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Technical Report No. 3

AN ESSAY KEY FOR THE PHOTOIDENTIFICATION
OF FARM CROPS AT SEVERAL INTERVALS
DURING THE GROWING SEASON
IN NORTHERN ILLINOIS

Part IV

PHOTO APPEARANCE OF CORN FIELDS

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By

Clyde F. Kohn

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Clyde F. Kohn, Director
Marjorie Smith Goodman, Research Assistant

Department of Geography
The College of Liberal Arts
Northwestern University
Evanston, Illinois

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AN ESSAY KEY FOR THE PHOTOIDENTIFICATION OF FARM CROPS
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Part IV

PHOTO APPEARANCE OF CORN FIELDS*

During early stages of growth, similarities between the photo appearance of corn and other field crops (see Part V) make it impossible to identify fields of corn on aerial photographs with any degree of accuracy. During later stages of growth, on the other hand, fields of corn can be readily identified on aerial photographs. During these later stages, five criteria aid the photo interpreter. (1) As the growing season progresses, corn becomes the tallest crop in the research area. Some varieties reach a height of nine feet. This outstanding growth produces a rough photographic texture, hereafter referred to in this report as a nubby texture. No other crop photographs in such a way (Fig. 17, Sample 1 /0.5 - 2.5_/). (2) The height of corn in a field produces a shadow which is long enough to be seen on aerial photographs (Fig. 17, Sample 18 /1.0 - 1.9_/). No other crop becomes tall enough to produce shadows. (3) Corn is not harvested until late

*The facts and conclusions stated in this part of Technical Report No. 3 pertain to the photo appearance of corn fields for the research area described in Parts I and II, a mile-wide strip extending westward from the shore of Lake Michigan at Winthrop Harbor in northeastern Illinois to within one and one-half miles of Antioch. Sixteen fields of corn scattered throughout this 13-1/2 square mile area were studied. Samples were selected to include corn in all possible associations with various landforms, soils, and farm practices.

in the growing season. It is generally the last crop, except soybeans, to be removed from the fields. Whereas other fields show harvest markings in July and August, fields of corn do not acquire such markings until September or October. (4) Much corn in the research area is cut and shocked in the field. These shocks can be readily identified on aerial photographs (Fig. 17, Sample 18 $\underline{1.2 - 3.1}$). This practice, however, no longer holds throughout the United States. (5) Lastly, fields of corn produce a unique range of tonal values during the growing season. During early stages of growth, corn fields have a light photographic tonal value (Figs. 9, 10 and 11). Photographic tones become increasingly dark as the growing season progresses (Figs. 12, 13, 14, 15, and 16). There is a lightening of tones only after the corn has been harvested (Fig. 15, Sample 2 $\underline{1.6 - 2.8}$) and (Fig. 15, Sample 14 $\underline{1.7 - 3.4}$) or after frost (Fig. 16, Sample 4 $\underline{0.5 - 0.4}$ and Fig. 17, Sample 1 $\underline{0.5 - 2.5}$).

Growing Corn in the Research Area

Farm practices in the growth of corn vary in the research area. These practices pertain to (1) the variety of seed planted; (2) the dates of planting; (3) the preparation of the fields; (4) fertilization of the crop; (5) the rotation cycle; (6) the uses made of the crop; (7) the date of harvest; and (8) the method of harvest. No variations seem to occur in methods of planting or cultivation.

Many varieties of corn are planted in the research area. Six of the more common varieties are included in the list of fields studied. The six varieties include Pioneer, Black Crow, Funks G-12, Funks G-30, DeKalb, and Ohio Silage Corn. Maturity rates of these six varieties range from 90 to 120 days.

The planting of corn in the research area begins on May 15 and continues through the third week of June. Seed is planted in continuous rows rather than in hills. Planting in two out of three fields follows spring plowing and disking. Other fields are plowed in the fall and disked in the spring.

Six out of seven corn fields are fertilized. Fertilizers in amounts of 100 to 350 pounds per acre consist primarily of 3-12-12.¹ Other fertilizers are in proportions of 3-8-8, 0-20-10, 2-12-6, or 2-12-16. Barn manure and raw rock phosphate are used on a few fields.

In the rotation cycle, about one-half of the corn follows hay or rotation pasture. Land use of the previous year on the remainder of the corn fields of the area is divided about evenly between oats and corn.

During the early stage of growth corn fields are cultivated from one to three times. Cultivation starts during the second week of June and ends during the second week of July. The work is done by tractor-drawn cultivators.

About 60 percent of the corn in the research area is cut for silage. The remainder is harvested for storage in cribs. Harvest in the fields of silage corn generally begins during the third week of September. Corn cut at this time is removed from the field as soon as it is cut. Harvest of corn for storage in cribs begins in mid-October.

¹Commercial fertilizers contain nitrogen, phosphate, and potash. Figures represent relative proportions of the three constituents. The formula 3-12-12 indicates 3 percent nitrogen, 12 percent phosphate, and 12 percent potash.

-4-

Nearly all of the crib corn is cut and placed in shocks in the fields.¹

Photographic Qualities Which Corn Fields
Share With Other Crops

As noted in previous sections of this report, nearly all crops of the research area have three properties in common. These properties -- form, size, and distribution of fields -- do not change with the growing season and are discernible without the aid of a stereoscope. Nearly all corn fields have a rectangular form (Figs. 3 and 9 to 17). The fields vary in size from five to forty acres. Their distribution over the research area presents no regular pattern. They are scattered throughout the area and account for approximately 26 percent of the total crop acreage. Corn is the second crop in the area on the basis of total acreage (Fig. 3). Many farms have two or more corn fields; but six farms have no corn fields. Of these six, three are cash grain farms, two are milk farms, and one is a rented farm on which only hay is harvested.

Photographic Qualities Which Differentiate
Corn Fields From Other Crops
at Selected Intervals During the Growing Season

Corn fields can be distinguished from other cultivated fields on aerial photographs of the research area during the later stages of growth in four ways: by tonal values; by texture; by field markings; and by objects and shadows associated with the growing and harvesting of corn. These indicators vary during the growing season, and the

¹ A few fields are harvested by corn pickers. No data were collected on the aerial photo appearance of such fields inasmuch as picking begins after October 19, the date of the last set of aerial photographs taken for this study.

photographic interpreter must know the general ground appearance of corn fields throughout the growing season if he is to identify fields of corn with reasonable accuracy. This is not difficult for someone familiar with agricultural practices for the growth patterns are related to climatic conditions and farming techniques of a specific area.

Photo Appearance of Corn Fields on May 28

On May 28 (Fig. 9) the ground appearance of corn fields varies considerably. At this date, corn in some fields is already two to three inches in height. The plants stand in parallel rows and are spaced at intervals of thirty inches. Other corn fields are planted but show no signs of growth. The remainder of the corn fields are prepared for planting but no seeds have yet been drilled. The top soil of all corn fields bears the markings of farm implements -- wheel tracks, disk tracks, and harrow tracks. Low portions of fields are moist and dark gray in color -- some nearly black. Higher portions are less moist and have a lighter gray color. Some appear nearly white.

The aerial photo appearance of corn fields on May 28 reflects their ground appearance. Fine parallel lines may be noted superimposed on a mottled background. (Fig. 9 and Plate 30).



Plate 30. Parts of two adjoining corn fields on May 28. Both are marked by faint lines superimposed on a mottled background.

The mottling results from variations in surface and moisture conditions and produces variations in tonal values within a given field. Tonal values, therefore, vary from seven to twelve (Fig. 9, Sample 1 $\sqrt{2.6 - 1.8}$ and Fig. 18) for an individual field. The fine parallel lines are a result of markings left by farm implements.

On the photographs for May 28, corn fields cannot be distinguished from other spring-planted crops (oats, barley, and soybeans). These crops also exhibit fine parallel lines superimposed on a mottled background. Objects and shadows which are associated with corn fields at later stages of growth do not appear on the May 28 aerial photographs.

Photo Appearance of Corn Fields on July 8 and July 13

Corn fields vary in both ground and photo appearance on July 8 and July 13 (Figs. 10 and 11). This variation results from differences in the date of cultivation (intertillage) of corn fields at this stage of growth. Cultivation of corn in the research area begins during the second week of June and continues through the second week of July. By July 8 many fields have been cultivated; others are undergoing cultivation. These differences are reflected in both the ground and photo appearance of the crop.

When observed on the ground on July 8 and 13, height and color of corn plants are relatively uniform throughout the area despite differences in the time of planting. Corn reaches heights of twelve to eighteen inches by July 8 (Plate 31)¹ and exceeds twenty inches in height by July 13 (Plate 32). The plants stand in rows and have

¹"Knee-high by the Fourth of July" is an old standard of measure for predicting the success of a corn crop.



Plate 31. Corn field on July 10. Plants are twelve inches in height and stand in rows spaced at thirty-inch intervals. This field has been cultivated. It exhibits a striped appearance. (See Fig. 10, Sample 1 /0.1 - 2.3/).



Plate 32. Corn field on July 14. Plants have a height of twenty-three inches. The field has not been cultivated recently. It does not have a striped appearance. (See Fig. 11, Sample 1 /0.3 - 1.9/).

bright shiny-green blade-like leaves which partially extend out over the space between rows. The ratio of ground without crop cover between rows to ground with cover is approximately two to one on July 8 and one to one on July 13. (Plates 31 and 32). Because the ground is not yet completely covered with crops, soil mottling resulting from slope and moisture differences within fields is still distinct and appears in all fields of corn at this time.

The soil in spaces between corn rows in recently cultivated fields is loose or pulverized; weeds and grasses are absent inasmuch as they have been turned under; and moist soil which has been turned up is darker than the soil near the corn plants which has not been disturbed. Thus these fields have a striped appearance (Plate 31, middle background). This striped appearance does not characterize corn fields which have not been cultivated recently (Plate 32). Depending on the date of cultivation, the inter-row areas may or may not contain grasses and weeds. In fields undergoing cultivation, tractor-drawn cultivators may be observed in operation along the line separating the cultivated portion from the uncultivated portion. The cultivated portion exhibits a striped appearance; the uncultivated does not.

The striped appearance of recently cultivated corn fields on July 8 and July 13 is recorded on aerial photographs taken on these dates (Fig. 10, Sample 1 $\langle 0.1 - 2.3 \rangle$). The stripes are superimposed on a mottled background. The dark stripes extend across darker areas of mottled backgrounds into lighter areas (Plate 33).



Plate 33. Stereopair: Recently cultivated corn field with striped texture on July 8 (0.5 - 0.4).

In some fields, striped portions end abruptly along a straight line and give way to the faintly lined texture which marked the aerial photo appearance of corn fields on May 28. By stereoscopic examination, one may often see a farm implement along the line separating the two kinds of field markings. Positions of the implement may be slightly different on the two pictures of a stereopair. Thus, the image is blurred as though out of focus. Such fields are undergoing cultivation (Plate 34, and Fig. 10, Sample 2 $\langle 2.4 - 1.2 \rangle$).



Plate 34. Stereopair: Corn field being cultivated on July 8 has striped texture in part (0.5 - 0.4) and faintly lined texture in part (0.5 - 0.3). A cultivator is in operation in the field (0.6 - 0.4).

Fields which have not been cultivated recently have faintly lined texture on a mottled background. Their aerial photo appearance is like that of May 28 (Plate 35 and Fig. 10, Sample 3 /1.0 - 2.1/).



Plate 35. Stereopair: Corn field, on July 3, which has not been cultivated recently. Faint lines appear on a mottled background.

Tonal values within individual fields of corn continue to vary. On July 8 this variation is from eight to eleven on the calibrated tone scale (Fig. 18 and Fig. 10, Sample 1 /0.5 - 2.2/).¹ On photographs of July 8 and 13 it is still difficult to distinguish corn from other spring sown crops, especially soybeans.

Photo Appearance of Corn Fields on July 21 and July 29

Although corn fields change significantly in both ground and aerial photo appearance after mid-July, there is little or no variation among individual fields of corn. The changes which do occur are reflected on the fourth and fifth sets of aerial photographs, taken on July 21 and July 29, respectively (Figs. 12 and 13).

The two major changes in ground appearance of corn fields between July 13 and July 21 are (1) in the height of plants and (2) in the extent of crop cover. By July 21, corn reaches heights

¹Tones could not be measured quantitatively on the July 13 aerial photographs (Appendix I).

of twenty-four to thirty-six inches -- a height which precludes cultivation. The ratio of bare ground to crop cover is approximately one to two at this time (Plate 36).



Plate 36. Corn field on July 21. Plants have a height of thirty-five inches. (Field is in Fig. 12, Sample 1 /0.2 - 1.9/)

The ratio is one to three on July 29 when plants are from thirty to forty inches tall. The dense foliage on July 21 and July 29 obscures soil mottling, characteristic of earlier ground and photo appearance of corn fields. Leaf color is only slightly darker than it was in early July.

Changes in aerial photo appearance of corn fields between July 13 and July 21 may be noted in both tone and texture. The only change between July 21 and July 29, however, is in tone. The tonal value of corn fields on these dates was as follows:

<u>Date</u>	<u>Condition of Crop</u>	<u>Tonal Value on Fig. 18</u>	<u>Fig. No. and Coordinates</u>
July 21	Uncut	11 - 13	Fig. 12, Sample 1 /0.3 - 1.8/
July 29	Uncut	9 - 11	Fig. 13, Sample 1 /0.3 - 1.8/

Under normal circumstances, the tone of corn fields is probably lighter on July 21 than on July 29. The July 21 photographs were taken immediately after a heavy rain. Apparently the densitometer failed to compensate fully for excess moisture which darkened all fields of the area on this date.

The photographic texture of corn fields is significant on July 21 and July 29. Fine parallel lines appear on a mottled background as at earlier intervals of growth;¹ but when viewed stereoscopically, the lines appear to stand up from the mottled background, giving a texture like that of corduroy cloth (Plates 37 and 38).²



Plate 37. Stereopair: Corn field with corduroy texture on July 21.



Plate 38. Stereopair: Corn field with corduroy texture on July 29.

¹Soil mottling which cannot be seen from the ground can be seen on aerial photographs taken at this time.

²The corduroy texture is not clearly defined in Figs. 12 and 13. Apparently it was lost in reproducing the two figures.

This textural quality is coarser than that of other cropped fields at this time, and enables the photo analyst to distinguish between corn fields and soybean fields. As a result the photo identification of corn fields after July 21 becomes more reliable.

Photo Appearance of Corn Fields on September 7

By September 7 (Fig. 14) individual corn plants reach heights of seven to nine feet, the maximum height of corn in the research area. Their leaves are dark, shiny-green in color. Foliage is dense and completely covers spaces between the rows. Plants are topped by beige-colored tassels and bear one or two ears of corn from twelve to fifteen inches in length (Plate 39).



Plate 39. Corn field on September 7. The plants are seven to nine feet tall and are in tassel and in ear. (This is the same field seen in Plates 31, 32, and 36).

On aerial photos, corn fields take on a nubby texture. The lination and mottline characteristic of corn fields at earlier intervals of growth disappear (Fig. 14, Sample 9 [0.2 - 1.8] and Plate 40). When viewed with a stereoscope, rows continue to stand up from the surface of the ground -- a quality which gave fields their corduroy texture in late July. The coarse nubby texture of corn fields on September 7 reflects the density of foliage. The great height of corn is indicated by a thin black, shadow line bordering northern edges of fields (Plate 40).



Plate 40. Stereopair: Three corn fields on Sept. 7 (0.3 - 0.2; 0.1 - 0.9; and 0.6 - 1.3). Texture is nubby and coarse. Overall appearance resembles corduroy cloth. Thin black shadows can be traced along the northern edges of fields.

On earlier photographs, shadows were not long enough to be seen. Corn fields register relatively dark tonal values on September 7 -- darker than fields of small grains but lighter than uncut hay fields. This results partially from the dark green color of the leaves and partially from shadows cast by the dense foliage (Plate 40).¹

¹Tones could not be measured quantitatively on the September 7 photographs (Appendix I).

Photo Appearance of Corn Fields on September 26

On September 26, some corn fields in the research area are being harvested for silage. The cut portions of these fields are marked by rows of corn stubble approximately ten inches high alternating with spaces of bare or weed-infested ground thirty inches wide.¹ Where soil is bare between the rows of stubble, soil mottling is visible as in early stages of growth. Tractor-drawn corn cutters may be seen in operation at the edge of the uncut portions of some fields. Uncut corn is yellow-green in color. Ears of corn are larger than they were on September 7 but the height of plants remains at seven to nine feet.

Early harvest for silage creates the only new feature in the aerial photo appearance of corn fields on September 26 (Fig. 15). Swath marks appear around the outer edges of the fields being harvested (Plate 41).



Plate 41. Stereopair: Swath marks around a field of corn which is being cut for silage on September 26.

¹ Swath marks in fields of harvested corn differ from swath marks in harvested hay. One or two swaths may be cut around the four sides of a corn field in order to "open the field up" for harvest. Thereafter, cutting parallels the corn rows. Cutting may be concentrated along one side or along two sides of the field. Swaths may sometimes be cut through the middle.

The swath-marked portion is wider on one or both of the two sides of the field which parallel the direction of the corn rows (Fig. 15, Sample 14 $\angle 0.5 - 3.2$; $1.0 - 3.3$; and $2.4 - 3.2$ /). Swath marks following the direction of the corn rows extend across the centers of some fields (Fig. 15, Sample 2 $\angle 1.8 - 0.5$ /). The harvested portions appear as faintly lined areas with a mottled background or in some instances, have a smooth texture. The aerial photo appearance of standing corn is like that of September 7. Such areas have a nubby coarse-corduroy texture with subdued mottling (Plate 41).

Tonal values of corn fields vary on September 26.

<u>Date</u>	<u>Condition of Crop</u>	<u>Tonal Value on Fig.13</u>	<u>Fig. No. and Coordinates</u>
Sept.26	Swath-marked	8-10	Fig. 15, Samp. 14 $\angle 2.4 - 3.1$ /)
Sept.26	Uncut	9-12	Fig. 15, Samp. 14 $\angle 2.2 - 3.1$ /)

Shadows along the northern edges of fields are especially well-defined where lighter swath-marked portions of fields border darker portions without swath marks (Plate 41 and Fig. 15, Sample 2 $\angle 2.0 - 2.7$ /).

Farm implements may be seen along such borders in some fields (Plate 42).



Plate 42. Stereopair: Corn field being harvested for silage. A corn cutter is in operation in this field ($0.5 - 0.4$). An implement may be in slightly different positions on the two pictures of a stereopair — an indication that the implement was in motion at the time of photography.

Photo Appearance of Corn Fields on October 5

Cutting of corn for silage continues through October 5; the date of the eighth set of aerial photographs of the research area (Fig. 16). By this late date early frosts, however, touch low lying portions of a few fields. Cutting corn for silage ends when frost becomes widespread.

The ground appearance of corn fields on October 5 is like that of September 26. Foliage of uncut portions is yellow-green in color except in a few depressions where frost has turned the color to light silver-beige (Plates 43, 44, and 45).



Plate 43; Corn on October 5: Frost has turned the color to silver-beige in low area (foreground); Corn on high ground (background) is yellow green (see Plates 44 and 45):



Plate 44. Close-up view of corn on high ground on October 5. Color is yellow-green (see Plates 43 and 45).

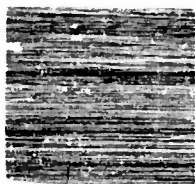


Plate 45. Stereopair: Corn field shown in Plates 43 and 44. The low spot with silver-beige color is at 0.5 - 0.1; the high ground with yellow-green color is at 0.7 - 0.1; the automobile seen in plates 43 and 44 stood at 0.8 - 0.1

Cut portions of fields, now widespread, are marked by rows of stubble alternating with spaces of bare or weed-infested ground thirty inches wide (Plates 46 and 47).



Plate 46. Corn field on October 5. The stubble is about ten inches in height (see Plate 47).



Plate 47. Stereopair: Corn field shown in Plate 46. The stubble in Plate 46 was photographed at 0.1 - 0.5.

Corn cutters continue to harvest the corn of some of the fields.

Aerial photographs reflect the effects of frost localized in the depressions of uncut portions of fields. Such fields regain the mottling which became subdued by dense foliage in early September. The tonal value of frosted areas is lower than that of areas which have not been touched by frost (Plates 45 and 48).

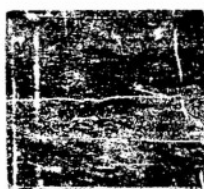


Plate 48. Stereopair: Depression with frosted corn on October 5. The depression extends from 0.4 - 0.0 to 0.9 - 0.7.

In all other respects, the photo appearance of corn fields is like that on September 26. More of the fields bear swath marks; some whole fields are so marked. The portions of fields which have been harvested present a smooth texture or photograph with faint lines on a mottled background (Plate 47, $\angle 0.7 - 0.3 \angle$). Tonal values (according to the calibrated scale, Fig. 18) vary as follows:

<u>Date</u>	<u>Condition of field</u>	<u>Tonal Value on Fig.18</u>	<u>Fig. No. and Coordinates</u>
Oct. 5	Harvested	3-10	Fig.16, Samp.18 $\angle 0.6 - 0.8 \angle$
Oct. 5	Uncut	10-12	Fig.16, Samp. 1 $\angle 0.3 - 2.0 \angle$

Narrow black shadows are distinct along northern sides of uncut fields and uncut portions of fields (Plate 47, $\angle 0.9 - 0.6 \angle$); and corn cutters appear along the line between cut and uncut portions of some fields (Plate 47, $\angle 0.9 - 0.3 \angle$)

Photo Appearance of Corn Fields on October 19

Several new properties characterize the aerial photo appearance of corn fields on October 19 (Fig. 17). These reflect practices followed in harvesting "crib corn".¹ By the middle of October all corn in the research area is touched by frost. As a result, it can no longer be harvested for silage.

In ground appearance, on October 19, corn fields vary in appearance depending on the harvesting of the corn. (1) In some fields where the corn has been cut and removed, only stubble remains. These corn fields appear as they did on October 5. (2) In other fields, corn is still standing. The appearance of these fields is nearly like uncut fields on October 5. Only the color has changed; it is now silver-beige throughout. (3) Corn in the third type of field may be cut but lies in bundles or sheaves on the ground or stands in shocks arranged in rows across fields. Shocks are cone-shaped, with a height of seven to eight feet, and have bases of approximately six feet in diameter. Fields marked by sheaves and shocks are also marked by rows of stubble at thirty-inch intervals across fields and by soil mottling. (4) Some fields present a complex appearance. Corn in one part of such a field may have been cut for silage and removed, whereas corn in another part may have been cut but has been left standing in shocks. Corn in still another part may be uncut (Plates 49 and 50).

¹The term "crib corn" is used because corn cut during October is husked and stored in corn cribs. Crib corn is grown especially on hog and beef fattening farms. Some crib corn in the area is grown as a cash grain crop.



Plate 49. Corn field on October 19. Stable at the right marks a portion of the field which was cut earlier for silage. Corn at the left will be cut for the crib. (Field is the same as that in Plate 50).

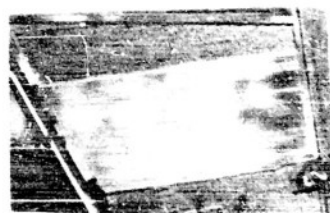


Plate 50. Stereopair: Corn field on October 19. Corn has been harvested in part for silage (0.5 - 0.5). The remainder will be cut for the crib (0.5 - 0.9). (Field is the same as that in Plate 49).

The photographic texture of corn fields on October 19 (Fig. 17) is generally like that on photos taken on October 5 and September 26. Cut fields have faint lines and are mottled (Fig. 17, Sample 18, $\angle 0.5 - 2.0 _ /$) whereas uncut fields have a nubby, coarse-corduroy texture (Fig. 17, Sample 18 $\angle 2.0 - 1.3 _ /$). Parallel rows of white objects resembling pin heads, however, cross a few fields (Plate 51 and Fig. 17, Sample 18 $\angle 1.2 - 3.1 _ /$) and a lacy texture marks a few other fields (Plate 52 and Fig. 17, Sample 18 $\angle 0.7 - 1.9 _ /$). Both of these markings are superimposed on the faintly lined and mottled backgrounds of cut portions of fields. The pin heads are shocks of corn. Their conical shapes are reflected by triangular shadows which can be seen by use of the stereoscope (Plate 51). The lacy texture is the result of sheaves of corn lying on the ground in preparation for shocking (Plate 52).



Plate 51. Stereopair: Field of corn shocks on October 19.



Plate 52. Stereopair: Corn field on October 19. Lacy texture is formed by sheaves of corn lying on the ground in preparation for shocking.

Tones of corn fields on aerial photographs are lighter on October 19 than on October 5. Whole fields of uncut corn now have the tonal value which was recorded only by frosted depressions on October 5 (Fig. 17, Sample 19 $\angle 1.8 - 1.2 \angle$). The contrast in tonal values is shown in the table below:

<u>Date</u>	<u>Condition of Field</u>	<u>Tonal Value on Fig.18</u>	<u>Fig. No. and Coordinates</u>
Oct. 5	Harvested	8-10	Fig. 16, S. 18 $\angle 0.6 - 0.8 \angle$
Oct.19	Harvested	7-9	Fig. 17, S. 18 $\angle 1.2 - 3.1 \angle$
Oct.19	Uncut	10-11	Fig. 17, S. 19 $\angle 1.8 - 1.2 \angle$

The Effect of Farm Practices on the Aerial Photo Appearance of Corn Fields

Variations in dates of cultivation, dates of harvest, methods of harvest, and uses made of the corn crops, all affect the aerial photo appearance of corn fields. Variations in other farm practices do not affect the aerial photo appearance of corn fields in the research area. These variations are in seed varieties, planting dates, field preparations, fertilization, and land use prior to corn in the rotation cycle.

Variations in dates of cultivation are recorded on sets of aerial photographs taken between mid-June and mid-July. By these variations, the photo interpreter can determine which fields have been cultivated recently (within a day or two prior to photography), which fields have not been cultivated recently, and which fields are undergoing cultivation at the time of photography. This in itself is relatively unimportant but the photo appearance of fields at this time does vary according to the condition of cultivation.

In the research area two different uses are made of the corn raised. On some farms it is cut for silage before the corn ripens. The fields of corn which are used for this purpose can be recognized on aerial photographs taken between mid-September and mid-October. Such fields have faint lines on a mottled background, resulting from field markings left by harvest machinery. Some of the corn raised in the research area is allowed to ripen and the ears are cut to be stored in a crib. Fields of corn which are raised for this purpose acquire harvest markings after mid-October. These field markings are indicated on aerial photographs by rows of pin heads (shocks of corn) or a lacy texture (sheaves) superimposed on a faintly lined and mottled background.

The purpose for which corn is raised is an indication of the type of farm economy practiced by an individual farmer. On dairy farms corn is raised in large part for silage; on beef and hog farms and on cash grain farms corn is allowed to ripen and is stored in cribs.

Conclusions

Corn is one of the major crops of the research area. It can be identified on aerial photographs with relative ease and accuracy during the second half of the growing season. Identification of corn fields is achieved primarily through their textural properties which are unique from July 21 until harvest, and by field markings after harvest. Identification is achieved secondarily by shadows and by tonal qualities. The tonal quality of corn fields at each

interval of growth is not so outstanding as that of hay fields but still serves as an aid to identification.

Corn fields have four characteristics which they share in common with other crops of the research area: (1) corn fields are of the same size and form as fields of other crops; (2) the photo appearance of corn fields is not affected by variations in landforms and soils and by most variations in farm practices; (3) corn fields pass through only one cycle of growth and harvest during the growing season; and (4) there are periodic limitations to the identification of corn crops on aerial photographs.¹

Five unique characteristics give corn fields distinctive aerial photographic properties. These characteristics are:

- (1) Corn crops grow taller than other crops of the research area. This characteristic gives corn fields the coarsest texture and the only shadows which can be seen in cropped fields on aerial photographs of the research area.
- (2) Corn fields are harvested primarily in rows rather than in concentric bands and some of the harvested crops are stored in shocks in the field. Fields of shocked corn have most distinctive markings on aerial photographs.
- (3) Corn crops are harvested later than other major crops of the research area; some are harvested even after complete frost. The distinctive coarse corduroy texture of fields of standing corn can be seen on aerial photographs to the very end of the growing season, harvest markings being acquired only after mid-September.

¹Only hay is different from other crops in the area in respect to the last two characteristics.

- (4) Corn fields undergo greater color change with the first frost than do other fields of the area inasmuch as many of the corn fields are unharvested at the time of the first frost. The tone of frosted corn on aerial photographs is outstanding.
- (5) Unlike other crops of the research area, the color of corn deepens progressively throughout the whole growing season, becoming lighter only after harvest or frost.¹ The trend of tonal changes can be traced on a series of aerial photographs taken at different intervals throughout the growing season. Tones become increasingly dark from the beginning of the growing season until frost or harvest lightens them.

¹ Hay goes through a double cycle of color change and small grains lighten as they mature.

KEY FOR THE AERIAL PHOTO IDENTIFICATION OF CORN BY CHANGES THROUGHOUT THE GROWING SEASON

	May 23 One Week Before to One Week After Planting (1) (See Fig. 9)	July 9 Five to Seven Weeks After Planting (2) (See Fig. 10)	July 13 Six to Eight Weeks After Planting (3) (See Fig. 11)	July 21 Seven to Nine Weeks After Planting (4) (See Fig. 12)	July 29 Eight to Ten Weeks After Planting (5) (See Fig. 13)	September 7 Fourteen to Sixteen Weeks After Planting (6) (See Fig. 14)	September 26 Seventeen to Nineteen Weeks After Planting (7) (See Fig. 15)	October 6 Eighteen to Twenty Weeks After Planting (8) (See Fig. 16)	October 19 Twenty to Twenty-two Weeks After Planting (9) (See Fig. 17)
Tone	Densitometer value Tone scale value	9 to 16 8 to 11	26 to 48 11 to 15	11 to 26 9 to 11	18 to 31 9 to 12	15 to 21 7 to 14	15 to 21 7 to 14	15 to 21 7 to 14	15 to 21 7 to 14
Form and size	Rectangular-10 to 40 acres								
Shadow						Very narrow black shadow in discernible elong north edges of fields.	Shadow is especially noticeable where portions of standing corn edging portions which have been cut and removed.		
Texture	Very parallel lineation superimposed on a mottled background. (Earlier portions of mottled background are coincident with depressions. Vegetation is not heavy enough to obliterate such sag and small mottling.)	Fine parallel lineation superimposed on a mottled background. Lineation often takes the form of wide dark bands alternating with fine white lines. Dark bands seem to extend dark patches of mottled background for short distances into the white portions. This form of banding may end abruptly along a straight line and give place to regular lineation. (Alternating dark and light banding is caused by cultivation of soil between rows of corn.)	Very faint parallel lineation superimposed on a mottled background.	Fine lineation on a mottled background. Stereoscopic examination shows that lines of rows stand up regularly from the background so that the overall appearance resembles that of corduroy cloth.	Texture of the previous stage is dominant -- column 4.	Texture is much like that of the previous two stages. Mottling has become subdued in most fields. Stereoscopic examination shows a pebbly surface which takes away from the very regular lineation of earlier stages.	Texture is like that of the previous stage. Mottling has become very distinct locally (as a result of frost which has lightened tops of corn in hollows.)	Texture is like that of the previous stage. Mottling has become very distinct locally (as a result of frost which has lightened tops of corn in hollows.)	Texture is like that of the previous stage. Mottling has become very distinct locally (as a result of frost which has lightened tops of corn in hollows.)
Relation to surrounding features		A corn cultivator can often be seen on the line separating the two types of lineation. If moving at time of photography it is more advanced in position in subsequent overlapping photographs.							
Pattern	No clearly pronounced field distribution. This type of the basic grove of the area and is found on nearly every farm.								
Limitations	Corn cannot be distinguished from other spring down crops - oats, barley, and soybeans.	Corn cannot be distinguished from soybeans. Soybeans are the cover on very few fields in this area so the chance of error in identifying soybeans as corn is small.	Limitation is that of the five to seven weeks stage -- column 2.	Preliminary examination by stereoscopic observation reveals that corn has rougher texture. Rows stand up more boldly than those of soybeans. Resemblance between corn and corduroy cloth is more striking.					

FIG. 16
Tones could not be graded. Scene is exaggerated in darkness as a result of excess ground moisture after rain.



FIG. 16

DENSITOMETER VALUE
IN MILLIMETERS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215

TONE SCALE VALUE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215