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MISCELLANEOUS ANALYSES OF FEEDING STUFFS.

THE DIGESTIBILITY OF WHEAT.

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MISCELLANEOUS ANALYSES OF FEEDING STUFFS.

HARRY SNYDER.

ERRATA.

Page 134—Read: Blue joint hay, digestible protein 3.7 in place of 4.7.

Page 135—Read: Barley, digestible nitrogen free extract 56.6, in place of 5.66.

Page 138—Read: Nutrative ratio 6.4 in place of 6.5 in second paragraph 6th line.

Page 138—Read:

(2.08 + 3.31 + 8.10) × 1860	=	25096
.76 × 4225	=	3211
Total Calories,		28307

(Minn. Bulletin No. 36, Nov. 1894).

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MISCELLANEOUS ANALYSES OF FEEDING STUFFS.

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On account of the prolonged drouth of the past summer, the question of fodder, in some sections of the state, will require careful consideration. Many inquiries have been received from farmers regarding the comparative cost and composition of various foods. In many cases, samples of fodders and grains have been sent to the laboratory for chemical analyses. These analyses are published at this date, so that all who have occasion to either purchase or sell fodder during the coming winter may profit by the results.

The chemical analysis of a fodder, as ordinarily made, does not give all the information that a farmer desires, but for general comparative purposes the analysis gives much valuable information. The purchaser can judge for himself, as to the quality of the fodder or grain, whether it is musty or otherwise inferior. The analysis tells, practically, what the food contains, and by means of simple calculations, as will be explained later, the comparative amounts of muscle forming, and heat producing bodies which a given sum of money will purchase, can easily and readily be determined. Hence the analysis may serve as a guide to show which food will be the most economical to purchase or sell.

The important compounds present in fodders and food stuffs have been discussed in previous bulletins of this station. A few additional facts, however, about the comparative food values of the various compounds are given so as to aid in using the figures.

The analyses recorded in this bulletin are from samples of fodders grown under the conditions of climate and soil of this state; hence the results are better adopted to our conditions, than average analyses of materials grown elsewhere.

EXPLANATION OF TERMS USED.

Water.—In all food stuffs, even those which have been thoroughly sun and air dried, there is an appreciable amount of water present. Substances like meal and flour which appear perfectly dry to the "feel" are not free from water. In the tables of analyses, the figures for water represent the amount which is present in every hundred pounds of the material. The last traces of water are removed by drying the substance in an oven at a temperature of 212 degrees Fahrenheit, when all of the water in the material is converted into steam and escapes.

The dry substance is what is left after all of the water has been removed from any material. Frequently the results of the analyses are expressed on the dry substance or water free material, as it is called. In this bulletin all of the results are given as they are present in the original material, or as ordinarily used, unless otherwise stated.

The Ash is what is left after the dry substance is burned. It is sometimes called the mineral or inorganic part. The ash is important inasmuch as it furnishes the main portion of the necessary materials for bone growth. Too much ash especially when it is rich in silica (sand), or of strong alkalies, as in the Russian thistle, is objectionable. The ashes from all grains are usually the richest in phosphates, and hence the most valuable for bone growth. In nearly all mature agricultural products there is less than ten per cent. ash. There is generally a sufficient amount of ash in all food products for bone growth.

The organic matter is that portion which is converted into smoke and volatile products when the dry matter is burned; hence the organic matter is readily found by subtracting the ash from the dry matter.

From the feeder's point of view the organic matter is divided into two large classes of compounds: (1) The non-nitrogenous compounds, and (2) the nitrogenous compounds. This division is made according to the presence or absence of the element nitrogen. Starch and sugar contain *no* nitrogen, hence they are *non*-nitrogenous compounds, while albumen, the white of the egg, contains nitrogen, and hence is a nitrogenous compound.

The non-nitrogenous compounds include cellulose (mainly woody material), starch, sugar, fats, and the jellies which are known as pectose substances. In some fodders, in addition to these, there is a small amount of non-nitrogenous materials, like lignin, and the pentoses, which possess no food value. The non-nitrogenous compounds make up by far the larger portion of the dry matter of a fodder. There is from four to ten times more of the non-nitrogenous compounds in any ordinary food, than introgenous compounds. There is usually a sufficient amount of non-nitrogenous material in all foods, but the nitrogenous compounds are liable to be too deficient.

The fats and other bodies soluble in ether, known as the *ether extract*, are very concentrated forms of non-nitrogenous compounds. In the grains and milled products, the ether extract is nearly pure fat while in the grasses and hays it is from 50 to 65 per cent. pure. All fats contain about one half more carbon, the charcoal element, than is found in starch or sugar. Hence when fats are digested and undergo oxidation, and combustion within the body, they produce over twice as much heat as starch or sugar. The fat in the food has more to do with producing heat in the body, and but little to do, directly, with furnishing fat for the production of milk. In fact any good cow will give much more fat in her milk for a given period than there is fat in her food. A certain amount of fat in a food is essential, too large a a quantity when not associated with a sufficient amount of protein is objectionable.

The fiber constitutes the frame work of the plant, and is composed mainly of cellulose (woody material). The fiber is not entirely indigestible; in many foods it is about half digestible. Ordinary amounts of fiber, when associated with a sufficient amount of digestible materials is unobjectionable. The fiber and ash, in the foods as ordinarily used, ought not to exceed forty-five per cent. of the total nutrients because they represent too much inert material in a fodder.

Nitrogen-free extract. In the analysis, the starch, sugar and jelly (pectose) substances are all classed together under the head of nitrogen-free extract. The compound word nitrogen-free, means free from nitrogen. The bodies are all easily soluble in dilute acids and alkaline solutions. The term nitrogen-free extract, when applied to the fodder is a very indefinite one, but when only the digestible and valuable part of the nitrogen-free extract is considered, and not the inidgestible part, which possesses no value, the term becomes much more definite.

The Nitrogenous Compounds. The characteristic building material of these compounds is the element nitrogen. The nitrogenous compounds are, by far, the most expensive and the most important materials found in food stuffs. Unfortunately the terms employed to designate these bodies are somewhat confused. By many, the terms nitrogenous compounds, proteids and albuminoids are used synonymously. To the chemist these terms all have different meanings. *Crude* protein or total nitrogenous compounds is the term which includes and designates *all* of the nitrogenous bodies. The term protein represents only a *single* class of the total nitrogenous compounds. The crude protein or total nitrogenous compounds, includes, besides protein, amides, and alkaloids, bodies which possess little or no food value.

Protein is the largest and most important class of the nitrogenous compounds. The proteids are the materials out of which the muscles are formed, they enter into the compositon of the tissue of the nervous system, the ligaments, bones, hoofs, hair, and all of the vital fluids. The protein compounds supply the waste materials, and keep the complicated machinery of the body in repair. A certain amount of protein in the food is absolutely necessary to repair the waste of the body, and this necessary protein must be supplied before growth or the production of meat or milk can take place.

When an animal is supplied with all the digestible protein necessary to maintain the body, the excess is either stored up in the body, or used for producing fat in the milk.

Hence the necessity for keeping up a good supply of protein in the food. In fact, the chief benefit which is derived from the food consumed comes from the small amount which is in excess of that required for maintenance

In the tables, the nitrogenous material in the form of true protein is indicated in the column headed: "Per cent. of total nitrogen in the form of true protein."

The indigestible part of fodders. In all fodders and grains there is a certain amount of each of the food nutrients which is indigestible and can not be counted upon for food purposes. The amounts of the various indigestible nutrients in fodders have been determined by a number of American Experiment Stations.

In the tables the composition of every hundred pounds of fodder as ordinarily used, is given. On the same line under the head of parts digestible, is given the pounds of each digestible nutrient in the hundred pounds of fodder. Under the head of composition is given what is in the fodder, and under parts digestible, is given the amount which can be counted upon for actual food purposes. The results under parts digestible are calculated from the average results of American Digestion Co-efficients, and from the composition of the materials as here reported. The digestible nutrients of the grains and milled products are calculated mainly from our own results, published in Bulletin No. 26, and from experiments conducted for this purpose. In some cases where the digestibility of the food had not been determined, the digestion coefficieuts of other foods of the same class, and having about the same composition, were used.

In the table of analyses, the composition of all of the field cured crops show a less amount of hydroscopic moisture than is usually given for these crops or is present in crops grown in a climate where the atmosphere is more moist. This difference is easily accounted for by the fact that the atmosphere of this state is usually very dry, hence when the crops are air dried, they contain a correspondingly less amount of moisture.

AVERAGES OF MINNESOTA ANALYSES.

TABLE LIX. —Field Cured Crops.

		Composition of 100 lbs. of Fodder						Parts Digestible					Percent of total nitrogen as protein
	No. of samples	Water	Ash	Ether extract	Crude protein	Nitrogen-free extract	Fiber	Dry matter	Ether extract	Crude protein	Nitrogen free extract	Fiber	
Clover hay, red	6	12.25	6.78	2.97	12.67	41.08	24.05	52.5	1.5	7.6	28.0	12.0	85
Pea hay	5	12.50	8.95	2.75	12.37	36.29	27.13	52.5	1.4	7.4	25.1	12.7	84
Vetch	1	14.00	7.10	2.22	12.69	46.87	17.12	51.6	1.3	7.2	30.5	8.8	75
Timothy hay	4	12.32	5.11	2.38	6.07	43.50	30.62	50.8	1.3	3.4	27.2	16.2	82
Blue grass hay	4	14.00	6.92	3.91	8.45	37.52	29.20	50.0	2.2	4.6	23.6	16.4	85
Millet hay	1	12.00	8.95	1.50	6.52	41.03	31.00	55.2	1.0	3.9	27.5	21.	81
Mixed prairie hay	4	15.90	6.70	2.40	6.02	41.58	27.40	48.7	1.2	3.4	26.5	15.	85
Upland prairie hay	4	12.50	6.25	2.80	5.91	46.22	26.32	50.5	1.4	3.5	27.7	14.1	85
Blue joint hay	4	15.14	6.31	2.40	7.44	38.41	30.30	46.8	1.2	4.7	22.5	16.4	87
Sedge grass	1	10.16	7.66	2.00	5.94	44.12	30.12	50.2	1.1	3.4	26.4	18.9	80
Oat hay	2	15.00	6.87	3.25	8.75	38.01	28.12	51.8	1.3	5.7	23.9	17.4	80
Corn fodder	10	15.00	4.25	2.93	6.46	50.11	21.25	57.8	2.2	3.9	37.1	14.1	85
Wheat straw	3	7.41	9.22	.97	3.25	40.88	38.27	42.3	.4	1.0	16.4	21.6	71
Oat straw	3	8.36	9.00	1.40	4.06	38.07	41.11	45.8	.5	1.5	20.4	23.	70
Barley straw	3	10.40	9.11	.95	3.45	35.43	40.66	44.7	.4	1.0	19.1	21.5	75
Clover straw	2	13.50	7.80	1.57	8.63	33.10	35.40	......	......	......	......	......	......

Green Crops and Ensilage.

Rape, whole plant	6	86.00	1.06	.25	2.09	8.89	1.71	9.8	.2	1.5	7.0	1.1	61
Rape, leaves	1	88.00	1.00	.38	2.04	7.50	1.08	8.6	.2	1.5	6.2	.6	75
Pasture, blue grass	2	85.00	1.75	.70	3.00	6.30	3.25	1.03	.9	1.9	4.5	2.4	70
Green clover	4	86.00	1.48	.75	3.36	6.54	1.87	9.3	.5	2.3	5.2	1.0	67
Ensilage, corn	12	74.00	1.40	.80	1.95	14.72	6.28	17.2	.6	1.2	11.3	3.7	82
Sugar beets	4	85.00	.85	.10	1.75	11.80	.50	14.1	1.	1.5	11.8	.5	60
Mangles	2	86.00	1.25	.25	1.95	9.45	1.10	10.6	1.	1.5	8.5	.5	55

Grains.

Barley	6	11.78	3.32	2.70	11.20	65.88	5.12	70.6	1.8	9.1	5.66	2.4	94
Corn	7	11.00	1.50	3.88	10.25	71.72	2.25	80.1	3.1	9.2	67.4	1.1	95
Millet seed	6	12.50	3.82	3.89	10.61	61.11	8.07	70.0	2,9	9.0	48.5	5.6	....
Oats	5	9.00	3.62	4.88	10.70	65.05	6.75	65.5	3,9	9.2	49.4	1.6	94
Peas	4	9.84	3.40	1.03	22.00	58.00	5.73	80.2	.5	19.4	55.1	4.5	96
Rye	2	11.00	2.10	2.01	12.75	70.04	2.10	72.9	1.5	10.5	58.	1.3	92
Wheat	25	11.00	1.92	2.05	13.75	69.03	2.25	73.	1.5	11.0	57.3	1.3	97
"Goose" wheat	1	10.85	1.81	1.77	16.41	66.60	2.50	72.	1.4	13.1	55.3	1.5	95
Flax seed	2	5.60	3.78	3.95	25.31	18.41	7.40	....	....	....	....	....	....

AVERAGES OF MINNESOTA ANALYSES (*Continued*).

Milled Products.

		Composition of 100 lbs. of Material.						Parts Digestible.					
	No. of samples.	Water.	Ash.	Ether extract	Crude protein	Nitrogen free extract.	Fiber.	Dry matter.	Ether extract	Crude protein	Nitrogen free extract.	Fiber	Percent total nitrogen as protein.
Corn meal	6	12.00	1 50	3.8	10.00	71.70	1.00	79.2	2.8	9.00	66.4	1.00	96.
Corn cobs	3	10.75	1.20	.44	1.43	54.03	32.15	53.8	.2	.2	32.0	20.00	80.
Cotton seed meal	3	8.14	7.95	11.20	44.38	22.71	5.61	65.0	10.0	32.00	16.0	4.2	91.
Gluten meal	3	10.00	.75	7.6	28.2	52.1	1.35	78.3	6.7	24.5	46.4	.6	92.
Germ meal	2	7.00	1.25	6.47	14.0	67.3	4.25	72.5	6.1	12.3	50.0	2.4	93.
Linseed meal (o. p.)	4	10.00	5.50	8.20	31.00	36.80	8.5	71.1	7.3	27.6	28.7	4.8	92.
Oat feed	2	10.00	4.2	6.2	15.00	57.1	7.5	56.0	3.7	11.1	37.0	3.1	92.
Wheat bran	12	10.50	6.01	4.95	15.65	52.04	10.85	60.0	3.6	12.5	38.5	3.6	96.
Wheat shorts	15	10.50	3.25	3.01	13.25	64.47	5.52	67.0	2.3	10.	54.4	1.5	98.
Wheat germ	8	10,50	2.75	3.50	16.25	64.75	2.25	70.	2.4	13.8	58.3	1.5	97.
Wheat flour	15	10.50	.50	.55	11.25	77.2	....	85.	.4	10.6	73.3	....	98.
Wheat flour, "Red Dog"	8	10.00	2.25	2.75	15.75	67.65	1.60	78.	2.0	13.5	60.1	1.2	97.
Wheat screenings	4	10.00	2.20	2.75	13.80	67.65	3.60						
Cockle bran	3	11.00	3.3	2.5	10.6	63.5	9.2						

The term *nutritive ratio* is frequently made use of in connection with feeding stuffs. The nutritive ratio is the ratio which exists between the digestible protein and the digestible non-nitrogenous compounds. A nutritive ratio of 1 to 6.7 means that for every one pound of digestible crude protein there are 6.7 parts of digestible non-nitrogenous compounds. A wide ration means a larger amount of non-nitrogenous compounds, a narrow ration a comparatively less amount.

To calculate the nutritive ratio first determine the pounds of digestible protein in the food used. Then calculate the pounds of digestible fiber and nitrogen-free extract. Multiply the pounds of digestible fat by 2.5, because the fat produces so much more heat and is considered 2.5 times more concentrated than the nitrogen-free extract compounds. Add the digestible fiber, nitrogen-free extract, and corrected fat together, and divide the sum by the digestible protein, the result is the nutritive ratio.

In case a cow consumes 18 pounds of blue grass hay and ten pounds of bran per day the digestible nutrients and nutritive ratio are found as follows: From the table take the number of pounds of each digestible nutrient in a *hundred pounds* of the feed used Put the decimal point two places to the left so as to represent the amounts in *one* pound. Multiply the pounds of fodder used, by the amount of each separate digestible nutrient in one pound of that fodder.

The digestible nutrients in every hundred pounds of the blue grass hay and wheat bran used are:

	Protein.	*Ether Extract.*	*Fiber.*	*Nitrogen-free Extract.*
Blue grass hay	4.6	2.2	16.4	23.6
Wheat bran	12.5	3.6	3.6	38.5

The digestible nutrients in *one* pound would be a hundredth part of each amount above. In eighteen pounds of blue grass hay, there are the following amounts of each digestible nutrient: Crude protein 18 x .046 = .83 lbs.; fiber .164 x 18 = 2.95 lbs.; nitrogen-free extract 18 x 236 = 4.25 lbs., ether extract 18 x .022 = .4 lbs. In ten pounds of bran the digestible nutrients are: Protein 10 x .125 = 1.25

lbs., fiber 10 x .036 = .36 lbs., nitrogen-free extract 10 x .385 = 3.85 lbs., ether extract 10 x .036 = .36 lbs.

Tabulating the total pounds of each nutrient in both hay and bran we have:

	Protein	*Fiber*	*Nitrogen-free Extract*	*Ether Extract*	*Corrected Ether Extract.*
18 lbs. hay	.83	2.95	4.25	.40	.76 x 2½ = 1.90
10 lbs. bran	1.25	.36	3.85	.36	
Total nutrients	2.08	3.31	8.10	.76	1.90

Adding the digestible fiber, nitrogen-free extract and correct fat togetner, it gives 13.31 pounds of digestible non-nitrogenous compounds. 3.31 + 8.10 + 1.90 = 13.31. Dividing this number, which is the total digestible non-nitrogenous compounds, by the digestible protein, it gives 6.4. 13.31 ÷ 2.08 = 6.4. The nutritive ratio is 1 to 6.5. There is one part of the digestible protein to 6.4 parts of digestible non-nitrogenous compounds.

Heat produced by foods. When the food is digested it produces a definite amount of heat and muscular energy, which can be measured by the work that it is capable of doing. The heat produced is measured in calories. A calorie is the amount of heat required to raise the temperature of a kilogram of water from 0 to 1 degree Centigrade, or 2.2 lbs. of water 1.8 degrees Fahrenheit. One pound of digestible protein yields 1860 calories, a pound of digestible fiber or nitrogen-free extract compounds yields the same amount. One pound of digestible fat yields 4225 calories. The heat units, measured in calories, produced by the previous ration are found by adding the digestible protein, fiber, and nitrogen-free extract and multiplying the sum by the factor 1860. Then multiply the digestible fat by the factor; 4525, and add the two results.

(2.08 x 3.31 x 8.10) x 1860	=	25096
1.90 x 4225	=	8027
Total calories		33123

The amount of heat produced by various foods is an important factor, especially when the climate is very severe;

then a larger amount of heat will be required by the body. This heat must be supplied by the food.

NUTRIENTS AND HEAT UNITS BOUGHT FOR A DOLLAR.

The amount of digestible nutrients and heat units which can be purchased for a given sum of money, is the most important point to take into consideration in economic feeding. The prices of grain and milled products are not always in proportion to their actual values. A dollar expended in one food will frequently buy more digestible nutrients and heat units than when expended in other foods.

In the table LX. are given the pounds of digestible nutrients and of heat units which can be purchased for one dollar, when the prices are as stated.

In the table it will be seen that when corn is fifty cents per bushel or corn meal is eighteen dollars per ton, one dollar will buy more digestible protein and other nutrients in the form of bran or shorts at fifteen and sixteen dollars per ton. When the corn meal is the same price per ton, twelve dollars, the dollar would be as wisely expended in corn meal as in shorts.

When barley is selling at forty-eight cents per bushel, it will pay well to sell some of the barley, and even buy wheat at fifty cents per bushel, or corn meal at eighteen dollars per ton. Again, when oats are selling at twenty-eight or thirty cents per bushel, it will pay to sell part of the oats and buy some cheaper grain or mixture.

When timothy hay is selling for eight dollars per ton, and clover hay at ten dollars per ton it will be cheaper to to sell the timothy and keep the clover or buy the clover in preference to the timothy.

When the differences are small between two foods, as to the amounts of digestible nutrients which can be purchased for one dollar, the farmer can use his own judgment, and purchase or sell as best suits his purpose. The table is to be used more as a guide. When the differences are large, and much in favor of one food at a certain price, it will be econo my to purchase the food which will give the larger amount of digestible protein and other nutrients for a given sum of money.

TABLE LX.—Digestible Nutrients and Heat Units Bought for One Dollar.

Kind of fodder or grain.	Price per ton	Pounds Digestible.				Heat units
		Dry matter	Protein	Ether extract mainly fat	Nitrogen free extract and fiber	
Bran	$12.00	100	20	6	71	194.610
Bran	15.00	80	16	5	56	155.045
Corn meal	18.00	87	10	3	74	168.915
Corn meal	12.00	132	15	5	112	257.345
Corn and cob meal	15.00	100	10	3	86	191.235
Corn shelled, 50c bu	....	87	9	3	75	168.915
Wheat shorts	12.00	111	17	4	90	216.029
Wheat shorts	16.00	85	12	3	70	165.195
Oats, 30c per bu	....	72	10	4	56	139.760
Linseed meal	28.00	51	19	5	24	91.105
Linseed meal	24.00	59	23	6	28	120.210
Barley, 48c per bu	....	71	9	2	59	134.930
Peas, $1 per bu	....	48	12	3	36	101.955
Peas, 70c per bu	....	68	16	4	49	137.900
Gluten meal	22.00	71	22	6	43	146.250
Cotton sead meal	28.00	47	23	7	14	97.395
Wheat, 50c per bu	....	87	14	2	70	155.987
Timothy hay	8.00	127	9	3	108	230.295
Prairie hay	6.00	163	11	4	138	294.040
Clover hay	10.00	105	15	3	82	193.095
Millet hay	8.00	138	10	3	121	256.236
Rye, 45c per bu	....	88	13	2	72	166.550

In case the grains or fodders are at different prices from those stated in the table, either add or subtract the proportional amount of each nutrient, or calculate from the tables the amounts purchasable for one dollar. In order to do this, first find how many pounds of fodder or grain can be purchased for the dollar, multiply this amount by the per cent. of digestible nutrients contained in the fodder, which will give the pounds of digestible nutrients that can be purchased for one dollar.

In case wheat bran is eighteen dollars per ton, the dollar will purchase 111 pounds of bran, each pound of bran contains 1.25 pounds digestible protein, hence 111 pounds bran contain about 14 lbs. of digestible protein. In like manner the other digestible nutrients are determined. In the table LX. the value of the manure is not taken into consideration. Inasmuch as all grains are sold by weight instead of the measured bushel, the legal weight per bushel, of the various grains, as approved by the Minnesota Legislature, April 17, 1893, are given.

	Pounds per bushel.		Pounds per bushel.
Barley	48.	Millet Seed	48.
Buckwheat	50.	Oats	32.
Corn, shelled	56.	Peas	60.
Corn on cob	70.	Potatoes	60.
Clover seed	60.	Rye	56.
Wheat	60.		

In the purchasing of foods the preference should be given to those foods which contain the largest amount of digestible protein, because the protein is, by far the most expensive and important nutrient in foods. In case the difference in digestible protein is small, the one having the largest amount of digestible non-nitrogenous compounds should be purchased. When oats are thirty cents, and corn is fifty cents per bushel, a dollar will purchase nine pounds digestible protein in the form of corn, and ten pounds in the form of oats, but in the corn there is nearly twenty pounds more of starch, etc., than in the oats, which more than makes up for the pound less protein in the corn.

When linseed meal is twenty-eight dollars per ton, and and corn fifty cents per bushel, a dollar will buy ninteen pounds of digestible protein, and twenty-four pounds of digestible carbohydrates as linseed meal, and nine ponnds of protein and seventy-five pounds of carbohydrates, as corn. Ten pounds of protein are in favor of the linseed meal, while fifty-one pounds of carbohydrates are in favor of the corn. The additional fat in linseed meal, will bring the fifty-one pounds of carbohydrates in the corn down to forty-six. The question is: which is worth more, nine pounds of protein, or forty-five pounds of car bohydrates? This depends upon what the corn or linseed meal is to be mixed with or fed to. When the linseed meal is selling at the lower figure, twenty-four dollars per ton, the nutrients are in favor of the linseed meal.

When corn meal is selling at eighteen dollars per ton, and corn and cob meal at fifteen dollars per ton, the corn and cob meal will be as cheap as the corn meal, provided that only those cobs are present which actually belong to the corn. The same amount of digestible protein will be purchased in each case, ten pounds, but in the corn and cob meal there are thirteen pounds more of the digestible carbohydrates. In purchasing corn and cob meal there is some risk of getting more cobs than belong in the meal, which greatly reduces the value. When there is only two dollars per ton difference in the selling price of the two, it will be cheaper to purchase the corn meal, because the manure will be worth more, and the cost of hauling will be less on the more concentrated food.

When you are doing your own grinding it will be cheaper to feed the corn, as corn and cob meal, when the corn is selling at fifty cents per bushel, than to sell the corn and buy corn meal at eighteen dollars per ton. Ten bushels of shelled corn corn will weigh 560 pounds, and with the cobs it will weight 700 pounds. The 560 pounds of corn, and the 140 pounds of cobs will contain the following amounts of digestible nutrients:

	Dry Matter.	*Protein.*	*Fat.*	*Fiber.*	*Nitrogen free extract.*
Corn....................	448	51	17	6.1	375
Cobs....................	75	.3	.3	28.0	45

The corn cobs have added seventy-five pounds of digestible dry matter composed almost entirely of fiber, and nitrogen-free extract compounds.

When cotten seed meal and linseed meal are selling at the same price, there is but little difference between the feeding value of the two. Gluten meal at twenty-two dollars per ton compares very favorably with linseed meal at twenty-four dollars per ton. There is a pound more digestible protein in the linseed meal, but in the gluten meal there are fifteen pounds more of digestible carbohydrates, which more than make up for the pound less of protein.

Gluten meal is not as constant in its composition as it should be; quite frequently it is mixed with the germ meal, which is a valuable food, but not so valuable as the gluten meal. Hence in purchasing gluten meal, as well as some of the other mill products, it would be wise to send a sample to the Experiment Station to see if it is all right.

FACTORS WHICH INFLUENCE THE COMPOSITION OF CROPS.

The factors which influence the composition and value of fodders are: (1) Stage of growth at which a fodder is harvested. (2) Effects of climate and season. (3) The time required for maturing the crop. (4) The protection which the crop is given after harvesting. (5) Quality of the seeds sown. (6) Quality and condition of soil.

The stage of growth at which a fodder is cut, has much to do with its composition. In the case of timothy, cut at different stages of growth, there is a marked difference in composition. In the year 1891 samples of timothy were cut at three different stages of growth and analyzed. The composition of the timothy for each period on a uniform basis of ten per cent. water, was:

	Before Bloom.	*In Early Bloom.*	*Ripe.*
Ash	7.09 per ct.	6.32 per ct	5.45 per ct.
Ether Extract	2.87 "	2.51 "	2.22 "
Crude Protein	9.84 "	7.62 "	6.42 "
Crude Fiber	28.17 "	31.12 "	32.52 "
Nitrogen Free Extract,	42.02 "	42.43 "	43.39 "

The largest amount of dry matter is obtained when the timothy is ripe, while the largest amount of protein is obtained from early to late bloom. The same is true with clover and nearly all agricultural crops. The first stages of growth are devoted mainly to the formation of nitrogenous compounds, while the materials which are added to the crop in the last stages of growth are mainly non-nitrogenous compounds. Early cutting gives a smaller amount of a more concentrated fodder. While late cutting gives a larger quantity, and a less concentrated fodder.

Effects of Seasons. When the growing season is favorably prolonged, larger amounts of starch and other non-nitrogenous compounds are stored up in the plant because the conditions are more favorable for this kind of growth. It seems that plants devote their energy, at first, more to the formation of the nitrogenous compounds, than to the development of the non-nitrogenous compounds.

In early and late varieties of any kind of food products, the early maturing varieties will invariably show the larger proportion of protein, while the late varieties will show the larger amount of starch and other carbohydrates. Hence in aiming to secure as early ripening crops as possible by means of selection of seeds and otherwise forcing tbe growth, there is no loss of food value with the early maturing crops, but if anything, there is a gain by having a larger proportion of nitrogenous compounds on account ot the plant being forced in that direction.

Even the potato, which is strictly a starchy food, is influenced by this condition. Early varieeies of potatoes contain more protein than later varieties on account of more starch being formed in the later varieties during their prolonged growth. In early and late maturing crops of the same variety, the difference in composition falls on the protein, which is in favor of the early maturing varieties, and on the starch, which is in favor of the late maturing varieties. The early maturing varieties are placed at a little disadvantage on account of a shorter growing period and a shorter time to procure their mineral food from the soil. All early maturing crops should be favored with thorough cultivation and manuring in order to make up for this shorter period of growth. Early maturing varieties require that the soil should be in its best condition.

The effect of heavy showers and prolonged rains on hay after it is cut, and when it is in stacks which are uncovered and unprotected, is quite noticeable. In the season of 1891, which was a very rainy one, a sample of timothy weighing twenty-five pounds, was exposed to one heavy shower and three heavy dew falls. The sample was exposed in all five days and at the close weighed 21.5 pounds. The timothy was spread on a canvas cloth over a wire screen and covered with a wire screen, so as to prevent any of the hay from blowing away. The rain removed twelve per cent. of the best part of the dry matter of the hay. The sample was in early bloom when cut.

The per cent. loss of each nutrient was as follows:

Ash	17.26
Ether Extract	7.47
Crude Protein	7.69
Fiber	.20
Nitrogen-free extract	25.78

In actual hay making the losses would have been even larger, because some of the hay would have been lost mechanically.

THE DIGESTIBILITY OF WHEAT.

HARRY SNYDER.

The frequent low price of wheat and the high price of corn has created much interest in regard to the use of wheat as an animal food. The usual high price of wheat has prevented its extensive use as an animal food, and hence its digestibility has never been determined.

The digestibility of the wheat was determined mainly to observe the difference in digestibility between the whole grain and the cracked grain, and also to learn how the digestibility of wheat compares with that of other grains.

The wheat was fed to young pigs in two ways. In one case, whole wheat and coarsely ground (cracked) corn was fed, half and half by weight; in the other case, cracked wheat and corn was fed. The ration was the same in each case, except as to the difference in the way in which the wheat was fed. The results were duplicated, and those for the whole wheat were duplicated on different animals.

TABLE LXI.—Digestibility of Wheat, Whole and Cracked.

	Per cent. Digestible.	
	Whole Wheat.	Cracked Wheat.
Dry matter	72.	82.
Ash	44.	50.
Ether extract (fat)	60.	70.
Protein (gluten)	70.	80.
Fiber	30.	60.
Nitrogen-free extract	74.	83.

The results show a diffence of ten per cent. digestibility in favor of the cracked wheat. Had the wheat formed more than half of the ration, the difference in digestibility would have undoubtedly been even greater.

When the wheat was fed whole, the loss consisted mainly of undigested kernels. These grains, when recovered from the dry manure, showed but little of the effects of the digestive organs. They were coated with a covering of mucus material, and when this coat was removed by washing with distilled water, the recovered wheat grain had practically the same composition as when fed.

TABLE LXII.—Composition of Whole Wheat as Fed and the Whole Wheat in the Manure.

	Whole Wheat as fed.		The whole wheat in manure.	
Water	10.95	per cent	12.42	per cent
Ash	2.20	"	2.14	"
Ether extract (fat)	2.17	"	2.10	"
Protein (gluten)	14.18	"	13.75	"
Fiber	2.83	"	2.70	"
Nitrogen-free extract	67.67	"	66.89	"
Total	100.		100	

The only noticeable difference is about two and one-half per cent. more water in the wheat recovered from the manure. When the results are compared on the basis of the dry matter, the difference in composition between the two samples is very slight.

The digestibility of cracked wheat compares very favorably with other grains. It does not appear to be quite as digestible as corn, but the dry matter is more digestible than that of barley, shorts or bran. For comparison the digestibility of a few other grains and products, as determined at this station, is given.

TABLE XLIII.—Digestion Co-Efficients of Wheat and other Grains.

	Cracked wheat.	Cracked barley.	Wheat shorts.	Wheat bran.	Cracked corn.
Dry matter	82.	80.	76.	69.	90.
Ash	50.	6.	5.	6.	1.
Ether extract	70.	79.	70.	75.	78.
Protein	80.	81.	75.	75.	90.
Fiber	60.	48.	33.	30.	48.
Nitrogen-free extract	83.	86.	86.	70.	94.

When corn and wheat are both selling at fifty cents per bushel, the fifty cents will purchase the same amount of digestible dry matter of either wheat or corn, but the digestible dry matter in the bushel of wheat contains two and one half pounds more of digestible protein, while the bushel of corn contains two and one half pounds more of digestible carbohydrates. The amount of heat units produced by each grain is about the same.

TABLE LXIV.—Digestible Nutrients in a Bushel of Wheat and Corn.

	Dry Matter.	Fat.	Protein.	Carbo-hydrates.	Heat Units.
Wheat	43.5	1.	7.	35.	82.345
Corn	43.5	1.5	4.5	37.5	84.407

Inasmuch as the bushel of wheat contains more digestible protein, this food is better suited to produce pork with more lean meat, than is corn. Furthermore the manure from the wheat is worth about twenty-five per cent. more than the manure from the corn.