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TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 454 SEPTEMBER, 1932

DIVISION OF CHEMISTRY

Digestibility and Production Coefficients of Hog Feeds

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**In cooperation with U. S. Department of Agriculture.

The value of a pig feed depends chiefly upon its content of digestible protein and productive energy. The average composition, productive energy and digestible protein are given for a number of pig feeds. Tentative standards for pig feeding are given, for use in connection with the productive values here presented. The results of 14 digestion experiments on pig feeds are given, with a compilation of 139 other digestion experiments with pigs. Pigs have lower digestive powers than ruminants and higher digestive powers than chickens. The power of pigs for digesting crude fiber and fibrous feeds is especially low. Tentative production coefficients are given for pig feeds. They can be used to calculate the productive energy of pig feeds.

CONTENTS

BULLETIN NO. 454 SEPTEMBER, 1932

DIGESTIBILITY AND PRODUCTION COEFFICIENTS OF PIG FEEDS

By G. S. FRAPS

The value of a feed to an animal depends upon the ability of the animal to digest and utilize it, as well as on the nature of the feed. The digestibility of various feeds is measured by experiments with the animals which use it. It is known that digestive powers vary with different kinds of animals (4,5); the differences are greater with coarse feeds, such as hays and fodders, than with concentrated feeds, such as corn or cottonseed meal. Ruminants such as sheep and cows (4) have the power to digest and utilize part of the crude fiber and other constituents of roughages, while poultry (5) and hogs have little power to digest such material. Animals also vary in their ability to utilize the digested material; pigs seem to make better use of digested material than ruminants. There are also differences in the value of the digested material to animals. The digested portions of fodders and roughages have less value to cows than the digested portions of concentrates, such as corn, pound for pound (6 9). This fact is taken into consideration in calculating the productive energy of feeds.

DIGESTION EXPERIMENTS WITH PIGS

The number of digesttion experiments which have been made with pigs is considerably less than the number made on ruminants and about the same number as have been made on poultry. Texas Bulletin 329 (4) contains a calculation of 1028 American digestion experiments on ruminants. Bulletin 372 (5) contains 151 experiments on poultry, 39 of which are forign experiments. This Bulletin gives coefficients of digestibility for 153 digestion experiments with hogs or pigs, 14 of which are here reported for the first time by the Texas Agricultural Experiment Station, and 54 of which are German experiments.

METHOD OF WORK

The animals were kept in elevated pens, on metal screen with ⅞-inch openings which permitted the passage of the solid and liquid excrement. A wire screen of 4 meshes to the inch retained the solid excrement while the liquid excrement was conducted by means of a galvanized iron funnel to a glass vessel in which it was saved for analysis. The preliminary period was 5 days and the digestion period was 6 days. The excrements were collected daily and the solid excrement weighed and dried for analysis. The liquid excrements were made up to volume and aliquots taken for analysis; this work will be presented in a subsequent publication. When a mixture of feeds was used, as was done in some cases, the coefficients of digestibility of one of the feeds were calculated by the use of the coefficients of digestibility of the other feed taken from averages of other experiments made by us.

FEEDS USED IN THE TEXAS DIGESTION EXPERIMENTS

The ordinary chemical composition of the feeds used in the experiments are given in Table 1. The barley used was whole barley, with the husk. All the feeds are of good quality and of good composition, as is shown by the analyses given in the table.

Digestion Coefficients

The coefficients of digestibility secured from each pig in the Texas experiments are given in Table 2. As is to be expected, there are differences between the digestion coefficients secured on the same feed by the two animals

COMPILATION OF DIGESTION EXPERIMENTS

A compilation was made of a number of digestion experiments with pigs, and all those which were found are given in Table 3. Both American and foreign experiments are included. The average coefficients from the Texas experiments given in Table 2 are also included in Table 3. No attempt was made to find all the foreign digestion experiments on pigs. The feeds are listed in alphabetical order, and averages are given when two or more experiments were made.

DIGESTION BY PIGS AS COMPARED WITH DIGESTION BY POULTRY AND RUMINANTS

The rather limited data on the digestion coefficients of feeds for pigs here presented are compared in Table 4 with digestion coefficients for similar feeds fed ruminants (3, 6, 9) and poultry (5). As a rule, pigs have lower digestive powers than ruminants and higher than chickens. There are, however, many exceptions to this rule. The protein of corn, of linseed meal, and of rice polish is digested to a greater extent by pigs than by ruminants. The extent of digestion of the protein of cottonseed meal, oats, rice bran, wheat bran, and wheat gray shorts or flour middlings, is practically the same for pigs as for ruminants. Fat is digested to a smaller extent by pigs than by ruminants in almost all cases. The nitrogen-free extract is digested about the same by pigs as by ruminants, and to a greater extent by pigs than by poultry, with almost all feeds. The exceptions are wheat and wheat gray shorts, which are digested to a greater extent by ruminants than by pigs or poultry.

The most pronounced differences in digestion for the three groups of animals are for crude fiber. Pigs have a greater power to digest crude fiber than have chickens but much less than ruminants. Neither chickens or pigs are adapted to use feeds which contain much woody or fibrous material. The digestive organs of pigs and chickens can handle concentrated feeds, high in sugars, starch, or protein, but are poorly adapted to handle hays, fodders, chaff, oat hulls, rice hulls, stems, or other fibrous materials.

Table 1. Percentage composition of feeds used in digestion experiments with hogs (Texas).

Laboratory Number		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	Used in Exp. No.
26247	Barley, ground	12.15	2.42	7.27	67.22	8.19	2.75	7
25789	Barley, unground	10.22	1.70	5.06	70.60	10.22	2.20	7
31126	Corn	9.94	4.34	2.93	71.49	9.78	1.52	10
25791	Corn chops	10.16	3.61	2.35	72.33	10.11	1.44	1
25975	Corn chops	10.05	3.81	1.93	72.86	10.12	1.23	3
26147	Corn chops	10.58	4.15	2.07	72.03	9.81	1.36	5
26314	Corn chops	9.65	4.30	2.43	72.15	10.20	1.27	9
31201	Corn chops	10.19	3.54	2.21	72.80	10.06	1.20	13
31215	Corn chops	10.55	4.39	2.58	71.97	8.90	1.61	15
26285	Cottonseed meal	45.50	6.08	10.16	26.16	6.25	5.85	8
26315	Cottonseed meal, 43% protein	42.76	7.38	11.65	27.66	4.94	5.61	9
25993	Cottonseed meal, 43% protein	43.12	7.07	10.90	27.01	6.60	5.30	4
25974	Meat and bone scraps	47.45	7.87	1.88	2.54	6.36	33.90	3
31173	Milo, ground	11.41	2.85	2.26	73.07	8.61	1.80	12
31154	Milo, whole	12.29	2.93	1.82	69.74	11.47	1.75	11
31200	Rice bran	12.67	12.91	14.31	39.32	7.47	13.32	13
31214	Rice polish	12.62	11.57	2.13	59.31	8.56	5.81	15
26146	Wheat bran	17.91	4.33	8.50	55.94	7.39	5.93	5
26286	Wheat bran	17.83	4.51	8.96	54.87	7.95	5.88	8
26185	Wheat gray shorts	18.43	4.95	6.03	57.83	8.23	4.53	6

Table 2. Individual digestion coefficients secured in experiments here reported.

Laboratory Number		Protein	Ether extract	Crude fiber	Nitrogen free extract	Period Number	Pig Number
25789	Barley	66.7	14.2	14.7	81.7	2	1
25789	Barley	73.9	26.3	12.4	82.9	2	2
26247	Barley, ground	77.1	39.5	16.1	84.6	7	1
26247	Barley, ground	73.9	43.3	21.4	84.8	7	2
25791	Corn	69.1	58.2	35.6	91.3	1	1
25791	Corn	83.5	71.5	64.4	96.0	1	2
31126	Corn	66.2	65.6	41.1	90.9	10	1
31126	Corn	67.1	60.7	41.4	91.4	10	2
25993	Cottonseed meal (fed with corn chops)	88.4	87.9	16.6	70.6	4	1
		91.3	93.6	31.1	74.1	4	2
26315	Cottonseed meal (fed with Corn chops, 26314)	84.6	92.6	29.3	61.0	9	1
		84.8	91.6	29.2	64.9	9	2
25974	Meat and bone scraps (fed with corn meal, 25975)	97.7	100.0			3	1
		98.8	100.0			3	2
31173	Milo, ground	77.8	64.9	75.7	97.3	12	1
31173	Milo, ground	82.8	67.5	75.2	97.5	12	2
31154	Milo, whole	54.9	49.9	45.5	76.2	11	1
31154	Milo, whole	67.5	56.4	67.6	91.0	11	2
31200	Rice bran (fed with corn chops, 31201)	60.7	75.3	17.6	61.4	13	1
		73.3	83.9	22.5	69.0	13	2
31214	Rice polish (fed with corn chops, 31215)	85.2	83.1	26.0	92.5	15	1
		73.4	89.3	52.7	94.6	15	2
26286	Wheat bran (fed with cottonseed meal, 26285)	79.7	59.1	20.2	71.8	8	1
		81.5	56.1	24.0	71.8	8	2
26185	Wheat shorts	79.0	63.5	15.5	79.4	6	1
26185	Wheat shorts	84.2	66.7	19.9	76.7	6	2
26146	Wheat bran (fed with corn chops, 26147)	71.7	26.0	40.3	66.1	5	1
		77.2	47.3	26.7	74.5	5	2

Table 3. Average digestion coefficients for pigs.

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen free extract	Reference Number
Alfalfa, before blooming (23% protein, 27% fiber)	1	67.8	9.3	30.5	53.8	132
Alfalfa, beginning to bloom (14% protein, 33% fiber)	1	33.7		21.1	66.1	131
Barley and ground corn (1 to 1)		66.9	73.9	13.7	89.1	58
Barley and ground corn (1 to 1)		66.1	61.7	16.3	88.6	59
Barley and ground corn (1 to 1), Average	2	66.5	67.8	15.0	88.9	
Barley bran (18.5% protein, 8% fiber)	1	85.5	60.7	2.6	80.2	148
Barley feed meal (16.6% protein, 0.8% fiber)	1	94.8	82.2	64.1	97.3	149
Barley, whole and ground, 4 to 7% fiber		55.6	36.1	16.8	81.6	56
Barley, whole and ground, 4 to 7% fiber		52.3	29.9	11.4	80.7	57
Barley, whole and ground, 4 to 7% fiber		81.5	57.0	48.7	86.6	65
Barley, whole and ground, 4 to 7% fiber (whole)		70.3	20.3	13.6	82.3	86
Barley, whole and ground, 4 to 7% fiber (Russian feed)		79.4	70.8	26.8	86.0	100
Barley, whole and ground, 4 to 7% fiber (Russian feed)		79.2	12.9	7.5	87.0	101
Barley, whole and ground. 4 to 7% fiber (German feed)		77.3	40.4	18.9	88.4	102
Barley, whole and ground, 4 to 7% fiber (Winter)		68.9	24.4	2.9	87.5	103
Barley, whole and ground, 4 to 7% fiber (good quality)		73.4	16.8	8.4	89.5	104
Barley, whole and ground, 4 to 7% fiber (best quality)		77.2	56.2	25.5	91.2	105
Barley, whole and ground, 4 to 7% fiber (ground)		61.1	80.0	0.7	86.9	60
Barley, whole and ground, 4 to 7% fiber (ground)		59.3	57.7	6.6	85.5	61
Barley, whole and ground, 4 to 7% fiber (ground)		75.5	21.4	18.8	84.7	91
Barley, whole and ground, 4 to 7% fiber (ground)		82.3	25.3	.0	89.8	138
Barley, whole and ground, 4 to 7% fiber, Average	14	71.0	39.2	14.8	86.3	
Beans or bean meal		80.1	30.2	15.1	90.6	107
Beans or bean meal		87.5	52.4	4.5	91.2	141
Beans and bean meal, Average		83.8	41.3	9.8	90.9	
Beets, feeding (8.9% protein, 6.3% fiber, dry basis)	1	58.2	.....	88.4	96.1	116
Beets, feeding raw (8.8% protein, 5.7% fiber, dry basis)	1	55.7	.....	72.7	97.2	117
Beet leaves, acid (8% protein, 12.4% fiber, 60% ash, dry basis)	1	40.5	17.7	61.0	53.9	121
Beet pulp. (7% protein, 16-13% fiber, dry basis)		.....	.....	70.6	90.7	119
Beet pulp. (7% protein, 16-13% fiber, dry basis)		.....	.....	54.4	93.5	120
Beet pulp. (7% protein, 16-13% fiber, dry basis)	2	.....	.....	62.5	92.1	
Beet pulp, dried (8.8% protein, 17.9% fiber, dry basis)	1	32.2	.....	86.1	91.3	118
Beets, sugar (6% protein, 5.7% fiber, dry basis)	1	52.2	.....	100.0	98.8	113
Beets, sugar dried (5.8% protein, 5.6% fiber)	1	26.1	.....	80.2	96.3	114
Beets, sugar, dried and steamed	1	11.1	.....	82.7	96.7	115
Brewers grains, dry basis (21% protein, 17% fiber)		63.3	48.8	14.9	52.2	123
Brewers grains, dry basis (26% protein, 18% fiber)		77.5	56.7	13.7	43.4	151
Brewers grains, dry basis (31% protein, 13% fiber)		78.4	55.7	35.8	51.2	152
Brewers grains, dry basis, Average	3	73.1	53.7	21.5	48.9	

Table 3. Average digestion coefficients for pigs.—(Continued).

	Number averaged	Protein	Ether extract	Crude fiber	Nitrogen free extract	Reference number
Clover, red, before blooming (17% protein, 22% fiber, dry basis)	1	49.4	24.0	23.6	71.2	128
Clover, red, beginning to bloom 18% protein, 24% fiber, dry basis)	1	32.6	11.9	16.2	56.8	129
Clover, red, immediately after blooming (22% protein, 26% fiber, dry basis).	1	51.0	31.5	43.1	54.2	130
Corn and cob meal	1	75.7	82.0	28.5	83.6	62
Corn (whole)		66.7	63.2	41.3	91.2	94
Corn (whole)		79.4	74.0	43.6	93.9	106
Corn (whole)		68.7	45.6	38.3	88.8	63
Corn (whole)		89.9	77.6	48.7	93.9	67
Corn (whole), Average	4	76.2	65.1	43.0	92.0	
Corn chops		82.4	70.8	42.4	93.6	8
Corn chops		76.3	64.9	51.1	93.7	85
Corn chops, Average	2	79.4	67.9	46.8	93.7	
Corn, ground		78.2	76.3	----	89.8	15
Corn, ground		80.4	66.3	31.8	93.6	35
Corn, ground		69.8	83.7	.0	89.3	46
Corn, ground		76.2	87.8	.0	88.4	47
Corn, ground		82.4	64.4	28.1	96.4	48
Corn, ground		80.4	73.0	3.0	96.7	49
Corn, ground		73.8	67.3	38.0	91.3	50
Corn, ground		74.2	62.4	39.6	91.6	53
Corn, ground		75.3	70.8	29.7	92.9	54
Corn, ground		74.8	72.5	32.0	92.5	55
Corn, ground, Average	10	76.6	72.5	22.5	92.3	
Corn meal (finely ground)		86.1	81.7	29.4	94.2	64
Corn meal (finely ground)		93.2	62.7	76.8	92.1	83
Corn meal (finely ground)		93.2	65.3	60.9	94.0	84
Corn meal (finely ground), Average	3	90.8	69.9	55.7	93.4	
Corn, ground and pork cracklings (9.8-1) (9.2-1)		84.6	93.4		92.0	21
Corn, ground and pork cracklings (10.2:1) (9:1)		82.9	85.3			22
Corn, ground and pork cracklings (10.5-1) (10.3-1)		82.9	84.0			23
Corn, ground and pork cracklings (10.2-1) (10.1-1)		81.9	87.4			24
Corn, ground and pork cracklings (10-1) (10-1)		86.7	91.5			25
Corn, ground and pork cracklings (10-1) (9.6-1)		88.0	90.0			26
Corn, ground and pork cracklings (10-1) (8.3-1)		87.1	93.4			27
Corn, ground and pork cracklings (10-1) (8.3-1)		89.3	93.1			28
Corn, ground and pork cracklings, Average		85.4	89.8		92.0	
Corn, ground and red dog flour (2:1)	1	83.6	55.0		90.2	17
Corn, ground, red dog flour and pork cracklings (20:10:1)	1	85.6	68.9		92.5	30

Table 3. Average digestion coefficients for pigs.—(Continued).

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen free extract	Reference number
Corn, ground, red dog flour, tankage and pork cracklings		78.7	90.0		89.0	31
Corn, ground, red dog flour, tankage and pork cracklings		80.7	92.5			32
Corn, ground, red dog flour, tankage and pork cracklings		87.6	93.4			33
Corn, ground, red dog flour, tankage and pork cracklings		80.9	93.2			34
Corn, ground, red dog flour, tankage and pork cracklings, Average	4	82.0	92.3		89.0	
Corn, ground and tankage (6:1)		66.1	70.3		91.2	18
Corn, ground and tankage (5-1:4-1)		75.9	89.3	19.0	92.4	19
Corn, ground and tankage (4:1)		63.9	69.5		(89.7)	20
Corn, ground and tankage (1 to 7.5)		74.6	74.6	52.5	91.8	42
Corn, ground and tankage (1 to 7.5)		73.9	77.0	50.5	91.7	43
Corn, ground and tankage (1 to 7.5)		75.0	86.7	47.4	92.4	44
Corn, ground and tankage (1 to 7.5)		75.6	85.0	54.3	92.6	45
Corn, ground and tankage, Average	7	72.1	78.9	44.7	91.7	
Corn, ground, tankage and pork cracklings	1	72.7	85.3		(89.5)	29
Corn, ground, and wheat middlings (1-1)		87.5	82.5	54.9	92.9	16
Corn, ground, and wheat middlings (1-1)		77.9	83.1	16.6	86.1	51
Corn, ground, and wheat middlings (1-1)		76.7	83.8	7.6	85.8	52
Corn, ground and wheat middlings (1-1), Average	3	80.7	83.1	26.4	88.3	
Cottonseed meal		79.6	85.0	39.6	63.3	7
Cottonseed meal (25975)		89.9	90.8	23.8	72.4	88
Cottonseed meal		84.8	91.6	29.2	64.9	93
Cottonseed meal, Average	3	84.8	89.1	30.9	66.9	
Esparette	1	36.9	18.3	39.4	65.5	133
Fish meal		91.3	45.3			122
Fish meal, A		93.7	45.1			144
Fish meal, B		91.8	-----			145
Fish meal, Average	3	92.3	45.2			
Flour, red dog	1	88.9	-36.3		(91.2)	11
Kafir	1	77.1	62.1	67.3	96.2	6
Linseed meal		86.0	80.0	12.0	85.0	76
Linseed meal		92.0	61.8	19.5	79.7	78
Linseed meal, Average	2	89.0	70.9	15.8	82.4	
Meat and bone scraps	1	98.8	100.0			87
Meat meal		84.8	100.0		100.0	82
Meat meal		91.1	83.2			142
Meat meal, Average	2	88.0	91.6		100.0	
Milk, skim		99.1	100.0		100.0	80
Milk, skim		90.2	80.9		95.1	136
Milk, skim, Average	2	94.7	90.5		97.6	

Table 3. Average digestion coefficients for pigs.—(Continued)

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen free extract	Reference number
Milk, whole	1	94.2	97.5		93.7	137
Millet, hog	1	68.4	58.9	33.4	91.6	77
Milo, ground (31173)	1	80.3	66.2	75.4	97.4	96
Milo, whole (31154)	1	61.2	53.2	56.5	83.6	95
Oats, whole ground		78.4	86.3	21.9	78.3	5
Oats, whole ground		78.8	69.4	0.7	78.9	139
Oats, whole ground, Average	2	78.6	77.9	11.3	78.6	
Palm nut cake	1	70.0	78.3	35.6	76.9	124
Peas, ground	1	88.6	50.0	77.9	95.1	66
Pork cracklings		111.4	113.5			12
Pork cracklings		96.3	92.2			13
Pork cracklings		91.8	103.5			14
Pork cracklings, Average	3	99.8	103.1			
Potato, cooked	1	82.0	.....	.....	97.6	75
Potato, dried		17.0	.....	21.6	92.1	108
Potato, dried		55.3	.....	65.0	94.9	109
Potato, dried		36.0	.....	29.1	96.8	110
Potato, dried		25.3	.....	44.6	98.0	111
Potato, dried		.....	.....	20.5	88.0	112
Potato, dried, Average	5	33.4	.....	36.2	94.0	
Potato, raw	1	84.5	.....	.....	98.1	74
Rice bran, 13%protein, 10.4% fiber		75.7	86.5	20.5	80.6	2
Rice bran, 12.7% protein, 14.3% fiber		67.0	79.6	20.0	65.2	97
Rice bran, 12.8% protein, 9.5% fiber		57.6	76.2	.....	78.4	125
Rice bran, Average	3	66.8	80.8	20.3	73.7	
Rice polish, 2% fiber		87.5	87.1	55.2	95.6	3
Rice polish, 2% fiber		79.3	86.2	39.4	93.5	98
Rice polish, 2% fiber, Average	2	83.4	87.6	47.3	94.5	
Rye bran, 17% protein, 6% fiber	1	72.4	36.5	26.7	72.8	146
Rye feed meal, 13.6 %protein, 1.3% fiber	1	87.8	76.9		93.9	150
Rye meal, 12.5% protein, 1.5% fiber	1	81.7	35.2		93.0	140
Rye shorts, 18.3% protein, 3.7% fiber	1	82.4	56.5	42.4	87.5	126
Soybeans	1	93.6	83.8	29.5	101.4	81
Tankage		61.0	81.0		76.7	10
Tankage		78.0	100.0			143
Tankage, Average	2	69.5	90.5		76.7	
Vetch, before blooming with pods (21.9% protein, 27.5% fiber, dry basis)	1	47.9		44.2	43.1	134

Table 3. Average digestion coefficients for pigs.—(Continued).

	Number averaged	Protein	Ether extract	Crude fiber	Nitrogen free extract	Reference Number
Vetch, before blooming without pods (22.2% protein, 28.9% fiber, dry basis)	1	56.2	13.7	42.6	48.2	135
Wheat bran		76.3	80.2	19.2	68.3	4
Wheat bran		75.8	65.4	26.9	56.0	70
Wheat bran		74.4	78.1	39.1	75.0	71
Wheat bran		71.6	34.6	14.1	68.5	89
Wheat bran		80.6	57.6	22.1	71.8	92
Wheat bran		82.2	71.5	25.6	76.4	147
Wheat bran, Average	6	76.8	64.6	24.5	69.3	
Wheat chaff (9.3% protein, 26.6% fiber	1	20.3	.....	10.0	30.3	153
Wheat cracked		80.0	70.0	60.0	83.0	72
Wheat cracked		70.0	60.0	30.0	74.0	73
Wheat cracked, Average	2	75.0	65.0	45.0	78.5	
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		81.1	89.3	19.6	81.3	36
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		77.5	89.3	0.2	77.2	37
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		79.0	89.2	12.4	77.2	38
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		78.7	80.9	22.8	83.1	39
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		80.0	83.8	22.7	81.3	40
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		80.1	87.8	18.8	79.2	41
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		93.9	79.2	14.2	82.5	79
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		87.9	70.8	27.3	87.5	127
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		85.8	79.9	34.8	85.7	1
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		81.6	65.1	17.7	78.0	90
Wheat flour middlings or gray shorts (18%protein, 6% fiber)		91.3	93.3	62.9	91.8	9
Wheat flour middlings or gray shorts (18% protein, 6% fiber), Average	11	83.4	82.6	23.0	82.3	
Wheat mixed feed (8.5% fiber)		71.0		25.0	85.5	68
Wheat mixed feed (8.5% fiber)		76.0		48.0	88.0	69
Wheat mixed feed (8.5% fiber), Average	2	73.8		36.5	86.8	

Table 4. Percentages digested by pigs as compared with ruminants and poultry.

		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Number averaged
Alfalfa before blooming (23% protein, 27% fiber),	pigs	67.8	9.3	30.5	53.8	1
Alfalfa hay below 30% crude fiber,	ruminants	74.3	39.8	43.0	72.4	
Alfalfa beginning to bloom (14% protein, 33% fiber),	pigs	33.7	.....	21.1	66.1	1
Alfalfa hay over 33% croude fiber,	ruminants	69.3	32.3	46.4	68.8	
Alfalfa hay over 33% crude fiber,	poultry	63.4	21.8	1.4	34.4	
Barley, whole and ground, 4 to 7% fiber,	pigs	71.0	39.2	14.8	86.3	14
Barley, grain	ruminants	80.0	80.0	58.7	91.9	6
	poultry	72.0	58.1	10.8	82.1	21
Brewers grains	pigs	73.1	53.7	21.5	48.9	3
Brewers grains	ruminants	80.8	89.7	49.7	56.6	2
Corn, all	pigs	79.8	71.3	33.1	92.7	15
Corn, all	ruminants	64.1	88.4	30.6	92.3	15
Corn, all	poultry	73.6	86.9	13.2	90.2	43
Cottonseed meal	pigs	84.8	89.1	30.9	66.9	3
Cottonseed meal	ruminants	83.0	96.5	35.9	67.8	13
Cottonseed meal	poultry	76.1	86.2	13.2	90.2	8
Linseed meal	pigs	89.0	70.9	15.8	82.4	2
Linseed meal	ruminants	83.9	92.1	59.4	82.2	4
Meat meal	pigs	88.0	91.6	.....	100.0	2
Meat meal	poultry	86.7	93.1	.....	34.0	7
Oats, whole ground	pigs	78.6	77.9	11.3	78.6	2
Oats, whole ground	ruminants	79.0	86.4	41.6	81.9	8
Oats, whole ground	poultry	74.1	81.7	7.1	69.3	21
Rice bran,	pigs	66.8	80.8	20.3	73.7	3
Rice bran,	ruminants	69.3	82.8	22.6	73.6	5
Rice bran,	poultry	57.9	87.1	3.0	52.3	9
Rice polish, 2% fiber,	pigs	83.4	87.6	47.3	94.5	2
Rice polish, 2% fiber,	ruminants	67.9	85.9	14.9	92.2	4
Rice polish, 2% fiber,	poultry	80.9	94.8	4.3	89.3	4
Tankage,	pigs	69.5	90.5	.....	76.7	2
Tankage,	poultry	85.3	95.9	.....	43.5	4
Wheat bran	pigs	76.8	64.6	24.5	69.3	6
Wheat bran	ruminants	76.5	67.2	32.1	71.9	13
Wheat bran	poultry	59.9	50.0	7.9	54.1	
Wheat cracked,	pigs	75.0	65.0	45.0	78.5	2
Wheat cracked,	ruminants	81.9	77.4	55.3	94.0	5
Wheat cracked,	poultry	74.0	47.1	8.7	88.9	34
Wheat flour middlings or gray shorts,	pigs	83.4	82.6	23.0	82.3	11
Wheat flour middlings or gray shorts,	ruminants	84.2	88.5	35.7	90.3	7
Wheat flour middlings or gray shorts,	poultry	69.2	85.2	13.0	71.0	4

PRODUCTIVE ENERGY

A portion of the energy in the food eaten by an animal passes through in the undigested compounds in the solid excrement. Another portion appears in the liquid excrement, and in the metabolic products found in the solid excrement. Some of the energy is lost by fermentation in the intestines, and a portion is consumed by the work of digestion and other processes consequent upon the ingestion of the food. There finally remains a portion of the energy of the food, termed the net energy, which can be used for the maintenence and repair of the animal body, and for productive processes, such as the production of fat, flesh, milk, eggs, or for work or motion.

The proportion of the net energy which can be used for the various purposes of the animal appears to vary to some extent (2). It appears probable that a larger proportion of the net energy can be used for maintenance of the animal than for the production of fat. Thus, the process of transforming the various constituents produced by digestion into the form of fat, and into the other compounds formed in the gain of weight, involves a larger consumption or loss of energy, than does their use for the maintenance or repair of the body. In the production of milk, eggs, or even for work, different percentages of the net energy may be required for the transformation of matter involved in the processes, so that the percentage of the net energy which appears as milk, eggs, etc., may be different. Therefore, if the excess of net energy of a ration over maintenance requirements is measured in terms of different uses made of it, different values may be obtained; one value when used for maintenance, another value when used for work, a third value when used for fattening, a fourth when used for milk, and so on. The net energy of a feed measured in terms of maintenance of an animal is considerably higher than when measured in terms of fat. H. H. Mitchell (11), for example, assumes that 100 per cent of the metabolizable energy may be used for maintenance, while 76 per cent of the metabolizable energy is used for fattening of hogs. The net energy of a feed measured by work done by the animal, or by milk produced might also be different from the value measured by maintenance or fattening.

It is important to know how much of the energy of a feed can be used for the various functions of the animal. But for the practical purposes of comparing energy values of feeds, calculating rations, and other services, it is necessary to avoid the confusion of several net energy values of the same feed, and adopt a single unit to be used for all feeds and for all calculations. For these purposes, Kellner (9) adopted the measurement of the fat produced on a fattening animal as the measure of the productive value of a feed. Of the various uses made by an animal of his feed, the production of fat is probably the most easy to measure. Kellner expressed the productive value in terms of starch. The same value is here used, is expressed in terms of energy.

The productive value of a feed, as here used, is measured by the quantity

of fat which a unit of the feed will put on a fattening animal, receiving a basal ration sufficiently above maintenance to ensure that the added units of feed will be used only for fattening purposes. While the net energy of a feed for production of milk, eggs, or work, or for maintenance, may be different from the productive energy measured by production of fat, yet the food required for these purposes can all be expressed in terms of such productive energy. For practical purposes, the single measure of net energy adopted is called the productive energy, and is measured in terms of fat.

ENERGY-PRODUCTION COEFFICIENTS FOR PIG FEEDS

It has been claimed that pigs have a greater power of utilizing the digested portion of feeds than have ruminants. Fingerling (10), by means of respiration experiments, ascertained that one pound of digested starch produced 0.355 pound of fat with hogs, compared with 0.248 pound with steers, while one pound of digested cane sugar produced 0.281 pound of fat on hogs, and 0.188 pound on steers. There was practically no difference with crude fiber; one pound of digested crude fiber produced 0.248 pound of fat on hogs and 0.253 pound of fat on steers. Fingerling estimates that the hog can produce about 30 per cent more fat than ruminants from the digested nitrogen-free extract of feeds. On the other hand, Mitchell (11) found no such wide differences in slaughter experiments with fattening hogs. When calculated by the method used for ruminants (3) with the coefficients of digestibility for hogs, the productive energy for the mixture of corn, tankage, and wheat middlings used by Mitchell, we found to be 83.7 therms per hundred pounds, while he calculated the value of the mixture to be 89.5 therms from the first experiment and 74.8 therms from the second experiment. The average productive value for the two experiments would be 82.1 therms, which is nearly the same as that calculated by the methods for ruminants (83.7). In view of the uncertainty regarding the exact power of the pig to utilize feeds as compared with ruminants, it was considered inadvisable to select a factor to make a correction for this power. It can be taken care of in formulating feeding standerds. The energy production coefficients were accordingly calculated by the method given on page 17 of Bulletin 329, except that the correction for crude fiber was omitted.

The results are given in Table 5, which also contains the reference to the factor used for fat or for correcting the values, if any, as well as the average coefficient of digestibility for protein. While the production coefficients here given are not considered to be strictly correct, they can serve as a starting point for the calculation of more exact coefficients.

USE OF PRODUCTION COEFFICIENTS

The approximate productive energy of pig feeds can be calculated from the chemical composition of the feed by multiplying the per-

centage of each constituent of the feed by the corresponding factor given in Table 5 and adding the products. The sum will be approximately the therms of productive energy furnished by 100 pounds of the feed. The digestible protein can also be calculated by multiplying the percentage of protein in the feed by the corresponding average coefficient of digestibility of protein given in Table 3. The product is the pounds of digestible protein in 100 pounds of feed. It must be recognized that neither the digestible protein nor the productive energy so calculated is exactly correct, since there are variations both in the nature of the constituents in the various feeds, and in the powers of individual animals to digest the feed and to utilize the digested material. Furthermore, as pointed out in the preceding section, hogs may have a greater power of storing energy than is provided for in the production coefficients here presented. However, the productive energy calculated by the method here given can be used to compare the values of different kinds of hog feeds with one another, in terms of productive energy. They can also be used to compare feeds of the same kind, but with different compositions. In connection with appropriate feeding standards, (discussed below) they may be used to calculate rations for feeding hogs. They can serve other useful purposes, even though the productive energy may be comparative values and not absolutely correct values.

COMPOSITION AND FEEDING VALUES OF HOG FEEDS

The average and minimum composition, the digestible protein, and the comparative productive energy for some hog feeds are given in Table 6. The production coefficients of the corresponding feed in Table 5 were used in these calculations; the productive coefficients for a feed nearly resembling it were used for feeds not listed in Table 5. The average composition is based chiefly upon analyses made in this Laboratory and applies to Texas feeds. The minimum guarantees used by the Feed Control Service are also given in the tables, and the digestible protein and productive energy are calculated for them. In some cases, the nitrogen-free extract is made a little higher than the minimum guarantee, in order to avoid too high a content of water, and to come nearer to giving the correct productive energy. Commercial feeds are frequently sold in Texas with the minimum guarantee given in this table. The guaranteed composition of mixed feeds may be calculated by the use of percentages of the various feed combined and of the minimum guarantee of each ingredient. The digestible protein and productive energy of the mixture can also be calculated in the same way. The results of such calculation would be the minimum guarantee of the mixture. Ordinarily the composition of the mixture should exceed the minimum guarantee in protein, fat, and nitrogen-free extract, and fall below it in crude fiber. The content of digestible protein and of productive energy should usually slightly exceed the results of the calculation made in this way.

Table 5. Tentative energy-production coefficients for hog feeds.

	Protein	Ether extract	Crude fiber	Nitrogen free extract	Factor	Reference number
Alfalfa, before blooming (23% protein, 27% fiber)	.689	.190	—.290	.576	CM	1
Alfalfa, beginning to bloom (14% protein, 33% fiber)	.342	.....	—.391	.708	M	2
Barley and ground corn (1 to 1)	.676	1.541	—.158	.952	BN	3
Barley bran (18.5% protein, 8% fiber)	.869	1.380	—.291	.859	BN	4
Barley feed meal (16.6% protein, 0.8% fiber)	.963	1.868	.369	1.042	BN	5
Barley, whole and ground (4 to 7% fiber)	.721	.891	—.159	.924	BN	6
Beans or bean meal	.851	.939	—.213	.974	BN	7
Beets, feeding (8.9% protein, 6.3% fiber dry basis)	.532	.....	.542	.926	N.9	8
Beets, feeding, raw (8.8% protein, 5.7% fiber dry basis)	.509	.....	.383	.937	.90	9
Beet leaves, acid (8% protein. 12.4% fiber, 60% ash dry basis)	.412	.402	.000	.577	BN	10
Beet pulp (7% protein, 16% fiber dry basis)	.....	.....	.300	.891	.9	11
Beet pulp, dried (8.8% protein, 17.9% fiber dry basis)	.294	.....	.521	.882	.9	12
Beets, sugar (6% protein, 5.7% fiber dry basis)	.477	.....	.645	.954	.9	13
Beet, sugar, dried (5.8% protein, 5.6% fiber)	.243	.....	.456	.927	.9	14
Beets, sugar, dried and steamed	.100	.....	.483	.936	.9	15
Brewer grains	.743	1.389	—.088	.524	AN	16
Clover, red, before blooming (17% protein, 22% fiber dry basis)	.502	.490	—.065	.763	CN	17
Clover, red, beginning to bloom (18% protein, 24% fiber dry basis)	.331	.243	—.144	.608	CN	18
Clover, red, immediately after blooming (22% protein, 26% fiber dry basis)	.518	.643	.144	.581	CN	19
Corn and cob meal	.769	1.864	—.312	.895	BM	20
Corn, whole	.774	1.480	.143	.985	BN	21
Corn chops	.807	1.543	.184	1.004	BN	22
Corn, ground	.778	1.640	—.078	.989	BN	23
Corn meal	.923	1.589	.279	1.000	BN	24
Corn, all	.811	1.621	.017	.993	BN	25
Corn, ground and pork cracklings	.868	2.322	0	.985	A	26
Corn, ground and red dog flour	.849	1.250	0	.966	B	27
Corn, ground, red dog flour and pork cracklings (20:10:1)	.870	1.782	0	.991	A	28
Corn, ground, red dog flour, tankage and pork cracklings	.833	2.389	0	.953	A	29
Corn, ground, and tankage	.732	2.040	.161	.982	AN	30
Corn, ground, tankage and pork cracklings	.739	2.206	0	.959	A	31
Corn, ground and wheat middlings (1-1)	.820	2.149	—.036	.946	A	32
Cottonseed meal	.862	2.304	.013	.717	AN	33
Esparette	.375	.374	.104	.702	CN	34
Fish meal	.738	1.027	0	0	B	35
Flour, red dog	.903	.832	0	.977	B	36
Kafir	.783	1.412	.403	1.030	BN	37
Linseed meal	.904	1.834	—.149	.882	AN	38
Meat and bone scraps	1.004	2.586	0	0	A	39
Meat meal	.894	2.369	0	1.071	A	40
Milk, skim	.962	2.057	0	1.045	B	41
Milk, whole	.958	2.521	0	1.004	A	42
Millet, hog	.695	1.339	.040	.981	BN	43

Table 5. Tentative energy-production coefficients for hog feeds. (Continued)

	Protein	Ether extract	Crude fiber	Nitrogen free extract	Factor	Reference number
Milo, ground	.816	1.505	.490	1.043	BN	44
Milo, whole	.622	1.209	.287	.895	BN	45
Oats, whole, ground	.799	2.015	—.297	.842	AN	46
Palm nut cake	.711	2.025	.063	.824	AN	47
Peanuts, whole (assumed)	.790	2.300	0	.360	———	47a
Peas, ground	.900	1.137	.516	1.019	BN	48
Pork cracklings	1.014	2.666	0	0	A	49
Potato, cooked	.833	0	0	1.045		50
Potato, dried	.339	0	.388	1.007		51
Potato, raw	.859	0	0	1.051		52
Rice bran	.679	2.090	.100	.789	AN	53
Rice polish, 2% fiber	.847	2.266	.189	1.012	AN	54
Rye bran, 17% protein, 6% fiber	.730	.830	—.032	.780	BN	55
Rye feed meal, 13.6% protein, 1.3% fiber	.892	1.748	0	1.006	B	56
Rye meal, 12.5% protein, 1.5% fiber	.830	.800	0	.996	B	57
Rye shorts, 18.3% protein, 3.7% fiber	.837	1.284	.136	.937	BN	58
Soybeans	.951	2.167	0	1.086	AN	59
Tankage	.706	2.340	0	.822	A	60
Vetch, before blooming with beans (21.9% protein, 27.5% fiber dry basis)	.447	0	.144	.462	M	61
Vetch, before blooming without beans (22.2% protein, 28.9% fiber dry basis)	.571	.280	.138	.516	BM	62
Wheat bran	.624	1.176	.208	.592	B.8	63
Wheat chaff (9.3% protein, 26.6% fiber)	.206	0	—.510	.324	M	64
Wheat cracked	.762	1.478	.164	.841	BN	65
Wheat flour middlings or gray shorts (18% protein, 6% fiber)	.847	2.136	—.072	.881	AN	66
Wheat mixed feed (8.5% fiber)	.675	———	.063	.837	.9N	67

Table 6. Average percentage composition of hog feeds with minimum guarantee, and calculated therms of productive energy and digestible protein in 100 pounds.

	Protein	Ether extract	Crude fiber	Nitrogen free extract	Water	ash	Productive energy therms per 100 lb	Digestible protein pounds per 100
Alfalfa leaf meal, Av.	21.5	2.6	15.8	40.5	7.7	11.9	34.1	14.6
Alfalfa leaf meal, min.	20.0	2.5	18.0	40.0	.....	.....	32.1	13.6
Alfalfa meal, av	14.6	1.8	29.9	36.8	8.6	8.3	19.4	4.9
Barley, min.	11.0	1.5	6.0	65.0	13.5	3.0	68.4	7.8
Barley chops or grain	12.0	2.1	6.3	67.5	9.3	2.8	71.9	8.5
Barley, no hulls, av.	12.5	2.6	3.0	71.8	8.4	1.7	92.8	11.9
Barley, no hulls, min.	10.0	2.5	2.5	72.0	.....	.....	90.2	9.5
Beans, pinto (seed)	22.9	1.3	4.1	58.1	9.3	4.3	83.4	20.3
Beet pulp, dried, av.	9.0	0.6	19.3	59.0	8.5	3.6	64.8	2.9
Beet pulp, dried, min	8.0	0.5	22.0	52.0	.....	.....	59.7	2.6
Bone meal, steamed, av.	25.5	2.2	0	4.2	5.2	61.7	31.3	25.2
Bone meal, special steamed, av.	7.7	0.6	2.7	4.9	3.3	80.8	9.3	7.6
Bone meal, special steamed, min.	5.0	0	3.0	4.0	.....	.....	6.8	3.5
Brewers dried grains, av.	21.9	6.3	17.8	43.9	6.7	4.1	46.2	16.0
Buttermilk, dried	34.4	5.0	.4	40.6	8.2	11.4	85.8	32.6
Cocoanut oil meal, av.	19.4	10.6	11.2	44.3	8.5	6.0	73.1	16.5
Corn chops	10.0	4.0	2.4	71.0	11.2	1.4	86.0	7.9
Corn chops, min.	9.0	3.5	3.0	70.0	13.0	1.5	83.5	7.2
Corn meal	10.1	3.5	1.7	73.1	10.4	1.2	88.5	9.2
Cottonseed feed, 41.12% protein, min.	41.1	5.0	14.0	26.0	.....	.....	65.8	34.9
Cottonseed meal, 43% protein	43.2	7.5	10.8	26.2	6.8	5.5	73.5	36.6
Cottonseed meal, 43% protein, min.	43.0	6.0	12.0	23.0	.....	.....	67.5	36.5
Cottonseed meal, 45% protein, min.	45.0	6.0	10.0	22.0	.....	.....	68.5	38.2
Darso seed or chops	10.3	3.2	2.5	72.9	9.7	1.4	90.5	8.3
Feterita seed or chops	12.7	3.1	2.5	69.3	10.7	1.7	88.5	10.2
Fish meal, min.	50.0	5.0	1.0	1.0	21.0	22.0	42.0	46.2
Fish scraps	56.7	7.9	8	4.6	7.4	22.6	50.0	52.3
Flour, red dog, min.	15.0	4.5	4.0	63.0	11.5	2.0	78.8	13.3
Hegari chop, min.	10.0	2.5	3.0	70.0			84.7	7.7
Hegari (grain or chops)	11.4	2.1	2.4	70.8	11.8	1.5	87.5	9.2
Hominy feed, min.	10.0	6.0	7.0	60.0			78.9	7.9
Kafir, min.	10.0	2.5	3.0	70.0	13.0	1.5	84.7	7.7
Kafir grain or chops	11.2	2.9	2.3	71.1	10.5	2.0	87.0	8.6
Linseed meal, old process	35.0	6.5	8.6	36.5	8.1	5.3	74.5	31.2
Linseed meal, 32% protein	32.2	10.2	9.9	37.6	5.3	4.8	79.5	28.7
Meat and bone meal (50% protein)	50.8	9.9	2.2	2.1	5.8	29.2	76.6	50.2
Meat and bone scraps, 50% protein, min.	50.0	6.0	3.0	2.0	9.0	30.0	65.7	49.4
Meat and bone scraps, 50% protein,	52.1	10.7	2.4	3.3	5.6	25.9	80.0	51.5
Meat scraps, 60% protein	61.2	11.8	3.2	1.7	6.2	15.9	84.5	53.9
Milk, dried skim, min.	20.0	.2	0	59.0	14.0	6.8	81.3	18.9
Millet seed	11.5	3.8	9.5	62.3	9.6	3.3	74.6	7.9
Millet seed, min.	11.0	4.0	10.0	57.0	13.0	5.0	69.3	7.5

Table 6. Average percentage composition of hog feeds with minmum guarantee, and calculated therms of productive energy and digestible protein in 100 pounds.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen free extract	Water	ash	Productive energy therms per 100 lb	Digestible protein pounds per 100
Milo chops, min.	10.0	2.5	3.0	70.0	12.5	2.0	86.4	8.0
Milo grain or chops	11.1	2.9	2.5	70.9	10.7	1.9	88.6	8.9
Oat groats, rolled	16.1	6.0	1.9	65.7	8.4	1.9	86.3	12.3
Oats, red, all samples	11.4	4.9	12.8	58.6	8.6	3.7	64.5	9.0
Oats, whole, min.	11.0	4.0	12.0	58.0	10.5	4.5	62.1	8.7
Oats, whole white	12.6	4.1	11.2	59.7	8.8	3.6	65.3	9.9
Peanut cake, 43% protein	42.2	11.0	13.2	23.2	5.7	4.7	78.5	35.8
Peanut cake or meal, 43% protein, min.	43.0	6.0	12.0	23.0	.....	.....	67.5	36.5
Peanut cake or meal, 45% protein, min.	45.0	6.0	10.0	23.0	.....	.....	69.2	38.2
Peanut hay, min.	10.0	3.5	24.0	44.0	.....	.....	25.2	3.4
Peanut kernels, min.	26.0	44.0	3.0	17.0	.....	.....	136.0	22.1
Peanut kernels or meats	31.5	47.2	3.8	10.0	5.1	2.4	143.1	26.7
Peanut meal, 43% protein	44.5	9.1	9.2	24.9	5.5	6.8	77.3	37.7
Peanuts, whole (with 25% shell of no value to hogs)	25.5	36.6	17.3	12.1	5.7	2.8		
Peas	24.6	2.0	3.0	57.4	9.7	3.3	84.5	21.8
Potatoes, sweet (original basis)	2.1	.3	1.0	28.1	67.3	1.2	31.1	1.7
Rice bran	12.8	13.1	12.7	41.7	9.0	10.7	70.2	8.6
Rice bran, min.	11.0	10.0	15.0	42.0	12.0	10.0	63.0	7.4
Rice, cleaned, min.	9.0	1.0	1.0	77.0	.....	.....	89.7	7.2
Rice polish	12.7	11.4	3.5	56.5	9.7	6.2	94.4	10.6
Rice polish, min.	11.0	6.0	4.0	60.0	12.5	6.5	84.4	9.2
Rice, whole ground	7.6	1.9	9.2	64.8	11.5	5.0	78.1	6.3
Rye chops	14.5	1.9	2.9	67.5	10.9	2.3	80.8	11.9
Sesame oil meal	40.3	9.4	6.4	24.0	6.8	13.1	73.7	34.2
Shrimp scraps	50.0	2.4	13.6	6.9	4.6	22.5	39.4	46.2
Soybeans (grain)	39.6	17.8	7.2	22.5	8.2	4.7	100.7	37.1
Soybean oil meal	44.6	7.2	5.1	29.2	7.9	6.0	89.7	41.8
Tankage, digester (45—50%)	48.6	9.7	2.8	2.9	6.7	29.3	59.4	33.8
Tankage, digester (60%)	60.9	8.3	2.1	2.4	7.5	18.8	64.4	42.3
Velvet beans and pods	17.6	4.7	13.4	50.2	9.7	4.4	62.2	14.9
Wheat bran, min.	14.5	3.0	10.0	54.0	13.0	5.5	46.6	11.1
Wheat brown shorts	18.0	4.7	6.2	56.7	10.0	4.4	60.0	13.3
Wheat chops	15.1	2.0	3.2	67.7	9.8	2.2	71.9	11.3
Wheat flour, red dog	16.1	2.8	2.6	66.2	10.1	2.2	77.8	13.4
Wheat germ, min.	30.0	10.0	2.5	45.0	.....	.....	75.9	22.5
Wheat gray shorts and screenings	17.7	4.4	6.1	57.2	10.2	4.4	75.2	14.8
Wheat gray shorts	18.0	4.5	5.6	57.8	10.0	4.1	75.4	15.0
Wheat gray shorts, min.	17.0	4.0	6.0	60.0	9.0	4.0	75.4	14.2
Wheat mixed feed	17.3	4.1	7.6	56.1	10.0	4.9	59.1	12.8
Wheat mixed feed, min.	16.0	3.5	8.5	54.0	12.5	5.5	56.5	11.8
Wheat white shorts or red dog, min.	14.5	3.0	3.5	65.0	11.0	3.0	79.1	12.9

STANDARDS FOR PIG FEEDING

Standards for feeding various kinds of farm animals have been prepared, for the purpose of aiding in formulating rations and otherwise aiding in intelligent feeding. It is generally recognized that, while such standards are helpful, they cannot be used as ironclad rules, for the reasons that feeds are variable in composition, animals vary in ability to digest and utilize the feeds, and conditions under which the animals are fed also vary. For these reasons, the same mixture does not always produce the same results. However, although the standards have their limitations, they are also useful and helpful in feeding and in solving feeding problems.

Standards for feeding swine have been prepared by Wolff-Lehmann, Kellner (10), Armsby (1), Henry and Morrison (8), H. H. Mitchell (11), and others. The Wolff-Lehman and Henry and Morrison standards are based upon the digestible crude protein and the digestible nutrients in the feeds. The standards of Kellner are based upon digestible pure protein (though the crude protein is given), and the starch equivalent; the starch equivalent is really the productive energy, expressed in terms of starch. The standards of Armsby are based upon digestible pure protein and the net energy. The standards of Mitchell are expressed in terms of protein and metabolizable energy.

The object of the standard is to permit the requirements of the pigs to be expressed in terms of any particular combination of feeds. It is obvious that the productive energy of the feed must be expressed in the same terms as the productive energy of the feeding standard, if the calculation back to feed is to be correct. Not any of the feeding standards mentioned above are expressed in the same terms of productive energy as are used in this Bulletin.

Tentative feeding standards for hogs, for use in connection with the productive values given in this Bulletin, were based upon the feeding standards mentioned above, and are given in Table 7.

Table 7. Tentative feeding standards for fattening hogs, per day and 1,000 pounds live weight.

Weight of animal pounds	Toal dry matter in feed pounds	Digestible protein pounds	Productive energy therms
30 — 50	44 — 63	7.0 — 8.0	35 — 50
50 — 100	33 — 43	5.3 — 6.0	30 — 34
100 — 150	30 — 41	4.4 — 5.0	26 — 33
150 — 200	28 — 38	3.4 — 4.2	24 — 31
200 — 250	25 — 36	2.9 — 3.8	21 — 29
250 — 300	20 — 32	2.6 — 3.4	18 — 26
Brood sows with pigs	20 — 28	2.4 — 3.0	16 — 24

In addition to digestible protein and productive energy, animals require minerals and vitamins. The discussion of these does not come within the scope of this Bulletin, but will be taken up at a later date.

The feeding standards here given may be used to calculate rations for pigs, using the productive energy and digestible protein given in Table 6 or the productive energy and digestible protein calculated from

the analyses of the particular feed and the coefficients in Table 5.

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SUMMARY

This Bulletin reports 14 digestive experiments with pigs on various feeds, with a compilation of 139 other digestion experiments with pigs made elsewhere.

Pigs as a rule have lower digestion powers than ruminants and higher than poultry. For many concentrates, pigs have as high digestive powers as ruminants, but their power is low for digesting crude fiber and fibrous feeds.

Pigs probably utilize a larger percentage of the net energy over maintenance for fattening, but the exact extent of the difference is uncertain.

Tentative production coefficients are given which may be used for making an estimate of the productive energy of corresponding pig feeds of known chemical composition.

The average composition and minimum guarantee of a number of pig feeds are given, together with their corresponding productive energy and digestible protein, calculated by use of the production coefficients.

Tentative standerds for pig feeding for use in connection with the productive values given in this Bulletin are presented.

References to Digestion Experiments, Table 3

Experiments No.

1— 8	Arkansas, Bulletin 133
9—35	Illinois, Bulletin 170
36—61	Illinois, Bulletin 200
62—64	Maine, Report 1886
65—71	Minnesota, Bulletin 26
72—73	Minnesota, Bulletin 36
74—75	Minnesota, Bulletin 42
76—77	Minnesota, Bulletin 47
78—84	Ohio, Bulletin 271
85—98	Texas (this Bulletin)

99—153 German—Bericht des Deutschen Landwirtschafsrats betreffend Futterungsversuchs mit Schweinen uber die Verdaulichkeit verschiedener Futtermittel, ausgefuhrt an den Landwirtschaftlichen Versuchsstationen zu Gottingen, Mockern and Munster I. W. von Prof. Dr. Fr. Lehmann, Geh. Hofrat Prof. Dr. O. Kellner und Geh. Regierungsrat Prof. Dr. F. Konig. Berlin, 1909, Verlagsbuchhandlung Paul Parey.

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