A STUDY OF RIPENING CORN

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In the fall of 1892 a line of investigation was undertaken by the writer with a view to determining some of the successive changes that take place in a crop of corn in the process of ripening, and also to ascertain the character, composition and quantity of product, and an indication of its feeding value, when harvested in different stages of growth. To this end five plots of one-fifth of an acre each of good well grown field corn were put in shock at intervals of a week, commencing on September 17, and ending October 13, and in addition a plot of equal area was left in the field until December 17, and the stalks then cut as in shocking, and weighed and sampled for analysis. The purpose was to follow as closely as possible, the most approved methods in common farm practice, and the fodder was shocked and left in the field and samples taken in the condition that it would be found in feeding from the shock several months later. On the date named the shocked corn grown on each plot was husked in the field, the corn and stover brought in and weighed separately and sampled for analysis. Weights were taken of the entire product of corn and stover from each plot. The shocks were twelve hills square and were put up by what is known as the "jack" system; that is, a scantling two by four inches by fourteen feet, supported at one end by two legs about four feet long, the other end resting on the ground, and a four inch fence board, five feet long, passing through a mortised hole four feet from the upper end of the scantling constituted a frame work around which the shocks were built, thus partially dividing each shock into four sections and enabling the fodder to cure perfectly although the first and second cuttings were

quite green when put up. When the corn was brought in on December 17, there was six or eight inches of snow on the ground, but all shocks were standing well and the corn fodder, except for a little snow that had drifted in, was found to be dry, bright and well cured.

The relative weights of corn and stover, and subsequent analyses revealed some interesting facts. The following table presents the yield and composition of stover from the several plots as shown by the weights taken December 17, and analysis later. Table No. 2 shows the same for the shelled corn.

TABLE NO. I. STOVER.

	Yield of dry field cured stover per acre in tons.	Percentage of Water.	Total Dry Matter.	PERCENTAGE IN DRY MATTER, OF				
				Ash.	Ether extract.	Nitrogen—free extract.	Crude fiber.	Crude protein.
Plot—I	2.	12.97	87.03	9.70	1.11	49.70	31.02	8.47
Plot—II	2.12	11.09	88.91	7.20	1.01	50.77	34.07	6.95
Plot—III	2.02	17.70	82.30	8.49	.11	47.79	38.27	5.34
Plot—IV	2.02	16.56	83.44	9.04	.34	50.55	34.88	5.19
Plot—V	1.77	13.33	86.67	6.40	.16	54.21	35.18	4.05
Plot—VI	1.12	13.08	86.92	6.17	.29	52.47	36.65	4.42

TABLE NO. II. CORN.

	Yield of ear corn per acre in bushels.	Percentage of water in kernals.	Total dry matter in kernals.	PERCENTAGE IN DRY MATTER (KERNALS), OF				
				Ash.	Ether extract.	Nitrogen, free extract.	Crude fiber.	Crude protein.
Plot—I	53.6	8.86	91.14	1.60	4.44	80.47	2.45	11.04
Plot—II	57.9	9.97	90.3	1.71	4.92	80.46	2.35	10.56
Plot—III	63.6	10.27	89.73	1.56	4.82	80.10	2.23	11.29
Plot—IV	64.3	11.29	88.71	1.37	5.48	80.70	2.00	10.45
Plot—V	60.3	15.00	85.00	1.65	5.25	80.00	2.18	10.92

The plots number from 1 to 5 according to time of cutting, and stover sample No. 6 was from the stalks left standing in the

field until winter. The first column shows that the highest yield of stover per acre was reached at the time of the second cutting, September 24. At this time the plant was yet green, only a few of the leaves had begun to dry, and the ears were well dented. It will be seen from the next table that the highest yield of corn had not yet been reached. The fall was peculiarly favorable for putting up corn fodder, as no killing frost came until the 10th of October. By the third week, October 1, the yield of fodder began to decline, but remained the same for the next week, October 8, and after that went down rapidly in the last, October 15, and still lower in the winter gathered product, showing a variation of an even ton per acre between extremes.

From table II it will be seen that the yield of husked corn per acre increased steadily from 53.6 bushels from the first cutting to 64.3 from the fourth, and dropped to 60.3 from the last. This loss in yield from the last cutting is believed to be partly due to a slightly defective stand of corn on this plot. The field, of which these plots constituted a part, contained 9.66 acres of clover and timothy meadow plowed the previous fall. Care was taken to secure plots of a uniformly even growth, but the last plot bordered on ground a little lower than that of the others, and the seed did not germinate quite so well. Just how much can be attributed to this cannot be determined, but the difference in the appearance of the corn, when standing, was so slight as to be hardly distinguishable, and it is not probable that this condition figured much, as the crop and stand were good on all plots, as will be seen from the yield per acre reported; and what little this plot lacked in stand would naturally be partially compensated for in a heavier growth of stalk and ears.

On looking to the composition of the corn at different stages of growth, as shown in table No. 2, we find much less variation in the kernels than in the stover. In fact, there is practically no change in the dry matter of the kernels except a slight increase in the ether-extract (fat), and a very small decrease in the protein; not enough, however, to materially affect the feeding value of the product in either case. From this standpoint the time of cutting seems to exercise but little influence; that

is, plot I, cut when the ears were in the "dough" stage of ripening, gave corn of practically the same chemical composition as that from plot V, cut four weeks later, when the ears were fully ripened. In the first column, showing yield of corn per acre, however, there is a difference, as before stated, covering a range of over ten bushels, that is well worth considering.

Another feature in this analysis that seems rather unusual or unexpected, at least, is shown in the percentage of water contained in the different samples of corn, increasing as it does from 8.86 per cent in the first cutting to 15 per cent in the last. In similar work, reported in Bulletin 21 of this station, the percentage was found to be much less as ripening progressed, although there is this difference—samples were taken in that case direct from the field at time of cutting, and in this work, as before stated, they remained in the field several months, in course of which they were well air dried. The sample from plot V was somewhat damp when taken to the laboratory, which accounts for its high percentage of water, but it will be seen that there is also a gradual and quite regular increase in all of the others, independent of the last.

On looking to the composition of the stover, as shown in table I, we also find a variation that is quite marked, which taken in connection with the varying yields of this product, will, to a considerable extent at least, compensate for some loss of corn from early cutting. It will be noticed that the percentages of both fat and protein show a marked decline, indicating a depreciation in the feeding value of stover corresponding with the diminishing yield as ripening advanced. The percentage of ash also shows a decline from 9.70 per cent in the first cutting to 6.17 in the last, but the other nutrients, nitrogen-free extract (carbhydrates) and crude fibre, remained quite constant in all the analyses.

We find, then, in summing up the results, that the stover suffered a loss in both quantity and quality after the second cutting, September 24, and that the corn showed a corresponding increase in quantity but not in quality.

In tables 3 and 4 the total amount of each nutrient and total

dry matter per acre in the stover and kernels are calculated on the several dates of cutting.

TABLE NO. III, STOVER.

Showing calculated amount of nutrients per acre on the several dates of cutting.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Dec. 17.
Ash, lbs. per acre	337	272	282	303	196	118
Ether extract, fat, lbs. per acre	38	38	4	11	5	6
Nitrogen-free extract, lbs. per acre	1,740	1,924	1,596	1,708	1,659	1,019
Crude fiber, lbs. per acre	1,078	1,283	1,263	1,179	1,076	712
Crude protein, lbs. per acre	296	339	176	171	122	85
Total dry matter, lbs. per acre	3,489	3,856	3,321	3,372	3,058	1,940

TABLE NO. IV, KERNELS.

Showing calculated amounts of nutrients per acre on the several dates of cutting.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.
Ash, lbs per acre	44	50	50	44	47
Ether extract (fat), lbs per acre	120	143	154	175	151
Nitrogen-free extract, lbs per acre	2,196	2,355	2,558	2,577	2,299
Crude fiber, lbs per acre	67	69	71	64	52
Crude protein, lbs per acre	301	309	361	334	313
Total dry matter, lbs. per acre	2,728	2,926	3,194	3,194	2,862

It will be seen from these tables that the largest amount of dry matter in the stover was secured at the time of cutting the second plot, September 24, and the greatest amount of dry matter secured in the kernels was reached at the time of cutting the third plot; and that the highest aggregate dry matter from an acre, 6,782 pounds, in the stover and kernels combined, was secured from the second cutting, and the next highest, 6,515 pounds, from the third cutting.

These results indicate that the best time for cutting the corn under investigation was from September 24 to October 1. By cutting on the former date 268 pounds of dry matter in the kernels was lost, and by waiting till the latter a loss of 535 pounds of stover and also a depreciation in quality was sustained.

Rigid dates of cutting cannot be prescribed, as the seasons and conditions are too varying. A description of the condition

of the crop when these plots were cut will be more reliable than dates. Plot I was cut when the kernels were in what would be termed the "dough" stage, not quite all dented, and the stalks and leaves were yet entirely green; plot II, corn well dented and the blades just beginning to dry; plot III, corn well ripened and the blades about half dry; plot IV, corn thoroughly ripened and the blades and husks rapidly drying up; plot V, blades and husks nearly all dry, only a few of the middle and more protected blades yet green, stalks also drying out considerable; plot VI, sample in the usual storm beaten condition of Iowa stalk fields in December. The purpose in leaving this plot uncut until December was to compare the stalk-field product under winter grazing conditions with well cured stover. This was the principal feature and the primary object of the experiment. The results show a striking loss entailed by this method, amounting first, to nearly half the product in yield, and second, a depreciation in feeding value. The total dry matter from the stover of this plot is only about one-half as much as that from the second cut plot, and the chemical composition indicates that the feeding value of the crop in this condition is less than half what it is when secured in its best form. By a misunderstanding of instructions a station employee gathered and fed the corn from this plot in October, but judging from the similarity of composition of the other corn samples, nothing of particular interest was lost. In taking the samples a bundle stalks leaves and husks were first run through a hand cutter and a portion of this sample, well mixed, was taken for analysis. On account of pressure of work in the laboratory, the chemical work was delayed for a time and the bundles hung in a dry, well ventilated barn, during which some loss of nutrients undoubtedly took place; but as they were all treated uniformly it is probable that the comparison was not affected unless it was in case of the stalk sample, which probably did not suffer from exposure in the barn after having stood in the field two months after maturity. The corn samples were taken by selecting twenty sound ears from each plot. The kernels and cobs were analyzed separately and although the analysis of

the cobs does not reveal any marked change, the result is here given for comparison.

TABLE V., COBS.

	Total dry matter.	Ash.	Ether-extract.	Nitrogen-free extract	Crude fiber.	Crude protein.	
Sample I	92.18	1.44	0.23	58.42	38.09	1.82	100
Sample II	90.73	1.76	0.01	59.20	36.90	2.13	100
Sample III	88.85	1.68	...	60.02	36.41	1.89	100
Sample IV	90.25	1.58	0.11	58.15	37.97	2.19	100
Sample V	80.10	1.45	....	59.93	36.62	2.00	100

SUMMARY OF RESULTS.

The conclusions that are fairly deducible from the results of this experiment we think are the following:

First. The stover of a crop of corn seems to reach the highest yield and the best condition for feeding at the stage of growth indicated by a well dented kernel and the first drying of the blades.

Second. The grain of a crop of corn seems to reach the highest yield and the best condition for utility at the stage of growth indicated by a well ripened ear and a half dried blade, and the best time for securing the crop with reference to the highest utility of both corn and stover would be found at a stage of ripening between the above.

Third. The loss resulting from stover remaining in the field under ordinary stalk field conditions two months after ripening amounts to about one-half of the dry matter and more than one-half of the total feeding value.

Fourth. After the stover has reached the best condition for cutting described elsewhere in this article there is a rapid decline in both yield and feeding value.

Fifth. There is but little change in the composition of the grain of a corn crop in the several stages of ripening herein described, and there is little if any decline in either yield or feeding value after the best condition is reached, nor does there seem to be much *gain*, except a small increase in yield, after the denting stage of the ears is reached.

Sixth. No material change occurs in the composition of the corn cobs during the several stages of ripening herein described.