup>1</sup> about 27 percent more supplement containing 35-percent protein would be required to reach the recommended level. Within each area the estimated increase needed was approximately as follows:

South-central.....	38 percent
Western.....	36 percent
Eastern.....	28 percent
Northwestern.....	21 percent
Northeastern.....	6 percent <sup>2</sup>

An inadequacy of 2 percentage points below a recommended level of 13-percent protein would require 67 percent more supplement to make up the deficiency, whereas an inadequacy of 1 percentage point at that level would require only 25 percent more supplement (see Table 8). It should be noted that on a percentage basis much more supplement is required to make up a given amount in adequacy when the recommended level is at 11 percent than when at 18 percent. This difference becomes especially noticeable as the level of inadequacy increases.

Table 9 shows the additional quantities of supplement needed to meet recommended levels in each phase of production in each of the areas from which samples were taken. These data show that the greatest need for more supplement was generally for growing hogs farrowed in the fall.

<sup>1</sup> Approximate average of recommendations for bred sows, nursing sows, and growing hogs on fair pasture.

<sup>2</sup> For spring production period only.

Table 8.—Percentage Increases in 35-Percent Protein Supplement Required to Meet Recommended Protein Levels in Swine Rations

When protein fed is this percentage point below recommended levels—	Percentage increase required when recommended level of protein in ration <sup>a</sup> is—								
	11%	12%	13%	13.5%	14%	14.5%	15%	16%	18%
.2	7	5	4	4	3	3	3	3	2
.4	15	11	9	8	7	6	6	5	4
.6	25	18	14	12	11	10	9	8	6
.8	36	25	19	17	15	14	13	11	9
1.0	50	33	25	22	20	18	17	14	11
1.2	67	43	32	28	25	23	21	18	14
1.4	88	54	39	34	30	27	25	21	16
1.6	114	67	47	41	36	33	30	25	19
1.8	150	82	56	49	43	38	35	29	22
2.0	200	100	67	57	50	44	40	33	25
2.2	275	122	79	67	58	51	46	38	28
2.4	400	150	92	77	67	59	52	43	32
3.0	(b)	300	150	120	100	86	75	60	43
3.5	(b)	700	233	175	140	117	100	78	54
4.0	(b)	400	267	200	160	133	100	67	47
4.5	(b)	(b)	900	450	300	225	180	129	82

<sup>a</sup> Rations assumed to consist of corn with 8-percent protein and supplement with 35-percent protein. To make 100 pounds of a ration containing 9-percent protein, 96.3 pounds of 8-percent corn and 3.7 pounds of 35-percent supplement are required. Thus a change of 3.7 pounds in supplement in 100 pounds of feed occurs with each change of 1 percentage point in crude protein content of the ration.

<sup>b</sup> Infinity since no supplement supplied.

Table 9.—Percentage Increases in 35-Percent Protein Supplement Required to Meet Recommended Protein Levels in Swine Rations in Five Areas, 1951<sup>a</sup>

(By phases of production)

Area	Spring			Fall		
	Bred sows	Nursing sows	Growing hogs	Bred sows	Nursing sows	Growing hogs
	(percentage points)					
Western	28	23	30	17	31	63
Northwestern	19	13	14	84	15	37
Eastern	21	5	23	10	13	60
South-central	72	22	34	38	40	38
Northeastern	25	11	2	(data not secured)		

<sup>a</sup> Interpolated from Table 8, using average weighted deficiencies shown in Table 5 and assuming the required protein level for bred sows and nursing sows to be 13.5 percent, and that for growing hogs, 12.5 percent.

## Relation of Pasture Use to the Amount of Commercial Protein Supplement Needed

The use of pasture has a tremendous effect on the amount of protein supplement required to feed swine. The Illinois Plan for Swine Feeding recommends rations in which the crude protein content can be 2 percentage points lower when swine are on good pasture than when they are in drylot.<sup>1</sup>

Assuming a ration, as was assumed in Table 8, in which corn with 8-percent protein is mixed with a 35-percent protein supplement, the following percentage increases in 35-percent supplement are required to bring a ration up 2 percentage points:

<i>Crude protein content of ration increased from—</i>	<i>Percentage increases in supplement required—</i>
14 to 16 (pigs up to 75 pounds) . . . . .	33
13 to 15 (gilts and young females) . . . . .	40
12 to 14 (hogs, 75 to 125 pounds, and mature sows) . . . . .	50
10 to 12 (hogs, 125 pounds, to market) . . . . .	100

These figures also indicate the percentage increases in supplement needed by a farmer who had good pasture which is no longer available. The percentage increases required might be even greater than those shown above, because many recommended pasture supplements contain 40-percent protein. For example, an increase of 58 percent in amount of supplement would be required if 60-pound pigs fed 40-percent protein pasture supplement in a 14-percent protein ration were put in drylot and fed 35-percent protein supplement in a 16-percent protein ration.<sup>2</sup>

On the other hand, a farmer who fed a recommended drylot protein ration of 16, 15, 14, and 12 percent could reduce his protein supplement requirements by 25, 29, 33, and 50 percent respectively when he began to use good pasture.

The availability and use of good pasture represent, therefore, a key factor in trying to ascertain the potential market for protein supplements among swine producers. Tables 1 and 3 show that many farmers did not have good pasture. One of the main causes for deficiency in rations fed to swine has been the failure to use adequate supplements when pasture was not available or when it was of poor quality.

<sup>1</sup> This plan appears in *Your hog business*, by S. W. Terrill (Ill. Agr. Ext. Cir. 719, 1955 printing).

<sup>2</sup> If the protein content of corn is taken at 8.5 percent, an increase of 36 percent in amount of 35-percent protein supplement would be required if used in both pasture and drylot, and an increase of 62 percent in amount of supplement would be needed if the shift were from a 40- to a 35-percent protein supplement.



Table 10.—Number of Brands of Swine Feed Used on the Farms Interviewed in the Five Areas, 1951

Area	Number of brands used in specified area and					Total number used in each area
	No other area	One other area	Two other areas	Three other areas	Four other areas	
Western.....	7	1	5	1	5	19
Northwestern.....	4	1	4	0	5	14
Northeastern.....	3	1	3	1	5	13
Eastern.....	6	1	3	1	5	16
South-central.....	6	0	3	1	5	15

.....	Number of brands used in					
	One area	Two areas	Three areas	Four areas	Five areas	All areas
.....	26	2	6	1	5	40

### Number of Brands of Feed Used

An indication of the nature of competition in feed distribution in Illinois is disclosed by an analysis of the brands of commercially mixed feeds used by the farms in this study.

Of the forty commercially prepared brands fed on the farms surveyed, twelve (or 30 percent) were fed in three or more of the five areas (Table 10). However, within each of the five areas, these twelve brands (produced by the larger feed manufacturers and distributed more widely) represented about three-fifths of all the brands sold. Two brands of feed were distributed in two of the five areas.

Twenty-six brands (65 percent of all those fed) were fed in only one of the five areas surveyed, but in the aggregate they accounted for a substantial tonnage of feed sold. These brands, distributed only in one area, averaged about one-third of all the brands fed in the individual areas. In some cases such brands were those of local feed mixers, but in other cases they were brands of larger feed mixers, some out-of-state, who serve only certain areas of Illinois. This analysis does not disclose the relative volume of the different brands sold, for quantities of each brand of feed fed were not secured.

The percentage of farms in each of the five areas using only one, two, or three and more commercial brands is shown below:

<i>Number of commercial brands used—</i>	<i>Western</i>	<i>North-western</i>	<i>North-eastern</i>	<i>Eastern</i>	<i>South-central</i>
One.....	61	50	88	79	70
Two.....	24	23	4	8	13
Three and more.....	4	4	0	0	3

The higher percentages of farms using only one brand in the eastern and south-central areas than in the western and northwestern areas is related to the fact that these areas had lower densities of swine and many dealers there handled only one brand of feed.<sup>1</sup> The very high percentage of farms in the northeastern area (smaller and with fewer dealers) using only one brand suggests a high degree of satisfaction with the feed used and the service received from dealers.

The data above show that in the northwestern area 77 percent of the farms used commercial brands of feed compared with 92, 89, 87, and 86 percent in the northeastern, western, eastern, and south-central areas respectively. However, the northwestern area had the highest percentage of farms using straight protein ingredient supplements (Table 1, page 5).

## **PART 2: DIFFERENCES IN ADEQUACY OF CRUDE PROTEIN IN SWINE RATIONS AS RELATED TO CERTAIN FACTORS**

Differences in the adequacy of protein in swine rations among phases of production and by areas have already been pointed out. Here, several other factors said to affect the use of protein supplements are analyzed.

**Differences among areas with the least and most swine.** Do areas with the most swine meet feeding standards for crude protein more closely than areas with the least swine? Only by a small extent. The area with the most swine (western) had about the same level of inadequacy as the area with the least swine (south-central). The eastern area showed only slightly more inadequacy than the northwestern area (Table 6).

**Differences between farms with the least and most swine within the same area.** The same question that was asked about areas applies to farms as well. To answer this question, farms in each area were arrayed according to the number of swine on each farm and then divided equally into three groups.

A comparison of inadequacy of rations fed in the group with the most swine and the group with the least swine is given in Table 11. (The third or intermediate group was not used in this analysis.) About the same percentage of farms in the two groups was found in several

<sup>1</sup> As shown in *The retail distribution of feed to Illinois farmers*, by R. J. Mutti and G. W. Stone (Ill. Agr. Exp. Sta. AE2953, page 5, March, 1954).

Table 11.—Comparison of the Inadequacy of Protein in Rations Between Farms With the Least Swine and Farms With the Most Swine, 1951<sup>a</sup>  
(By phases of production)

Phase of production	Percentage points below recommended percentages of protein				
	None	.1-1.5	1.6-3.0	3.1-4.5	4.6 and over
<b>Spring</b>	(percent of farms in each group)				
<b>Bred sows</b>					
Farms with most.....	38	15	29	12	6
Farms with least.....	40	17	10	16	17
<b>Nursing sows</b>					
Farms with most.....	61	17	14	4	4
Farms with least.....	51	19	20	10	0
<b>Growing hogs</b>					
Farms with most.....	59	17	11	9	4
Farms with least.....	36	23	21	11	9
<b>Fall</b>					
<b>Bred sows</b>					
Farms with most.....	54	14	23	9	0
Farms with least.....	35	14	17	17	17
<b>Nursing sows</b>					
Farms with most.....	40	17	24	16	3
Farms with least.....	40	14	19	22	5
<b>Growing hogs</b>					
Farms with most.....	51	10	13	23	3
Farms with least.....	20	23	26	23	8

<sup>a</sup> Excludes farms in the northeastern area and one-third of the farms—the intermediate group—in the other four areas.

of the sorts. In all phases of production the group with the least swine had a higher percentage of farms with inadequacies of over 3 percentage points and in only one phase a higher percentage of farms feeding adequate rations. However, there was a wider variation *within* each group of farms than *between* them.<sup>1</sup>

While the farms with the least swine generally had higher inadequacies of protein in their rations, potential increases in sales of protein supplements on a tonnage basis are greater on farms with the most swine simply because they have far more swine to feed.

**Differences among farms varying in number of swine.** Farms with the most swine in the south-central and eastern areas often had no

<sup>1</sup> An analysis of variance in average deficiency of protein fed growing hogs (spring and fall) disclosed that the higher deficiency of the group with the least hogs was not significant in the western area, but was significant in the south-central area at the 5-percent level.

more swine than farms with the least swine in the western and north-western areas. For this reason another analysis of deficiency, limited to spring data, was made, based on the actual number of swine on each farm (Table 12).

In each phase of production, a greater percentage of farms with 25 or more sows or 125 or more hogs had adequate rations than farms with less than 4 sows or 25 hogs. However, for nursing sows a higher percentage of the farms with 25 or more sows had rations 3 or more percentage points below recommendations than farms with fewer sows. In all four size groups shown in Table 12, the percentage of farms

Table 12. — Comparison of Inadequacy of Protein in Swine Rations According to Actual Size of Enterprise, Spring, 1951

Number of swine	Percentage points below recommended percentages of protein		
	None	Less than 3.1 points	Over 3.0 points
(percent of farms in each group in eastern, northwestern, south-central, and western areas, combined)			
<b>Bred sows</b>			
1 to 3.....	22	25	53
4 to 12.....	46	35	19
13 to 24.....	48	40	12
25 and over.....	36	55	9
<b>Nursing sows</b>			
1 to 3.....	48	43	9
4 to 12.....	63	29	8
13 to 24.....	71	19	10
25 and over.....	64	18	18
<b>Growing hogs</b>			
3 to 24.....	46	33	21
25 to 74.....	46	37	17
75 to 124.....	57	33	10
125 and over.....	68	28	4
(percent of farms in each group in the northeastern area)			
<b>Bred sows</b>			
1-10.....	20	70	10
11-20.....	12	76	12
21 and over.....	39	61	0
<b>Nursing sows</b>			
1-10.....	20	70	10
11-20.....	59	41	0
21 and over.....	70	30	0
<b>Growing hogs</b>			
1-10.....	50	50	0
11-20.....	65	35	0
21 and over.....	87	13	0

feeding rations from 0.1 to 3 percentage points below recommendations to growing hogs was similar.

A slightly higher percentage of farms with 13 to 24 sows fed adequate rations to both bred and nursing sows than farms having 25 or more sows.

In the northeastern area (from which data were secured on a slightly different sorting basis), a much higher percentage of farms with the largest swine enterprises fed adequate rations. As shown below, farms with less than 11 sows had a slightly lower weighted deficiency than farms with 11 to 20 sows for bred sows and growing hogs, but a much higher deficiency for nursing sows.

<i>Size of enterprise</i>	<i>Bred sows</i>	<i>Nursing sows</i>	<i>Growing hogs</i>	<i>All phases</i>
1-10.....	1.59	1.32	.20	1.04
11-20.....	1.75	.39	.31	.82
21 and over.....	.73	.49	.04	.42

The differences in average deficiency among these phases were significant at the 1-percent level.

**Differences related to income from swine.** Data for the spring production period were analyzed to compare differences in feeding ac-

Table 13.—Comparison of Inadequacy of Protein in Swine Rations According to the Percentage That Swine Sales Were of Operator's Gross Cash Income, Four Areas,<sup>a</sup> Spring, 1951

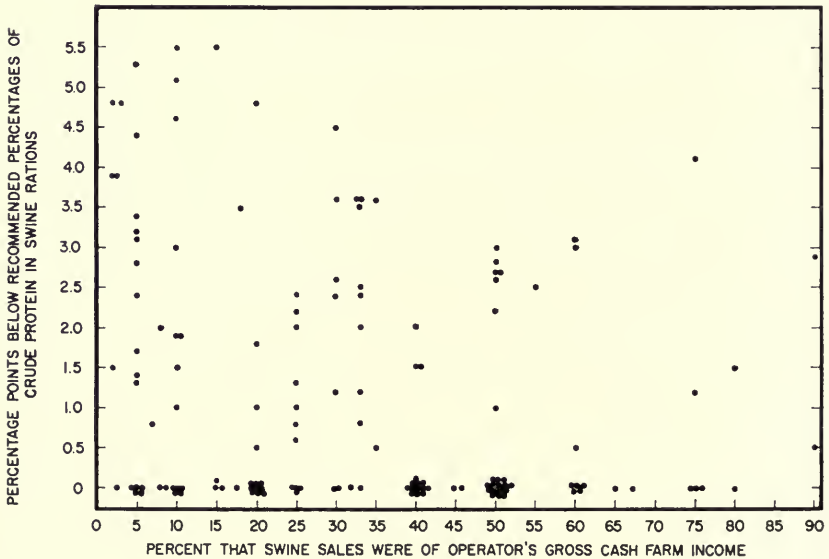
Percent of operator's gross cash income from swine sales	Percentage points below recom- mended percentages of protein		
	None	Less than 3.1 points	Over 3.0 points
	(percent of farms in each group)		
<b>Bred sows</b>			
Under 20.....	29	23	48
20 to 44.....	45	28	27
45 and over.....	29	55	16
<b>Nursing sows</b>			
Under 20.....	51	34	15
20 to 44.....	64	29	7
45 and over.....	59	32	9
<b>Growing hogs</b>			
Under 20.....	40	30	30
20 to 44.....	49	37	14
45 and over.....	63	32	5

<sup>a</sup> The northeastern area is not included because no data on swine sales were secured there.

ording to the percentage that swine sales were of the operator's gross cash income (Table 13). A smaller percentage of farms whose swine sales accounted for less than 20 percent of the operator's income fed adequate rations in two of the three phases of production.

A greater share of farms with 45 percent or more of the operator's income from swine sales fed adequate rations to growing hogs but a smaller share of them fed adequate rations to bred sows and nursing sows than farms whose swine sales accounted for 20 to 44 percent of the operator's income.

As in the other analyses of differences in adequacy of rations, variations in feeding practices *within* a given group were more noticeable than differences *among* different groups. The variations among individual farms in adequacy of protein in rations fed growing hogs farrowed in spring is shown in Fig. 2. Farms without any protein deficiency were located throughout the range of percentage of income from swine sales.



There was extensive variation among individual farms (each represented here by a dot) in feeding adequate quantities of protein to growing hogs farrowed in the spring. Adequate rations were fed by a substantial number of farms on which swine sales accounted for relatively small percentages of the operators' gross cash income, and several farms whose swine sales accounted for half or more of the operators' gross cash income fed inadequate rations.

(Fig. 2)

Table 14.—Comparison of Inadequacy of Protein in Swine Rations Between Farms on Prairie and Timber Soils, Western and South-Central Areas, 1951

Percentage points below recommended percentages of protein <sup>a</sup>	Bred sows		Nursing sows		Growing hogs	
	Prairie soils <sup>b</sup>	Timber soils <sup>c</sup>	Prairie soils <sup>b</sup>	Timber soils <sup>c</sup>	Prairie soils <sup>b</sup>	Timber soils <sup>c</sup>
	(percent of farms in each group)					
<b>Western area, spring</b>						
None.....	42	33	59	48	50	48
.1-1.5.....	15	27	15	16	23	20
1.6-3.0.....	27	20	18	16	15	24
3.1-4.5.....	12	20	4	12	8	8
4.6 and over.....	4	0	4	8	4	0
<b>Western area, fall</b>						
None.....	56	46	45	42	25	39
.1-1.5.....	22	25	25	8	15	13
1.6-3.0.....	16	12	10	29	20	26
3.1-4.5.....	6	13	20	17	35	4
4.6 and over.....	0	4	0	4	5	18
<b>South-central area, spring</b>						
None.....	23	29	59	48	55	37
.1-1.5.....	14	0	16	19	14	11
1.6-3.0.....	23	14	22	18	6	22
3.1-4.5.....	20	21	0	15	17	15
4.6 and over.....	20	36	3	0	8	15
<b>South-central area, fall</b>						
None.....	35	29	60	35	53	29
.1-1.5.....	13	0	0	12	11	12
1.6-3.0.....	22	35	24	23	11	24
3.1-4.5.....	13	12	16	24	14	29
4.6 and over.....	17	24	0	6	11	6

<sup>a</sup> Average deficiency for all phases of production was as follows: *western area*, prairie soils: 1.2; timber soils: 1.4; *south-central area*, prairie soils: 1.5; timber soils: 2.1.

<sup>b</sup> Soil association K in western Illinois and P in southern Illinois.

<sup>c</sup> Soil association L in western Illinois and O in southern Illinois.

**Differences related to soil association.** Approximately the same number of farms were selected from each of the two major soil associations in the western and south-central areas.<sup>1</sup> A summary of the differences in adequacy between these farms is given in Table 14.<sup>2</sup>

In the south-central area fewer farms on timber soils fed adequate rations in all but one phase of production than farms on prairie soils.<sup>3</sup>

In the western area differences between rations fed on farms with

<sup>1</sup> See footnote on page 4 for identification of these soils.

<sup>2</sup> When records in both the south-central and western areas were analyzed, it was found that the average deficiency for farms on timber soil was significantly higher (at the 5-percent level) than for farms on prairie soil.

<sup>3</sup> The difference in average deficiency for all production periods was significant at the 1-percent level.

Table 15.—Comparison of Inadequacy of Protein in Swine Rations Between Farms Operated by Owners and by Tenants, Western and South-Central Areas, 1951

Percentage points below recommended percentages of protein	Bred sows		Nursing sows		Growing hogs	
	Tenants	Owners	Tenants	Owners	Tenants	Owners
	(percent of farms in each group)					
<b>Western area, spring</b>						
None.....	44	32	52	55	50	48
.1-1.5.....	13	29	13	21	23	21
1.6-3.0.....	30	18	26	14	18	21
3.1-4.5.....	9	21	9	3	5	10
4.6 and over.....	4	0	0	7	4	0
<b>Western area, fall</b>						
None.....	52	47	43	44	43	23
.1-1.5.....	24	24	14	17	9	18
1.6-3.0.....	14	14	14	26	15	32
3.1-4.5.....	10	10	29	9	19	18
4.6 and over.....	0	5	0	4	14	9
<b>South-central area, spring</b>						
None.....	30	24	69	46	53	44
.1-1.5.....	6	9	12	18	17	12
1.6-3.0.....	23	16	19	23	6	16
3.1-4.5.....	6	28	0	10	12	19
4.6 and over.....	35	23	0	3	12	9
<b>South-central area, fall</b>						
None.....	39	30	79	36	59	40
.1-1.5.....	15	4	0	7	8	12
1.6-3.0.....	15	29	14	32	8	18
3.1-4.5.....	23	11	7	21	17	21
4.6 and over.....	8	26	0	4	8	9

prairie and timber soils were less distinct.<sup>1</sup> About the same number of farms on both these soils fed the same level of inadequate rations to growing hogs in the spring production period. Slightly fewer farms on timber soils than on prairie soils fed adequate rations to nursing sows and to bred sows in both spring and fall, but the reverse was true for growing hogs in the fall.

**Differences related to tenure.** In the western area approximately the same number of farms in the sample were owner-operated and tenant-operated. In this area, in four of the six phases of production, slightly more tenant-operated farms fed adequate rations than owner-operated farms. The greatest differences between tenants and owners occurred in the rations fed sows bred to farrow in the spring and growing hogs in the fall (Table 15).

<sup>1</sup> Differences of 0.2 percentage points in average deficiency were not statistically significant.



In the south-central area over twice as many farms in the sample were owner-operated as tenant-operated. A greater percentage of the tenant-operated farms fed adequate rations and a lower percentage fed rations whose inadequacy exceeded 3.0 points in all six phases of production.

**Differences between farms on prairie and timber soils with the same type of tenure.** Since differences in feeding in an area, associated with differences in soil, might be associated with differences in tenure status, a further analysis was made of the differences between owner-operated farms on prairie soils and owner-operated farms on timber soils, as well as between tenant-operated farms on prairie soils and tenant-operated farms on timber soils. The average inadequacy of protein in rations in each of these groups was as follows:

Area	<i>Owner-operators on</i>		<i>Tenant-operators on</i>	
	<i>Prairie soils</i>	<i>Timber soils</i>	<i>Prairie soils</i>	<i>Timber soils</i>
South-central..	1.60	2.25	1.47	1.27
Western.....	.85	1.55	1.38	1.06

The major points of these statistics are:

1. In both the western and south-central areas, the average deficiency<sup>1</sup> was lower for owners on prairie soils than for owners on timber soils.

2. The average deficiency was lower in both areas for tenants on timber soil than for tenants on prairie soil, but the variation among tenants was so great that the variation due to soil differences was not statistically significant at the 20-percent level.

3. In both areas owners on timber soils averaged a higher deficiency than tenants on timber soils.<sup>2</sup>

4. On prairie soils in the western area, owners had a lower deficiency than tenants,<sup>3</sup> but in the south-central area the mean deficiencies were about the same and the difference was not statistically significant.

The reasons for these differences might, in turn, be traced to differences in the financial position of operators on land of different productivity. This possibility, however, was not tested.

## SUMMARY

This study appraised the protein content of rations fed to swine on individual farms in 1951 in relation to recommendations of the Illinois Plan for Swine Feeding. Differences in the adequacy of protein fed

<sup>1</sup> Differences were significant at the 1-percent level.

<sup>2</sup> The difference was statistically significant in both areas at the 20-percent level and almost at the 5-percent level.

<sup>3</sup> The difference was statistically significant at the 5-percent level.

swine were determined within five areas in Illinois — western, north-western, northeastern, eastern, and south-central — selected because they represent varying levels in intensity of swine production.

The amount of protein supplement required to eliminate protein deficiency in each phase of production was determined, as were differences in deficiencies occurring among groups of farms varying in size of swine enterprise, proportion of operator's income from swine sales, soil association, and tenure.

Major findings with respect to the adequacy of protein fed were:

1. Nearly all farms fed a protein supplement at least part of the time.
2. About 7 out of every 8 farms used some commercially mixed protein supplement.
3. Alfalfa meal, meat scraps or tankage, skim milk, and soybean meal were the ingredient supplements fed in every area. The percentage of farms using a given ingredient varied considerably from area to area, reflecting differences in the availability and price of that ingredient.
4. A higher percentage of farms omitted protein supplements when feeding bred sows than when feeding either nursing sows or growing hogs.
5. The south-central and northwestern areas had the highest percentages of farms feeding swine in drylot — one-eighth of the farms in each area. Among phases of production in every area, the percentage of farms not making pasture available was higher for sows bred to farrow in the spring and for growing hogs farrowed in the fall.
6. The northeastern area had the highest percentage of farms making legume pasture available to swine; the south-central and eastern areas had the highest percentages making grass pasture available to swine.
7. About one-fourth of the farms fed rations containing the recommended level of protein in every phase of production conducted on those particular farms. However, among all areas in all phases of production, an average of half the farms fed rations that met the recommended levels for protein adequacy.
8. Among the five areas, the most significant differences in protein deficiency occurred in two phases of production: sows bred to farrow in the spring and growing hogs farrowed in the spring.
9. Among phases in the spring production period, differences in protein deficiency were most significant in the northeastern and south-central areas. Among phases in the fall production period, differences were most significant in the western area.

10. Within areas, rations were most and least deficient as follows:

<i>Area</i>	<i>Most deficient</i>	<i>Least deficient</i>
Western.....	Growing hogs, fall	Bred sows, fall
Eastern.....	Growing hogs, fall	Nursing sows, spring
South-central.....	Bred sows, spring	Nursing sows, spring
Northeastern.....	Bred sows, spring	Growing hogs, spring
Northwestern.....	Bred sows, fall	Growing hogs, spring

11. Farms in the northeastern and northwestern areas fed rations averaging a lower protein deficiency than rations fed in the eastern area, and considerably lower than rations fed in the western and south-central areas.

12. The average deficiency for all areas was about 1 percentage point below the recommended protein level. If this deficiency were to be eliminated by the use of a 35-percent protein supplement, a 27-percent increase in the amount of protein supplement used would be required.

13. Within areas, the percentage increases in protein supplement needed to eliminate deficiency ranged from only 2 percent (in the northeastern area for growing hogs farrowed in the spring) to over 59 percent (in the south-central area for sows bred to farrow in the spring, in the western and eastern areas for growing hogs farrowed in the fall, and in the northwestern area for sows bred to farrow in the fall).

14. Nearly two-thirds of all the brands of commercially mixed feed used were fed in only one of the five areas. One-eighth of the brands used were fed in all five areas.

Major findings as related to certain factors were:

1. In all phases of production the group with the least swine had a higher percentage of farms with protein inadequacies of over 3 percentage points. In only one of the six phases did the group with the least swine have a higher percentage of farms feeding adequate rations than the group with the most swine. Differences in average deficiency between these two groups were significant in the south-central and northeastern areas, but not in the western area.

2. A higher percentage of farms on which the operator's sales of swine represented 45 percent or more of his gross cash farm income fed adequate rations in the spring production period than farms on which the operator's sales of swine represented less than 20 percent of his gross cash farm income.

3. In the south-central area, farms located on timber soils averaged 0.6 percentage points higher deficiency than farms on prairie soils, but in the western area farms on timber soils averaged only 0.2 percentage points higher deficiency than farms on prairie soils. These differences were significant only in the south-central area.

4. A greater share of tenant-operators fed adequate amounts of protein in the south-central and western areas than owner-operators in those areas.

5. In both the south-central and western areas, owner-operators on prairie soils fed rations averaging less protein deficiency than owner-operators on timber soils. However, tenant-operators on prairie soils in these areas averaged more deficient rations than those on timber soils. Rations fed by owners on timber soils averaged a higher deficiency in protein than those fed by tenants on timber soils.

## APPLICATION OF FINDINGS

This study, dealing with matters pertinent to manufacturers and distributors of protein supplements, as well as to others who advise and serve farmers, showed a wide variation in swine-feeding practices among individual farms and within and among areas.

Because of such variation, those who advise farmers must find out the specific feeding practices and conditions on individual farms in order to make the soundest recommendations. Their educational and advertising programs should point out those times when farmers are apt to feed deficient amounts of protein, such as when pasture deteriorates or becomes unavailable, and when pigs weigh less than 75 pounds.

The 27-percent increase in protein supplement required in the areas studied to meet recommended levels provides only a reference point today in appraising the additional market for commercially mixed protein supplements. Current appraisals must consider *changes* in many factors, of which these are major:

1. Number of swine produced.
2. Protein content of formula feeds sold.
3. Use of pasture.
4. Seasonal distribution of swine farrowings.
5. Feeding and management practices such as earlier weaning, more extensive practice of creep feeding, and disease control.
6. Nutritional requirements of swine as determined by research studies.
7. Protein content of corn and other feedstuffs used.
8. Amount of home-mixed rations.

The findings of this study suggest that a greater use of protein supplement per animal will occur if the proportion of enterprises with 1 to 3 sows declines, for this size enterprise averaged somewhat higher protein deficiency than the large ones. Likewise, as the size of the swine enterprise increases on a given farm, supplement may need to be purchased because the availability per animal of pasture and of farm-produced grains and skim milk may be reduced. Therefore, changes in the size of swine enterprises are of concern to the feed industry.

The individual feed dealer is also affected by such changes because farmers with large swine enterprises tend to attract other dealers and more of these farmers may purchase straight protein ingredients to mix themselves or have mixed locally.

Illinois farm records<sup>1</sup> show that the more profitable swine enter-

<sup>1</sup>"Summary of farm business records on Illinois farms for 1953," by A. G. Mueller, in *Illinois farm economics*, No. 221, p. 1543, Nov., 1954.

prises (upper sixth of records) have used on the average about 20 percent less protein supplement per pound of pork produced than the less profitable swine enterprises (lower sixth of records). Thus it would seem that if farmers as a group improve the management of their swine enterprises they will tend to use less protein per animal. At the same time, it should be recognized that some farmers who have less profitable swine enterprises may be able to increase their net income by using more protein.

Continual study of farmers' feeding practices is needed. Particular attention should be given to finding out under what conditions limiting the amount of protein supplement is more profitable than free-choice feeding, which, many farmers contend, is the case on their farms. Further research on input-output relationships arising from feeding swine rations of different levels of protein will help answer this question, for the expected returns under varying price relationships between high-protein feeds and other feeds could then be determined. Other research determining how different feeding practices affect the use of labor and other farm resources would also be helpful in establishing the most profitable feeding plan on a given farm.

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