

Technical Report No. 3

AN ESSAY KEY FOR THE PHOTO IDENTIFICATION
OF FARM CROPS AT SEVER'L INTERVALS
DURING THE GROWING SEASON
IN NORTHERN ILLINOIS

Part III

PHOTO APPEARANCE OF HAY FIELDS

Project No. ONR 089-005
Contract No. N7 onr 45-005

Northwestern University

Technical Report No. 3

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

PART III

PHOTO APPEARANCE OF HAY FIELDS

By

Clyde F. Kohn

A Contract Between

Geography Branch, Earth Sciences Division
Office of Naval Research, Navy Department

and

Northwestern University

Project No. ONR 089-005
Contract No. N7 onr 45-005

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

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

July, 1953

TABLE OF CONTENTS

PART III. PHOTO APPEARANCE OF HAY FIELDS

Growing Hay in the Research Area.	2
Photographic Qualities Which Hay Fields Share With Other Crops	4
Photographic Qualities Which Differentiate Hay Fields From Other Crops at Selected Intervals During the Growing Season.	5
Photo Appearance of Hay Fields on May 28	5
Photo Appearance of Hay Fields on July 8 and July 13	6
Photo Appearance of Hay Fields on July 21 and July 29.	11
Photo Appearance of Hay Fields on September 7.	13
Photo Appearance of Hay Fields on September 26, October 5 and October 19.	17
The Effect of Farm Practices on the Aerial Photo Appearance of Hay Fields	19
Conclusions	20

LIST OF PLATES

Plate 13	7
Hay field on May 28 with fine parallel lines	
Plate 14	7
Hay field on May 28 with smooth texture	
Plate 15	7
Hay field on May 28 with faint field markings left by cutting of hay	
Plate 16	7
Alfalfa before the first cutting	
Plate 17	8
Swath marks in a recently harvested hay field	
Plate 18	8
Field of hay one week after harvest	
Plate 19	9
Stereopair: Hay field on July 8 with "hip-roof" design resulting from swath markings	
Plate 20	.10
Stereopair: Hay field on July 8. Hay on this field has been cut around the outer edges but is uncut in the center. The circle marks a farm implement.	
Plate 21.	12
Sweet clover in blossom	
Plate 22	.13
Stereopair: Hay field on July 21 with white fluff superimposed on a dark background	
Plate 23	.14
Hay at the second cutting stage.	
Plate 24	.14
Bales of hay lying in the field	
Plate 25	.15
Hay bales stacked in the corner of a field	

LIST OF PLATES (CONTINUED)

- Plate 2615
Field of hay at the second cutting stage
- Plate 2716
Windrows of hay
- Plate 2817
Stereopair: Hay stack along a lane leading
to barns
- Plate 2918
Stereopair: The field along the north side
of the road contains a new crop of hay which
was planted with oats earlier in the summer.
Thin spots in the cover appear lighter in
tone than the remainder of the field

LIST OF FIGURES

- Figure 9 Appendix
Aerial Photo Appearance of Farm Crops
Status: May 28
- Figure 10. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: July 8
- Figure 11. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: July 13
- Figure 12. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: July 21
- Figure 13. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: July 29
- Figure 14. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: September 7
- Figure 15. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: September 26
- Figure 16. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: October 5
- Figure 17. Appendix
Stereopairs Showing Aerial Photo
Appearance of Farm Crops, Status: October 19

Technical Report No. 3

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

Part III

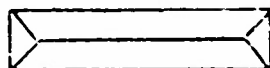
PHOTO APPEARANCE OF HAY FIELDS*

Compared with other crops within the research area, fields of hay can be identified readily on aerial photographs taken at intervals during the growing season. This is possible, in large measure, because hay is the only crop in the research area which has a dual harvest. The two cycles of growth through which the crop passes are recorded on aerial photographs by a cyclic progression of tonal values. On photographs taken during the earliest stages of growth, hay fields have a dark tonal value, the darkest of all cultivated crops (Fig. 9; Sample 1). The fields remain dark on later photographs until the time of their first harvest (Figs. 10, 11, and 12; Samples 1 to 4). Cutting the crop causes hay fields to have a lighter tonal value (Fig. 10; Samples 1 and 2). After harvest, fields of hay photograph increasingly darker until

*The facts and conclusions stated in this part of Technical Report No. 3 pertain to the photo appearance of hay 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. Twenty-three fields of hay scattered throughout the 13½ square mile area were analyzed. The samples include hay in all possible associations with types of landforms, soils, and variations in farm practices. It is felt that the keys developed in this study can be utilized in recognizing hay fields on aerial photographs of areas which have similar physical conditions during the growing season and where hay crops are harvested more than once during that time.

a second harvest once more lightens their tonal values.

Unique field markings, as well as tonal values, help to identify hay fields on a series of aerial photographs taken during the growing season. The markings most readily identifiable resemble a vertical view of a hip roof. (See sketch below):



These markings appear on photographs taken immediately after the hay has been cut (Fig. 13; Sample 7 $\angle 1.8 - 0.3 \angle$). Such markings photograph less and less distinctly after the harvest season until they are finally obliterated on photographs taken just prior to a second cutting. (Compare Sample 1 on Figs. 10 $\angle 2.4 - 0.5 \angle$ and 13 $\angle 2.0 - 0.4 \angle$). After the second harvest, hay crops again grow high enough before frost occurs to obliterate the photographic reproduction of the field markings left by harvesting operations.

Growing Hay in the Research Area

Within the research area, variations occur in (1) the types of hay planted; (2) the uses made of the crops; (3) the dates of harvest; (4) the methods of harvest; (5) the number of consecutive years that hay crops are permitted to grow without replanting; and (6) the practices of fertilization. Farm practices were recorded on interview sheets designed for this purpose (Fig. 5). No variations occur in the research area in methods of planting hay, and no hay fields are intertilled.

The chief hay crop in the area studied is alfalfa. Most of the remaining hay crops consist of mixtures of alfalfa and one or

more other hay types. These other hay types include alsike clover, timothy, sweet clover, red clover, Ladino, and brome grass. About one out of twenty-five hay fields contains no alfalfa.

The dates and methods of harvest depend in large measure on the uses which are to be made of the hay crops. There are three possible uses: for winter forage, for summer silage, and for summer pasture. Where crops are grown for winter forage there are two harvest periods. The first crop is cut during the second and third weeks of July; the second in September. Hay grown for winter forage is dried in the field, baled, and stored in hay mows or in stacks out of doors. Where hay is grown for summer silage, it is cut during the last week of June or the first week of July. It is chopped as it is cut and put into a silo without being dried in the fields. Following the harvest, a second crop is allowed to grow. During September this second crop is cut and used for winter forage. Finally, some hay fields are used during the latter part of the summer for pasture. Where this is practiced, one crop of hay is harvested in early July for winter forage and the fields are then pastured during the remainder of the summer. A second crop is not harvested.

In general, hay follows crops of oats in the rotation cycle. Hay is seeded at the same time that oats are planted or soon after. It is not cut, however, during its first summer of growth. Plants survive the winter and the crop is harvested for the first time at the beginning of the second summer. Some hay fields are not replanted for a number of years. One field in the area has been kept in hay, without replanting, for six years.

The application of fertilizers to hay fields also varies in the research area. About three out of four fields receive no fertilization during the year. Raw rock phosphate and barnyard manures are added to the remaining fourth.

Photographic Qualities Which Hay Fields
Share With Other Crops

Fields of hay in the research area share three photographic characteristics with other cultivated fields. These characteristics, moreover, do not change with the growing season and can be detected without the aid of stereoscopes. In the first place, nearly all hay fields, in common with other fields, are rectangular in form; and like other fields, they vary in size (Fig. 3 and Figs. 9 thru 17). On aerial photographs with a scale of 1:12,000, fields vary in size from those measuring two-tenths by five-tenths inches to those measuring 1.2 inches square. Dimensions are larger on the photographs having a scale of 1:10,000 -- at this scale the largest fields are approximately 1.5 inches square; whereas dimensions on the photographs having a scale of 1:14,400 are smaller -- at this scale the largest fields are approximately 1.1 inches square. On the ground, the fields range from five to forty acres. Lastly, as is true with other crops, there is no apparent order to the distribution of hay fields within the research area. They occur throughout the entire area and may be distinguished from uncultivated areas by their gray tones. The only significant difference in terms of distribution between hay crops and other crops is in the number of hay fields in the area. Thirty-one percent of the cropped land of the research area is

utilized for hay (Fig. 3). The total number of acres devoted to hay is greater than that of any other crop. Only three farms have no hay fields whereas twenty-eight of the fifty-five farms of the area have two or more fields of hay.

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

Hay fields can be distinguished from other cultivated fields on aerial photographs of the research area in three ways: by tonal value; by field markings; and by objects associated with the harvesting of hay. These indicators vary during the growing season, and the photo observer must know the growth pattern of hay crops in an area if he is to identify fields of hay with reasonable accuracy. This is not difficult inasmuch as growth patterns are related to the climatic conditions and farm practices of a specific area.

Photo Appearance of Hay Fields on May 28

Aerial photographs of the research area were first taken on May 28 (Fig. 9). At this date, hay crops in the research area are in their early period of growth. When observed in the field they have a deep-green color and stand from six to eight inches in height. In general, the crop covers a field almost solidly although in fields which have been seeded for only one year, the plants may stand in rows. These rows are emphasized by the stubble of small grain with which the hay was seeded during the previous summer. Most fields have not been recently replanted, however, and photograph without such regular markings. The "hip-roof" design

from the second cutting of the previous summer may or may not be present.

The aerial photo appearance of hay crops on the May 28 photos reflects this ground appearance of the crop. On the May 28 photos, hay fields have dark tonal values, comparable to tones 12 and 15 on the calibrated tone scale¹ (Figs. 8 and 9).

The recently planted fields are marked by fine closely-spaced parallel lines; (Fig. 9; Sample 20 $\angle 1.5 - 2.0 \angle$) the large majority, however, are old fields and do not appear with any such markings. (See Plates 13 and 14). Only faint field markings left by harvesting the crop can be traced around a few fields (See Plate 15).

No unique objects appear in association with hay fields at this date of growth.

Photo Appearance of Hay Fields on July 8 and July 13

The second and third aerial photographs of the research area were taken on July 8 and July 13, respectively (Figs. 10 and 11). Both sets of photographs show hay fields in various stages of harvest. Some of the fields are not yet harvested on either July 8 or July 13; some have been entirely cut; still others have been cut only around their outer edges.

When observed in the field, the uncut hay on July 8 and 13

¹Unfortunately, tones on the May 28 photographs cannot be measured quantitatively by use of the densitometer because the negatives of these photographs were lost by the personnel at Glenview Air Station. See Appendix I. Photographs on May 28 were not taken with sufficient overlap to permit the use of stereoscopic examination.



13



14



15

Plate 13. Hay field on May 28 with fine parallel lines.
(See also Fig. 9; Sample 20 $\angle 1.5 - 2.0 \angle$)

Plate 14. Hay field on May 28 with smooth texture.
(See also Fig. 7; Sample 1 $\angle 3.0 - 0.3 \angle$)

Plate 15. Hay field on May 28 with faint field markings
left by cutting of hay. (See also Fig. 7;
Sample 21 $\angle 2.5 - 0.4 \angle$)

now stands from twenty-four to thirty-four inches in height.
The dark green plants with their purple blossoms give an over-all
dark purple-green cast to the fields. (See Plate 16, and Fig.
10; Sample 1 $\angle 2.2 - 2.2 \angle$). This characteristic color enables
the observer to spot alfalfa in fields a mile or so away.



Plate 16. Alfalfa before the first cutting. The forty-
three inch scale indicates a height of twenty-
four to thirty-four inches. (See also Fig. 10;
Sample 1 $\angle 2.2 - 2.2 \angle$)

Those fields which have been cut only recently are covered with light white-green stubble and contain swath marks (See Plate 17, and Fig. 12, Sample 1 $\angle 0.1 - 0.5 \angle^1$).



Plate 17. Swath marks in a recently harvested hay field.
(See also Fig. 12, Sample 1 $\angle 0.1 - 0.5 \angle$)

In fields cut less recently, a second growth of hay may stand from four to ten inches in height. Such hay has a fresh green color. (See Plate 18, and Fig. 12, Sample 1 $\angle 0.1 - 0.5 \angle$)



Plate 18. Field of hay one week after harvest.
(See also Fig. 12, Sample 1 $\angle 0.1 - 0.5 \angle$)

¹ This photograph was actually taken at a later date than July 8 or 13 but was chosen because it illustrates tone and field markings especially well.

0 All fields which have been harvested show swath marks. In some fields a tractor and a hay baler may be seen standing in the harvested part of the field.

In fields where the hay crops are in the process of being cut, tractors with mowing attachments may be observed in operation at the edges of the uncut portions of the fields. The harvested portions, around the outer edges of the fields, may be dotted with bales of hay lying on the ground.

As a result of variations in the dates of harvest from field to field, the photo appearance of hay fields also varies. (Compare hay fields indicated on Fig. 10). The fields which are not yet cut by July 8 and 13 register 10 to 12 on the calibrated tonal scale¹ (Fig. 8 and Fig. 10, Sample 1 /0.3 - 0.5/ and Fig. 11, Sample 1 /2.0 - 1.8/. Some of the fields are marked by faint parallel lines; others have no markings. (Compare Plates 13 and 14).

Fields which have been harvested have a lighter tonal value, 8 to 11 on the tone scale (Fig. 8), and are marked by a "hip-roof" design. (See Plate 19 and Fig. 10, Sample 3 /1.0-1.2/ and Fig. 11, Sample 3 /1.2 - 1.0/.



Plate 19. Stereopair: Hay field on July 8 with "hip-roof" design resulting from swath markings. (See also Fig. 10, Sample 3 /1.0 - 1.2/ and Fig. 11, Sample 3 /1.2 - 1.0/.

1 The July 13 photographs were underexposed to the extent that the densitometer recorded practically no variation among the tones of different crops. Appendix I.

A large figure "X" with its arms extended to the four corners of the hay field can be discerned on the aerial photographs. This design results from the way the farm machinery pivots as it turns a corner.

Fields which are in the process of being harvested differ in a number of ways. The center of these fields registers a tonal value equal to the uncut hay fields. The tonal value of the outer edges of the fields where the hay has been cut is equal to that indicated for cut hay fields. (See Plate 20, and Fig. 10, Sample 1 $\angle 2.4 - 0.6 \angle$).



Plate 20. Stereopair: Hay field on July 8. Hay on this field has been cut around the outer edges but is uncut in the center. The circle marks a farm implement. (See also Fig. 10, Sample 1 $\angle 2.4 - 0.6 \angle$)

Stereoscopic examination often reveals farm implements in fields where the hay has been cut and in those in which the hay is being harvested. On fields of the latter type, the implements may be found on the border where tonal values change. (See Plate 20 above). Implements are very small, measuring one-sixtieth of an inch on photographs with a scale of 1:12,000. They appear as specks without character when viewed without the aid of a stereoscope but assume regularity of shape when viewed stereoscopically. Implements are especially noticeable if in operation at the time

of photography. The change in position of the implements on two pictures of a stereopair gives a blurred image as though the photos are out of focus.

In brief, the photo appearance of hay fields on July 8 and July 13 depends on whether or not the fields have been harvested or are in the process of being cut.

Photo Appearance of Hay Fields on July 21 and July 29

The research area was photographed for the fourth and fifth times on July 21 and July 29, respectively. Even at these late dates some of the fields in the research area are in the process of being cut for the first time. When observed on the ground, these fields resemble those being cut on July 8 and July 13.

By July 21 and July 29, however, most hay fields in the research area have been cut, and a second crop of hay has begun to grow. The only exceptions, of course, are the fields which are being summer pastured. The ground appearance of hay fields late in July depends, in large measure, on when the first crop of hay was cut. In fields which were cut before July 8, the hay stands twelve to eighteen inches in height by July 21. These fields are, therefore, solidly covered and the plants have a deep green color. Such fields are approaching the appearance they had before their first cutting. On the other hand, the hay in fields which were harvested later than July 8 or July 13 does not stand quite so high and is not so dark in color.

Around the middle of July, sweet clover comes into blossom. As a result, fields which include this plant are covered by

white blossoms at this time. (See Plate 21, and Fig. 12,
Sample 1 $\angle 1.5 - 1.7 \angle$).



Plate 21. Sweet clover in blossom. (See also Fig. 12,
Sample 1 $\angle 1.5 - 1.7 \angle$)

As a result of these variations in ground appearance of hay fields on July 21 and July 29, their photo appearance also varies. In general, however, the tonal value and field markings of hay fields on the July 21 and July 29 photographs are similar to or are modifications of those taken on July 8 and July 13. After correcting the value of tones to compensate for variations resulting from conditions inherent in the photographic processes, tones vary only slightly from those of the July 8 photographs (Compare Figs. 10, 12, and 13). Tones of uncut fields register 12 and 13 on the calibrated tonal scale (Fig. 8) on the July 21 photographs (Fig. 12, Sample 1 $\angle 2.5 - 0.5 \angle$, and 11 and 12 on the July 29 photos (Fig. 13, Sample 1 $\angle 2.5 - 0.5 \angle$). Tones of fields from which the hay has been cut register 9 to 12 and 8 to 11 respectively, on the July 21 and July 29 photographs (Fig. 12, Sample 1 $\angle 0.8 - 0.5 \angle$ and Fig. 13, Sample 1 $\angle 1.4 - 1.8 \angle$).

The white fluff which is superimposed on the dark background of a few uncut fields of hay is the result of white clover. (See Plate 22, and Fig. 12, Sample 1 $\angle 1.7 - 1.7 \angle$).



Plate 22. Stereopair: Hay field on July 21 with white fluff superimposed on a dark background. (See also Fig. 12, Sample 1 $\angle 1.7 - 1.7 \angle$).

In general, darker tones are indicated on the July 21 photographs than one might expect. This is a result of excess ground moisture following heavy mid-July rains in the research area. The system used in evaluating and standardizing tones fails to compensate for excess ground moisture conditions. (See Appendix I). By July 29, the ground was not wet and so photographed lighter than on July 21.

Photo Appearance of Hay Fields on September 7

A sixth set of aerial photographs of the research area was taken on September 7¹. By this date the second harvest of hay is generally under way. Again the fields fall into three categories: those in which the hay is not yet cut; those in which it has been cut; and those in which it is being cut.

¹ The September 7 photographs missed the research area for the most part and represent the mile-wide strip bordering the research area on the south. Sample 13, Fig. 14 shows the southern edge of Sample 1 on Figs. 9, 10, 11, 12, 13, 16, and 17.) Most of the ground photographs taken at this time cannot be pinpointed on the aerial photo samples in Fig. 14.

Fields of uncut hay on September 7 have a dark purple-green color. Stands of hay are dense and the crop is about twenty-four inches tall. (See Plate 23, and Fig. 14, Sample 13 $\angle 0.3 - 2.5 \angle$). No field markings are visible and no objects appear in the field.



Plate 23: Hay at the second cutting stage. The uncut plants are approximately twenty-four inches tall. (See also Fig. 14, Sample 13 $\angle 0.3 - 2.5 \angle$)

Fields in which the hay has been cut may or may not have certain features. In some, bales of hay lie strewn over the ground. (See Plato 24) .



Plato 24. Bales of hay lying in the field.

In other fields, stacks of baled hay, sixty to seventy feet long by fifteen to twenty feet wide and approximately twenty feet high, stand in the corners of some of the cut fields or near lanes leading to barns of the farmstead. (See Plate 25). Temporary fences may be seen around a few of these stacks. These are built so that the hay field can be grazed during the remainder of the summer without damage being done to the bales.

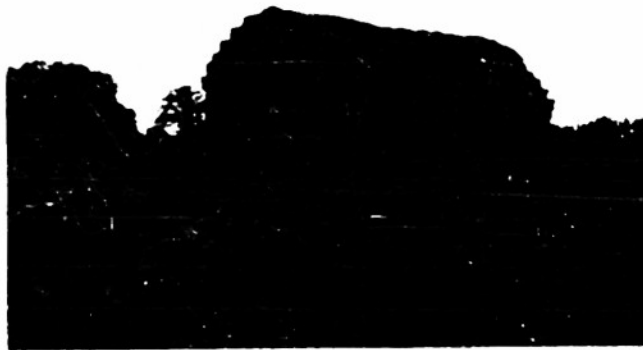


Plate 25. Hay bales stacked in the corner of a field. A fence has been built around the stack so that the field can be used for pasture without damage to the bales.

Those fields which are being harvested on September 7 are beginning to acquire swath marks and have a light gray-green color. (See Plate 26).



Plate 26. Field of hay at the second cutting stage. Hay is drying in concentric swaths.

On some fields, the uncut hay crop stands in the center of the field. From this center outward there is a belt of hay drying in swaths followed by a belt of dried hay which has been raked into windrows and another belt from which the hay has been baled and removed. (See Plate 27).



Plate 27. Windrows of hay.

The variations in ground appearance of the different hay fields is indicated on aerial photographs taken on this date. The hay fields on September 7 are indicated by tones and field markings similar to those of previous dates. The greater number of fields are unmarked, smooth in texture, and have dark tonal values¹ (See Fig. 14, Sample 13 /0.5 - 0.5/. On a few fields swath marks appear around the edges (Fig. 14, Sample 13 /1.2 - 0.5/. Such portions of hay fields have lighter tonal values. By stereoscopic examination, one can see objects resembling railroad

¹ Tones on this set of photographs could not be measured because the negatives were underexposed.

box cars standing in a few hay fields. (See Plate 28, and Fig. 14, Sample 10 /1.1 - 0.9_/_).



Plate 28. Stereopair: Hay stack along a lane leading to barns. See also Fig. 14, Sample 10 /_1.1 - 0.9_/_

These objects measuring one-fifteenth of an inch in length at a scale of 1:12,000 are the stacks of baled hay described above and shown in Plate 25.

Photo Appearance of Hay Fields on September 26, October 5, and October 19

By September 26, hay fields in the research area are beginning to grow again after their second cutting. Some are marked by faint swath marks but there are no signs of recent cuttings¹. Plants stand from 10 to 12 inches high and have a fresh green color. Hay which was seeded with small grains earlier in the growing season has also attained a growth of 10 to 12 inches by September 26. The ground appearance of these new crops is much like that of older crops with the exception that new fields are likely to contain spots of thin cover. New hay is also in rows across the fields. These rows are accentuated by rows of oats stubble.

¹Farmers avoid cutting hay after early September if the crop is to be held over for another year. Late harvest gives the plants little opportunity to grow before frost. Crops that have no late fall growth are likely to be killed by winter freezing.

The ground appearance of hay fields changes little after September 26. By October 19, however, frost wilts the plants and the fresh green color changes to dull gray-green.

On aerial photographs of September 26, October 5, and October 19, the tonal value of hay fields changes but the field markings and hay stacks in individual fields remain somewhat constant. (Compare Sample 1 on Figures 16 and 17 $\angle 0.3 - 0.5$ and $1.0 - 0.5$ on each Figure $\angle$). Tones register 10 and 11, 11 and 12, and 10 to 12, on September 26, October 5, and October 19 respectively (Fig. 8). All fields are either smooth or faintly lined (Figs. 16 and 17, Sample 1 $\angle 0.3 - 0.5$ and $1.0 - 0.5 \angle$). Many of the fields which were used for one of the small grains during the summer now have tonal values similar to fields of hay. (See Plate 29).



Plate 29. Stereopair: The field along the north side of the road contains a new crop of hay which was planted with oats earlier in the summer. Thin spots in the cover appear lighter in tone than the remainder of the field.

Light spots give a mottled effect to these fields (Fig. 16, Sample 18 $\angle 1.0 - 1.7 \angle$). Hay stacks which may be seen in fields on September 6 are still visible on photographs taken during October (Fig. 16, Sample 1 $\angle 1.4 - 2.1 \angle$ and Fig. 17, Sample 1 $\angle 1.7 - 2.7 \angle$).

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

Variations in farm practices appear to have only minor effects on the aerial photo appearance of hay fields. The dates of harvest are indicated by the appearance of the fields at different times during the growing season. Some fields are cut early; some late. The cut fields, in general, have light tonal values; the uncut fields register dark tonal values. Those fields which are in the process of being harvested at the time of photography show both light and dark tones. Cut fields also have field markings forming a "hip-roof" design until growth obliterates such markings.

The time of harvest often suggests the use of the hay crops. Those fields which are cut during the last week in June or the first week in July provide hay for summer silage. Those fields which are not cut until later in July provide hay for winter feed. On these fields, bales of hay may be seen strewn over the ground or piled in large stacks near the edge of the field.

Aerial photographs give no indication of variations in types of hay, number of consecutive years that crops stand on fields, or the ways in which the hay crops are fertilized. New plantings of hay, or hay planted with oats, can be identified by the regularity of the rows. These new fields are not solidly covered with the hay crop.

Conclusions

An examination of hay fields on aerial photographs taken at several stages of growth reveals that these fields may be identified with relative ease and accuracy. Hay fields have two characteristics which they share in common with other crops in the research area.

- (1) Hay fields are of the same size and form as fields of other crops; and
- (2) The photo appearance of hay fields is not affected by variations in landforms and soils, and only slightly by variations in farm practices.

These characteristics are of little help, therefore, to the photo interpreter.

On the other hand, hay fields do possess five characteristics which distinguish them from other crops on aerial photographs.

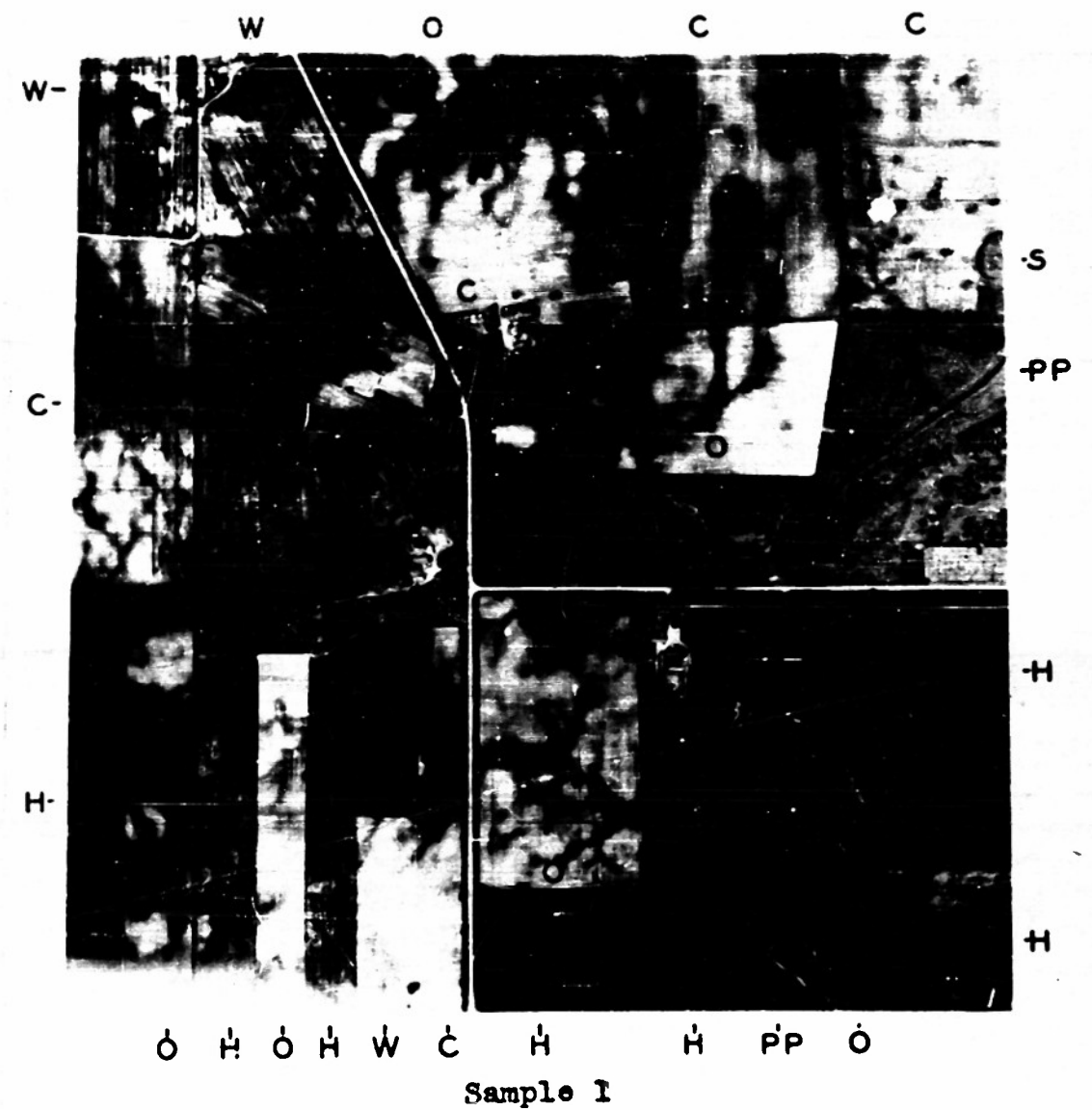
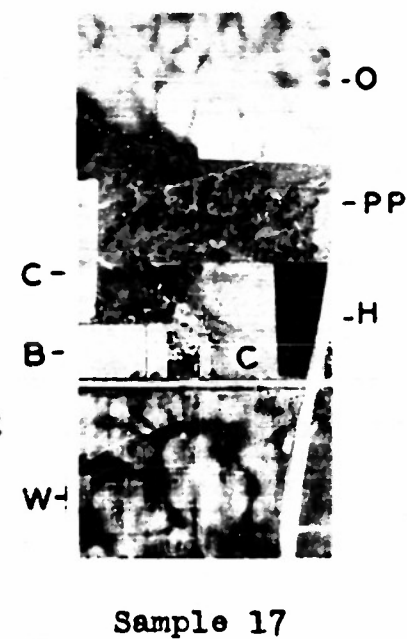
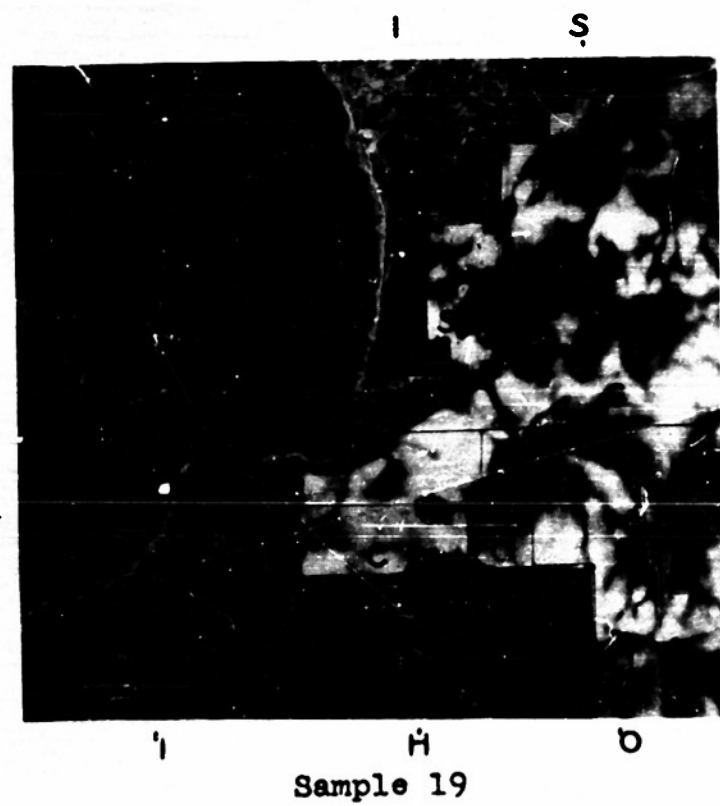
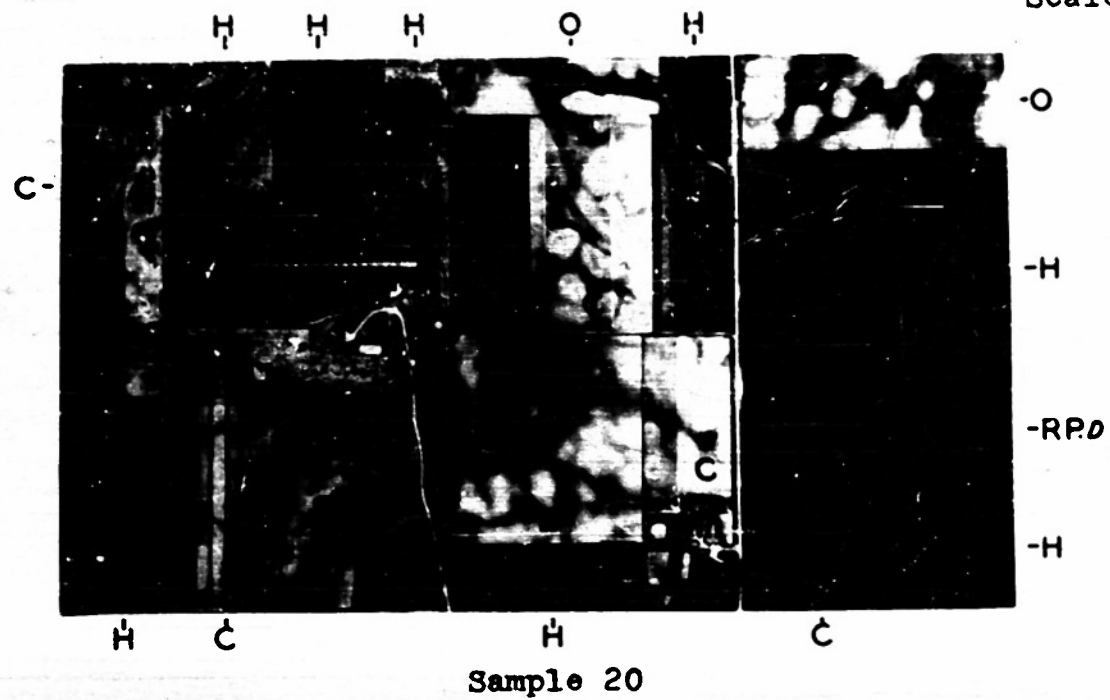
- (1) Unlike any other crop in the research area, hay has a dual harvest. The two cycles of growth through which the crop passes are recorded on aerial photographs by a cyclic progression of tonal values.
- (2) At each stage of growth there are unique field markings (texture), tonal values, and objects associated with hay fields.
- (3) Hay fields outnumber all other kinds of cultivated crops.
- (4) Tones of hay fields during their early, middle, and late stages of growth register more darkly than any other group.
- (5) There are no periodic limitations to the aerial photo identification of hay crops (as there are to the identification of other crops in the research area).

Before applying the above findings the photo interpreter should know in general (1) the physical conditions of the area being studied and (2) the type of farming and farm practices employed. With these facts in mind, the identification of hay fields in the area should not be a difficult task.

AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: MAY 28

Scale 1:11,300



LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

PP. PERMANENT PASTURE
RP. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
FP. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

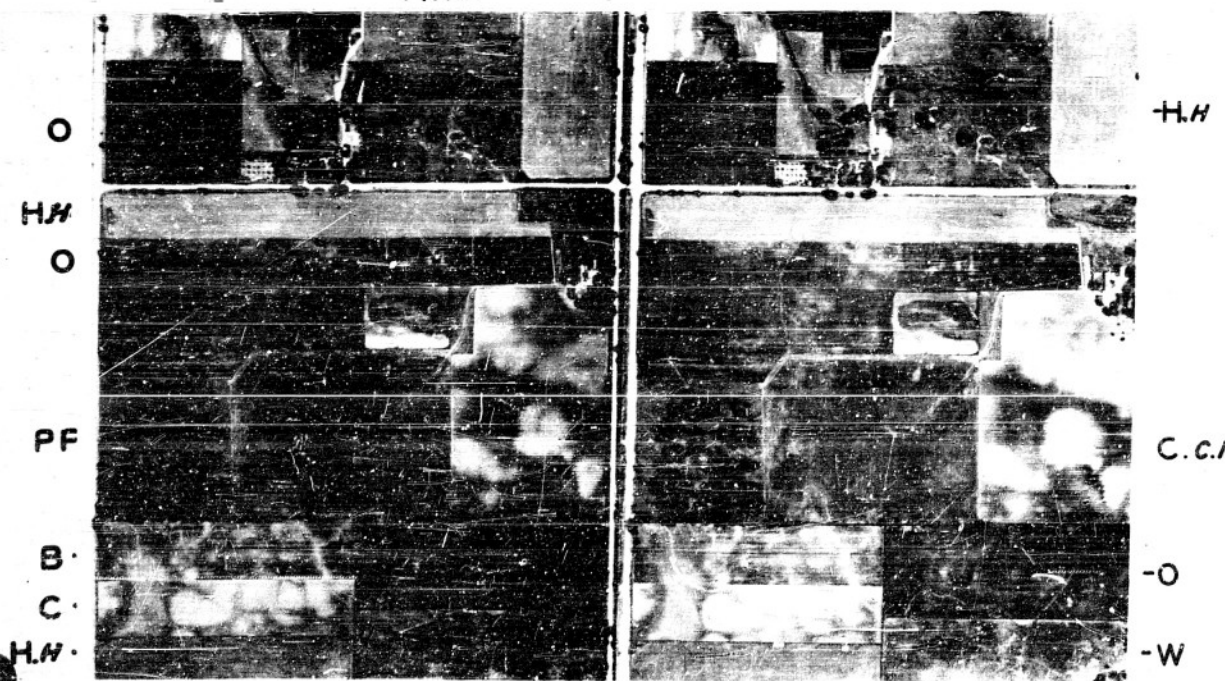
STATUS: JULY 8

Scale 1:12,000

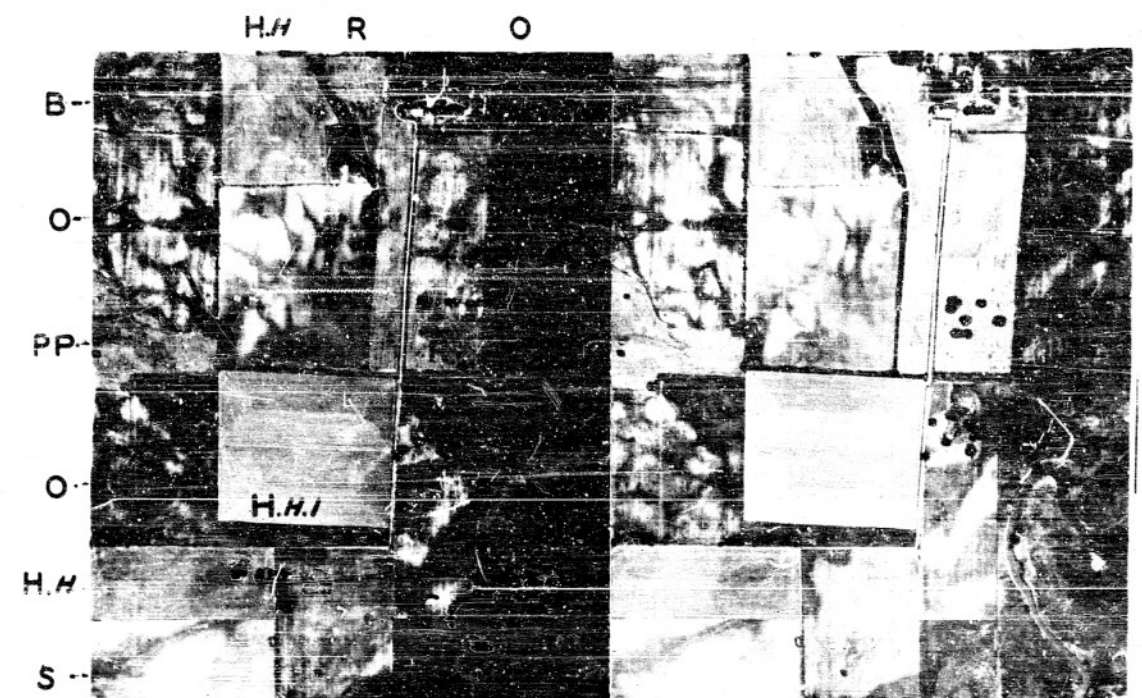


Sample 1

P.P.O



Sample 2



Sample 3

S

I

H

B

O

W

B



Sample 4



Sample 5

LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

PP. PERMANENT PASTURE
RP. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
FP. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

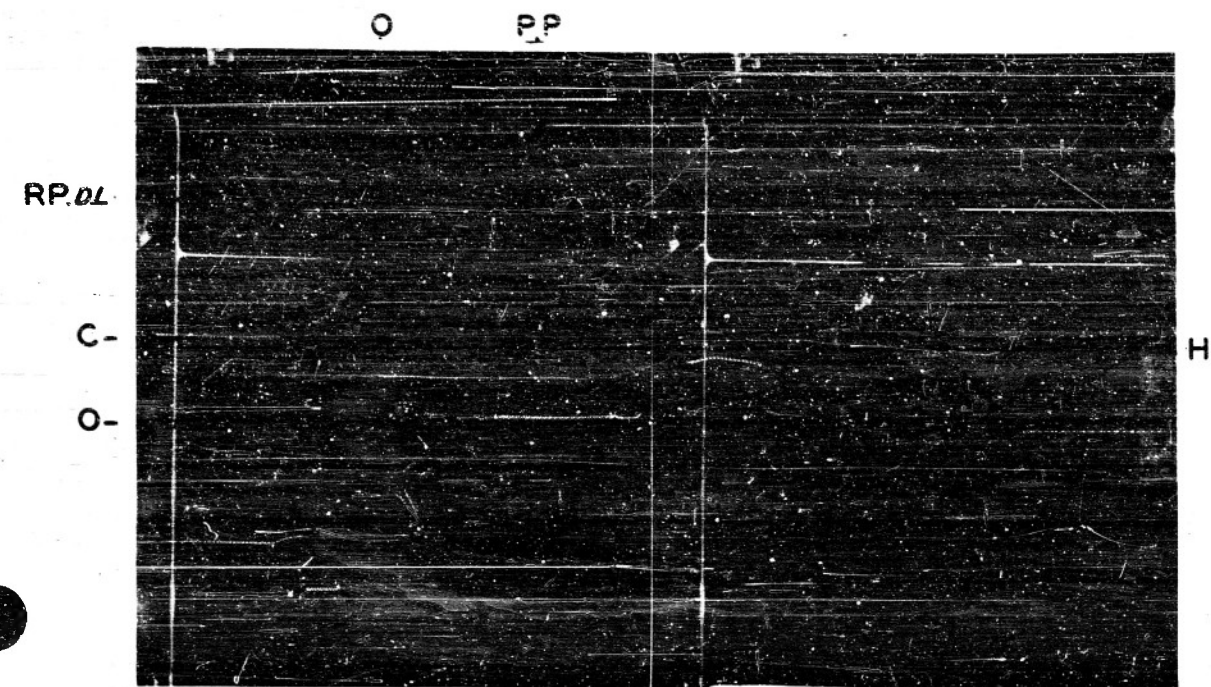
FIGURE 10

L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

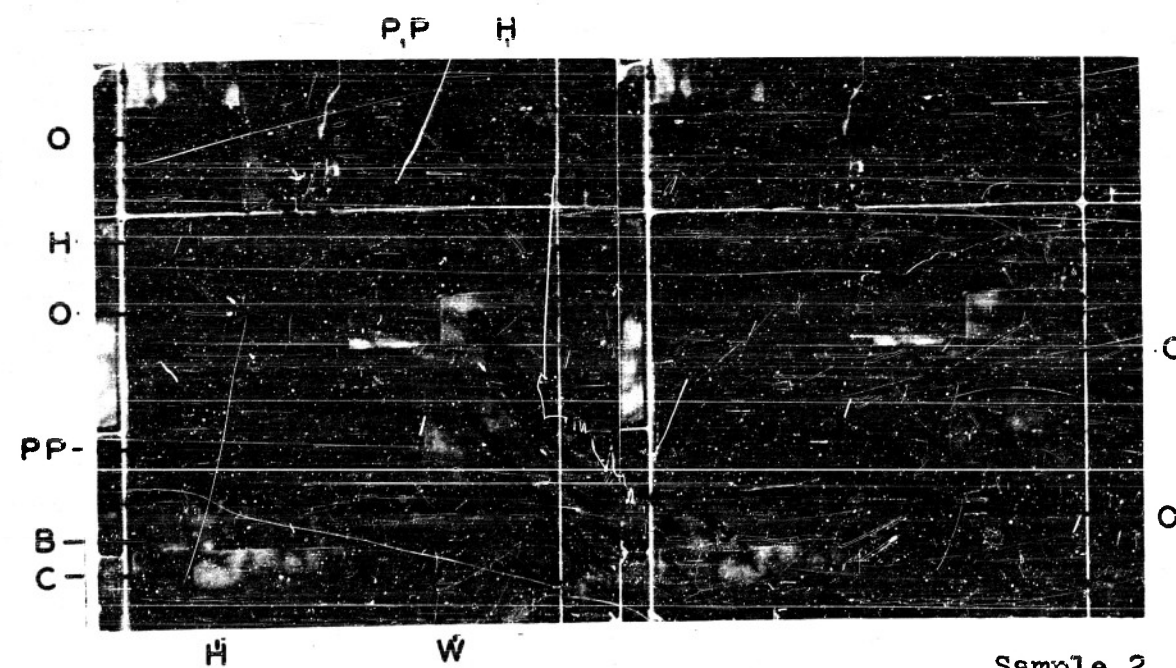
STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: JULY 13

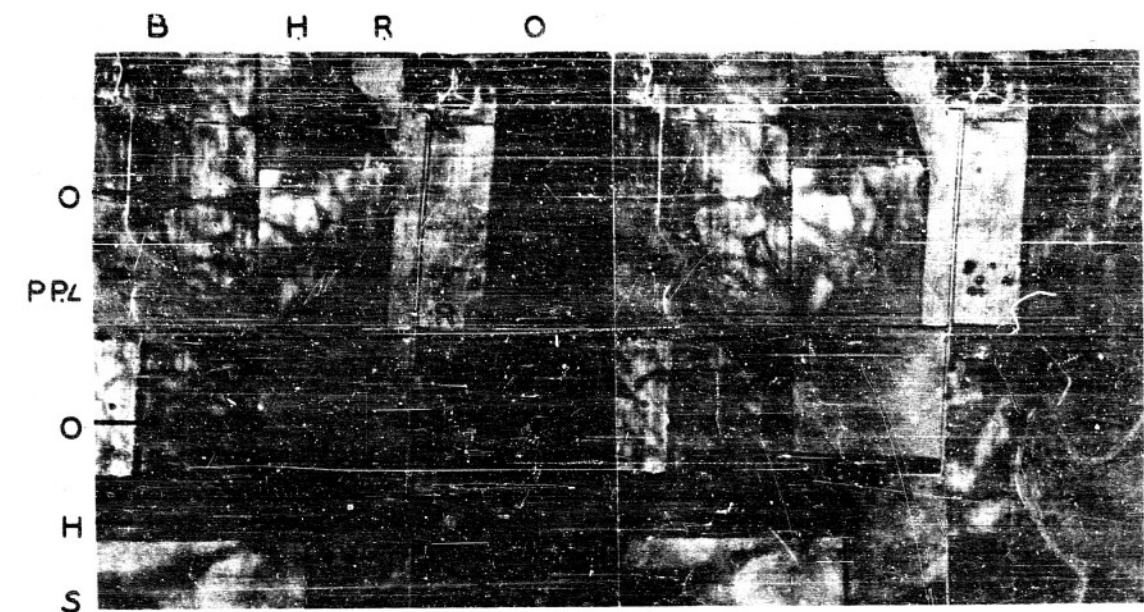
Scale 1:14,400



Sample 1



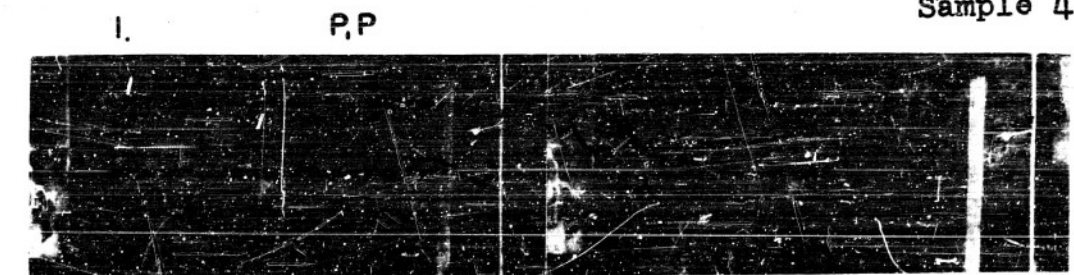
Sample 2



Sample 3



Sample 4



Sample 5

LEGEND

B. BARLEY	PP. PERMANENT PASTURE	R. RYE
C. CORN	RP. ROTATION PASTURE	S. SOYBEANS
H. HAY	W. WINTER WHEAT	I. IDLE
O. OATS		
C. CULTIVATED	H. HARVESTED	NH. NEW HAY
CS. CORN SHOCKS	HS. HAY STACK	NW. NEW WHEAT
D. DAIRY HERD	I. IMPLEMENTS	SD. STORM DAMAGE
FP. FALL PLOWED	L. LANE	SS. STRAW STACK
		P. PATH
		S. STUBBLE

L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

FIGURE 11

STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: JULY 21

Scale 1:14,400

O P.P.D Q

R.P.L.P-

C-

O-

H-

C

H P'P O.SD H H H

Sample 1

O.SD P.P.D H

C-

P.P.

B-

C-

-H
-O.SD

-C

-O

-W

Sample 2

B.SD H R Q B.

O-

P.P.L-

O-

H-

S-

S I

Sample 3

H H B O W B.SD

C-

W-

P.P.L

Sample 4

I. P.P

Sample 5

LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

P.P. PERMANENT PASTURE
R.P. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
FP. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

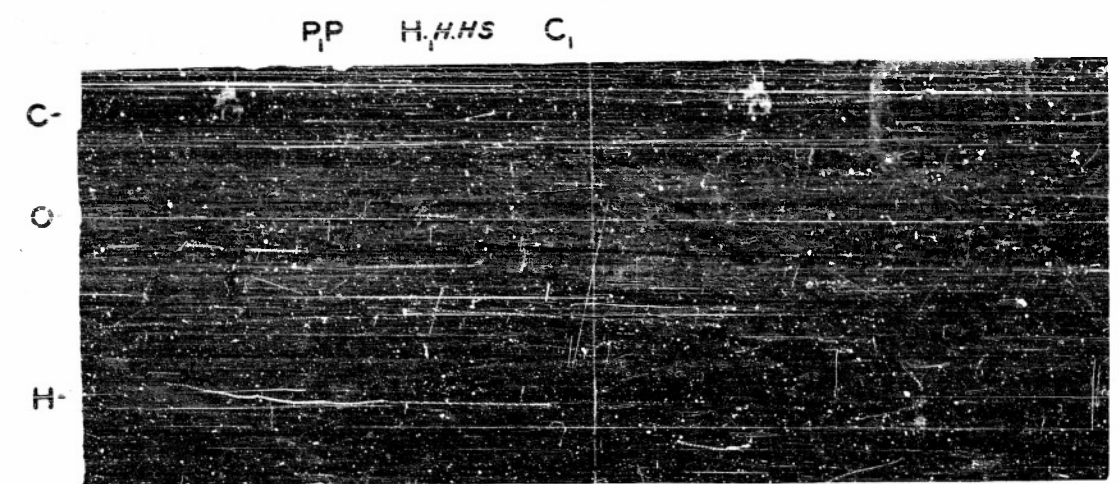
L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

FIGURE 12

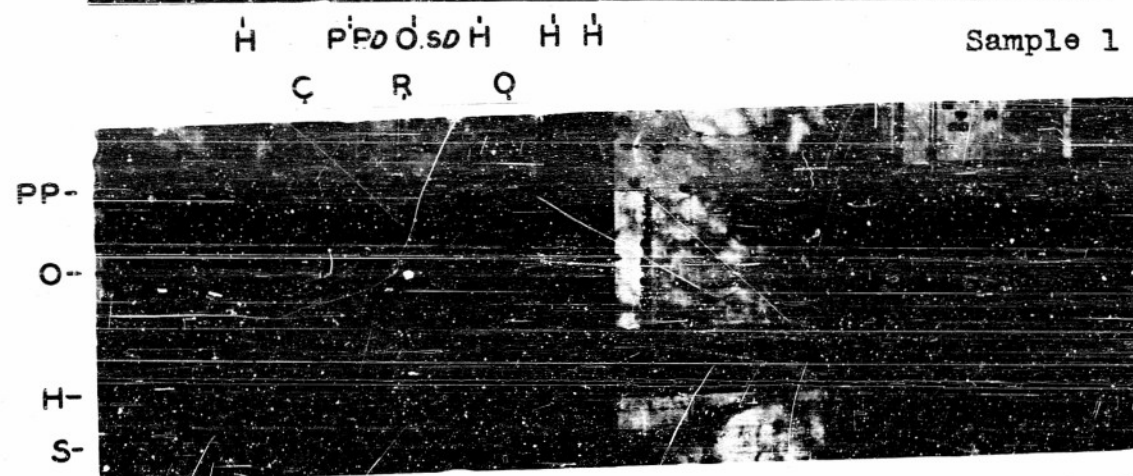
STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: JULY 29

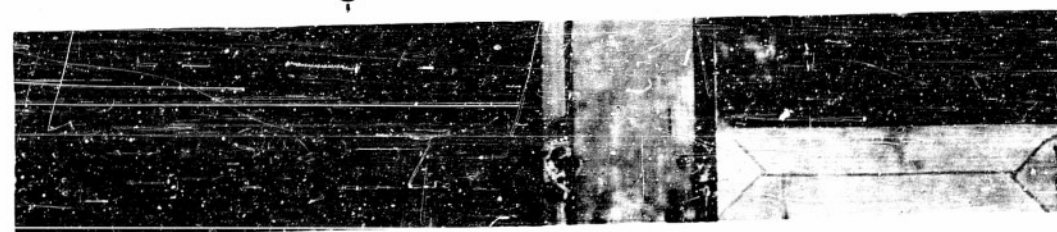
Scale 1:14,400



Sample 1



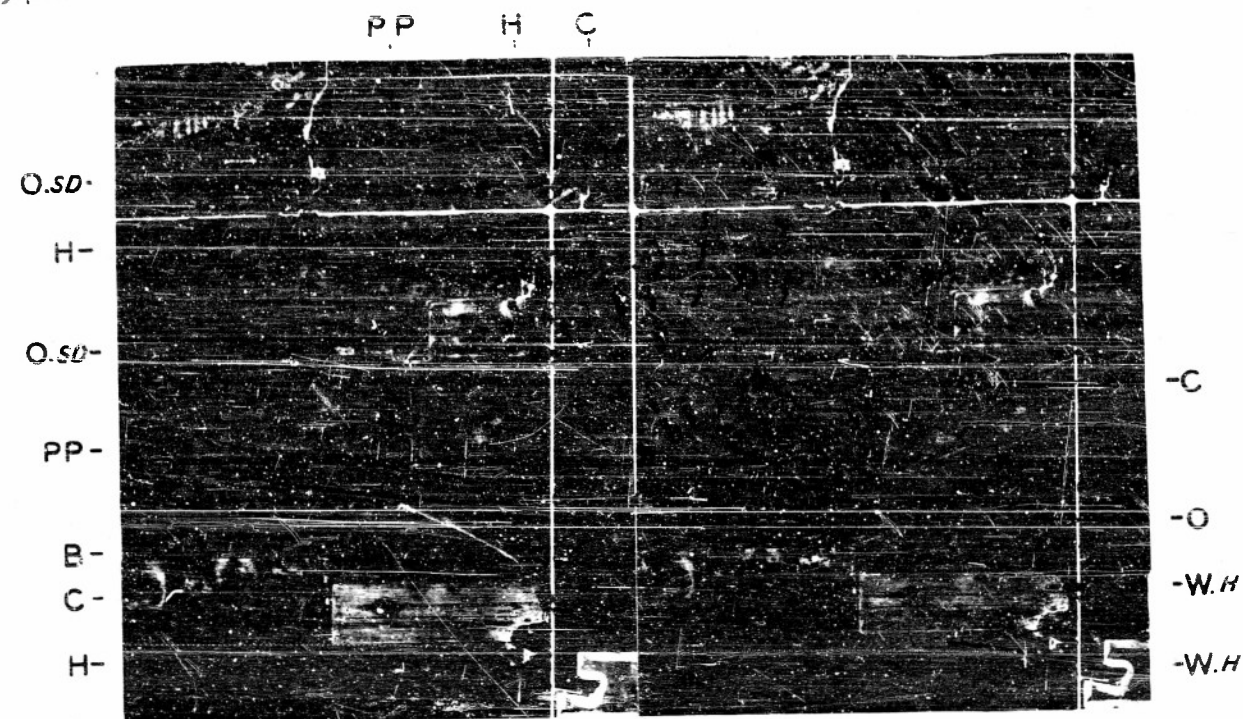
Sample 3



Sample 7



Sample 8



Sample 2



Sample 5

LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

PP. PERMANENT PASTURE
RP. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
FP. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

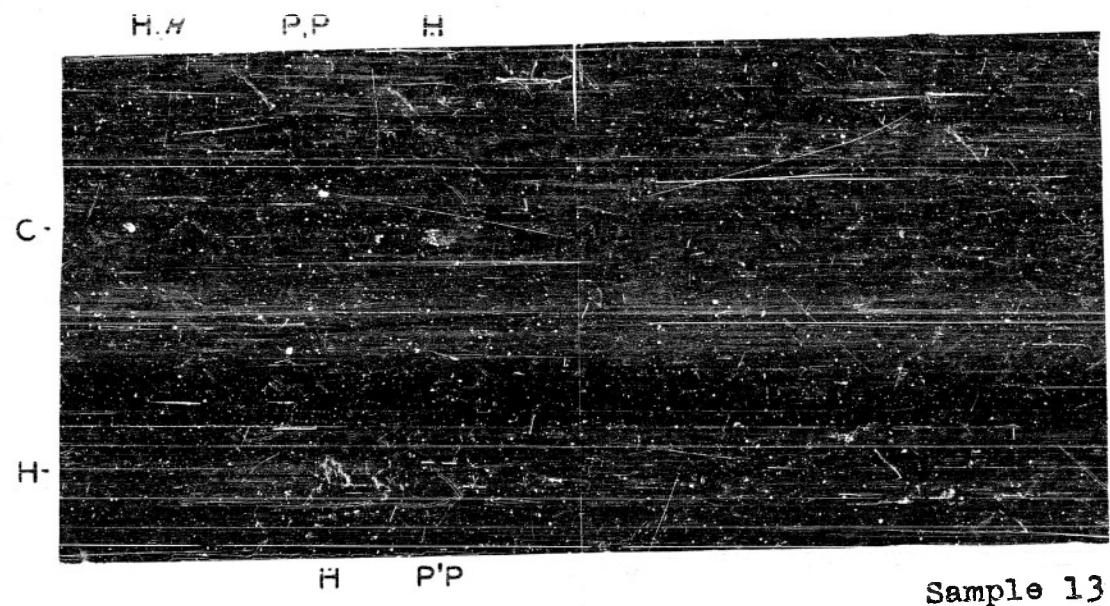
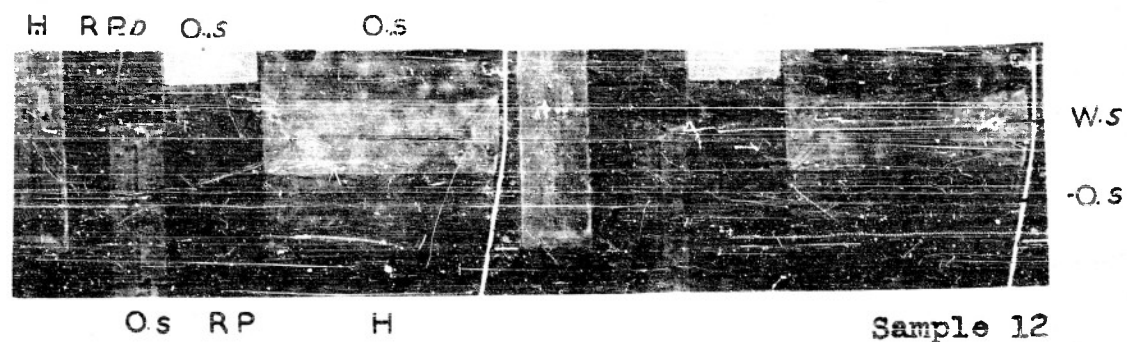
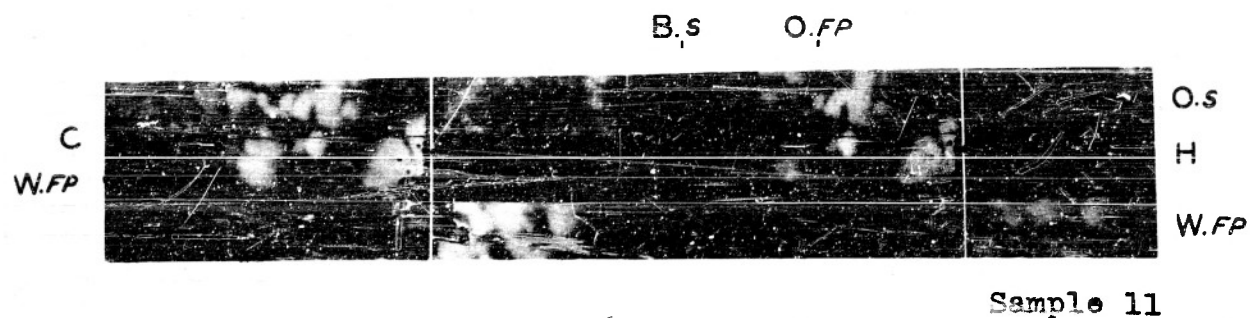
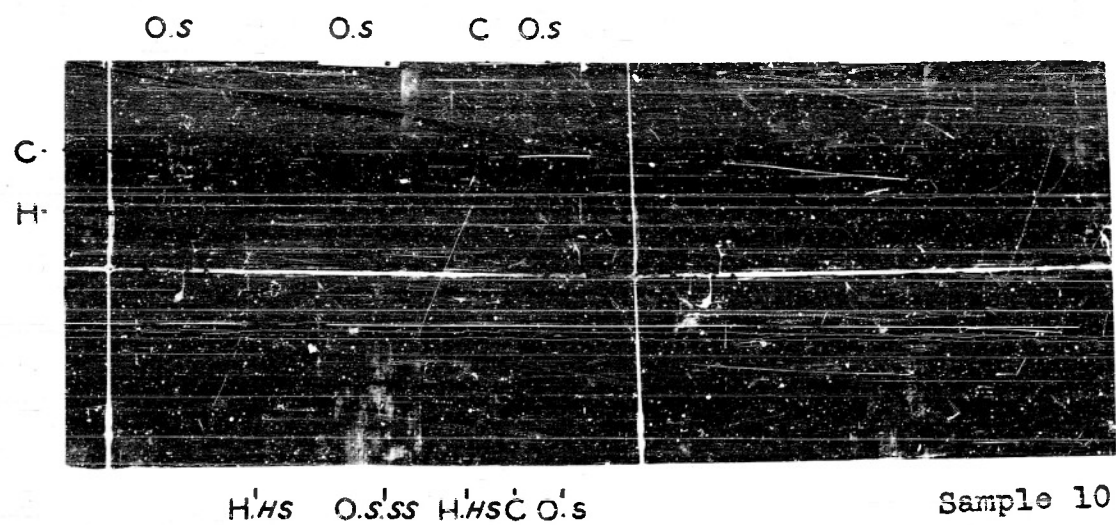
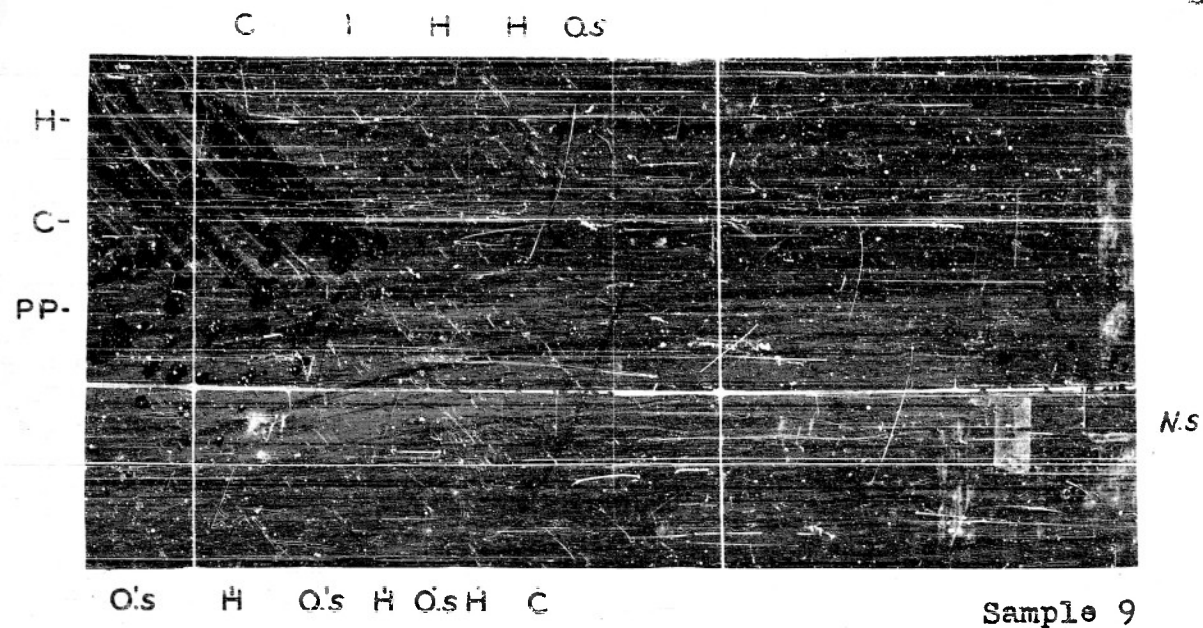
L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

FIGURE 13

STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: SEPTEMBER 7

Scale 1:14,400



LEGEND

B. BARLEY	PP. PERMANENT PASTURE	R. RYE
C. CORN	RP. ROTATION PASTURE	S. SOYBEANS
H. HAY	W. WINTER WHEAT	I. IDLE
O. OATS		
C. CULTIVATED	H. HARVESTED	NH. NEW HAY
CS. CORN SHOCKS	HS. HAY STACK	NW. NEW WHEAT
D. DAIRY HERD	I. IMPLEMENTS	SD. STORM DAMAGE
FP. FALL FLOWED	L. LANE	SS. STRAW STACK
		P. PATH
		S. STUBBLE

L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

FIGURE 14

STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: SEPTEMBER 26

Scale 1:14,400

C.H O.S C.H



C' C.H R.P.L.P Sample 14

C.H H.H



B.s B.s W.s C
O.S O.S F.P R.P

Sample 15



Sample 16

R.P.D.L.P.

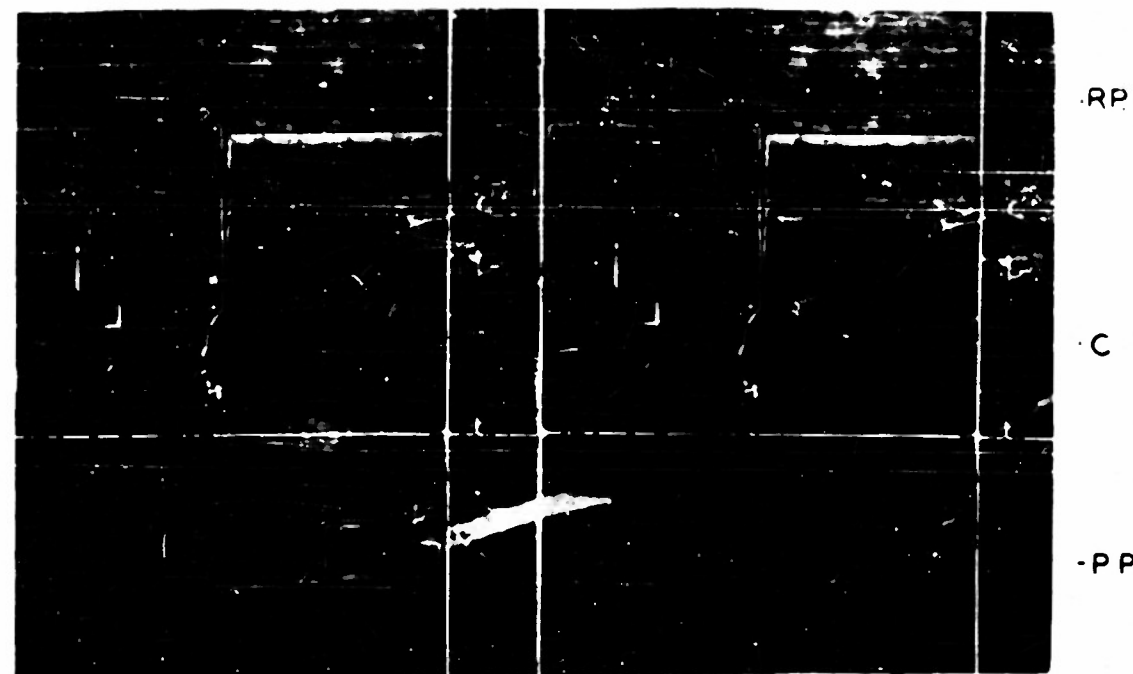
C.H-
O.S-

C.H-

O.S.NH

H-
O.S.NH-
O.S.NH-

P.P.



R.P.L.P C.H
O.S R.P

Sample 2



Sample 17

W.F.P P.P.D

LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

P.P. PERMANENT PASTURE
R.P. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
F.P. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

FIGURE 15

STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: OCTOBER 5

Scale 1:14,000

O.NH

PP,L.P

RPDL.P-

C-

OFP-

H-

H PP O.S RPL H
O.NH H RP

Sample 1

C-

CH

OS

-C.H

O.NH

C.H.I. P'P

Sample 18

I, P,P

Sample 5

I-

S-

S-

I-

-RPHS.P

C

O.S H R.S R.S O.S B.S Sample 19'S C W.NW C R.NW

PP-

OS-

H-

S-

H S' B.S O.S W.S B.FP

Sample 3

C-

WFR

p'p

Sample 4

LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

PP. PERMANENT PASTURE
RP. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
FP. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

L. M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS

FIGURE 16

STEREOPAIRS SHOWING AERIAL PHOTO APPEARANCE OF FARM CROPS

STATUS: OCTOBER 19

Scale 1:10,000

O.NH

P.P

RPDL.R

C-

O.FP-

H-

-RPD.PHS

H PP O's RP Sample 1 C.C.S.H C.H

RPL.R

C.H

O.S-

C.H

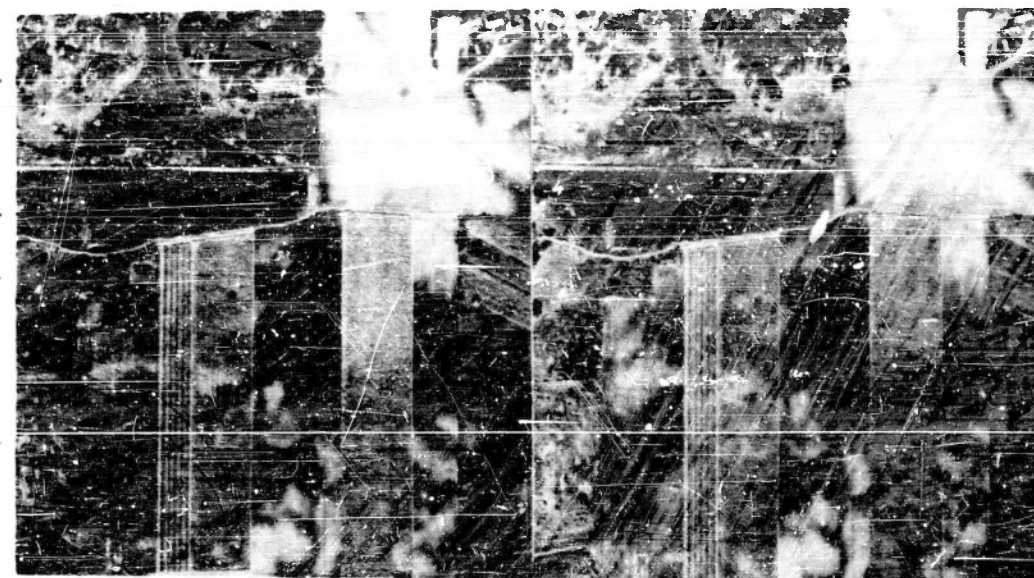
O.NH

-O.FP

-C.C.S.H

PP H

Sample 18



-W.NW

-RPD

Sample 19 H R_s R_s S' C' WNW C' R.NW

O.S

PP

O.S-

H-

S-

-C.H

Sample 3 S.H.I

LEGEND

B. BARLEY
C. CORN
H. HAY
O. OATS

PP. PERMANENT PASTURE
RP. ROTATION PASTURE
W. WINTER WHEAT

R. RYE
S. SOYBEANS
I. IDLE

C. CULTIVATED
CS. CORN SHOCKS
D. DAIRY HERD
FP. FALL PLOWED

H. HARVESTED
HS. HAY STACK
I. IMPLEMENTS
L. LANE

NH. NEW HAY
NW. NEW WHEAT
SD. STORM DAMAGE
SS. STRAW STACK

P. PATH
S. STUBBLE

FIGURE 17

L.M. SMITH-1951: AERIAL PHOTO IDENTIFICATION OF FARM CROPS