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Technical Report No. 3

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

Parts VI and VII

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Technical Report No. 3, Parts VI & VII

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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 VI

THE IDENTIFICATION OF FARM CROPS
ON SELECTED AERIAL PHOTOGRAPHS

By

Clyde F. Kohn

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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 VI

THE IDENTIFICATION OF FARM CROPS
ON SELECTED AERIAL PHOTOGRAPHS

A final exercise in the identification of farm crops on aerial photographs selected at random from the nine sets used in this study serves three objectives. (1) It gives the photo analyst an orderly method of procedure to follow when identifying farm crops on photographs taken at particular times during the growing season. (2) It demonstrates the extent to which the various farm crops can be identified at different times during the growing season. (3) It delimits the time during the growing season when optimum criteria are available for photoidentification of farm crops in the research area.

The procedure for identification of farm crops on photographs taken at any particular time during the growing season consists of two steps. First, the fields are grouped on the basis of outstanding photo properties which are shared in common by two or more crops. On photographs taken during the spring months (May 28), three groups of fields can be established. These groups are: (1) fields of forage crops -- hay, rotation pasture, and permanent pasture which have medium to dark gray tones and no soil mottling; (2) fields of spring planted crops --

oats, barley, corn, soybeans -- which vary in their tonal values from light to dark (7 to 12) and which are marked by faint parallel lines and distinct soil mottling; (3) fields of fall planted crops -- winter wheat -- which on May 28, have prominent parallel lines and distinct soil mottling. Fields of winter wheat can be grouped separately from other small grains and the row crops because it is a fall-sown crop. In the early spring months it covers the ground in a distinctive manner.

On all other photographs, fields can be classified into three groups: (1) fields of forage crops; (2) fields of row crops -- corn and soybeans; and (3) fields of small grain crops. At all stages of growth after early summer the row crops, corn and soybeans, cover the ground in a manner distinctive from the small grain crops.

After a field has been classified, the photo interpreter can then proceed to determine the precise identity of the crop. For example, a forage crop field having either a dark gray tone and a smooth texture or a light to medium gray tone and concentric swath marks is a field of hay. A forage crop field may be identified as rotation pasture if it has a medium to dark gray tone and one or more of the following: (1) a cluster of minute specks which represent a herd of cows; (2) fine light lines which are lanes extending from the field to the buildings of the farmstead. Many of the properties by which crops can be identified precisely are seen only by stereoscopic examination of aerial photographs.

Precise identification of some crops is impossible on photographs taken at certain times during the growing season. On the July 8 photograph, for example, corn and soybeans can be identified only as row crops. Some barley and oats crops are indistinguishable also on photographs taken at this time. Limitations attached to identification of these crops make the July 8 photograph of little value to the photo interpreter engaged in crop identification in the research area.

Optimum criteria for photo identification of all farm crops in the research area are available on photographs taken just before small grain harvest. On the July 21 and July 29 photographs, for example, all three forage crops are distinguishable; both row crops are distinguishable; and with few exceptions, the three small grain crops are distinguishable. These photographs are of maximum value to one engaged in photo identification of farm crops in the research area.

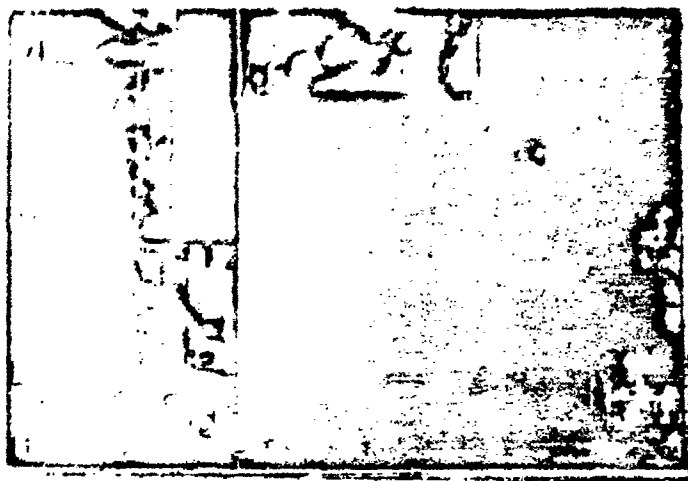


Plate 84. Photo selected from the May 28 photographs (Scale 1:11,300).

The Identification of Farm Crops on a May 28 Photograph¹

Fields on the May 28 photograph (Plate 84) fall readily into three groups on the basis of their outstanding photo properties. The three field groups are: (1) Fields of forage crops -- hay, rotation pasture, and permanent pasture (H, RP, and PP); (2) fields of winter wheat (W); and (3) fields of spring planted crops -- corn, oats, and barley (C, O, and B).² Only forage crops and winter wheat can be identified on the May 28 photograph. There is no possibility of distinguishing corn, oats, barley, and soybeans from each other. This photograph, therefore, is of little value to one engaged in crop identification.

¹ On the May 28 photo as on photos taken at all intervals of growth, cropped fields are distinguished from non-cropped fields primarily by rectangular form. A few non-cropped areas may have rectangular form but are more likely to be irregular. By and large, identification of cropped fields on selected photos is concerned with analysis of rectangular fields. The photos taken on May 28 did not provide sufficient overlap for stereoscopic analysis.

² Soybeans belong in the latter group but are not shown in Plate 84.

The Identification of Forage Crops on the May 28 Photograph

Fields of forage crops (H, RP, and PP in Plate 84) can be recognized easily on the May 28 photograph by a lack of soil mottling. They are characterized also by medium to dark gray tones and by either a lined or relatively smooth texture. The crops within these fields can be identified as follows:

1. H1 -- a forage crop because the field lacks soil mottling. The crop is hay rather than rotation pasture or permanent pasture because it has:
 - a. an exceptionally dark tone (15 on the tone scale)
 - b. a relatively smooth textureThis is an old hay field. See Part III, pp. 5-6.
2. H3 -- a forage crop because the fields lack soil mottling. It is hay rather than rotation pasture or permanent pasture because it has:
 - a. dark tone (12 to 13 on the tone scale)
 - b. closely spaced parallel lines
 - c. markings from the previous year's harvest of small grain /2.8 - 1.1/This is a new hay field. See Part III, pp. 5-6.
3. RP -- a forage crop because the field lacks soil mottling. It is a rotation pasture rather than hay or permanent pasture because the field has:
 - a. a medium to dark gray tone (11 to 13 on tone scale)
 - b. faint parallel lines /2.9 - 0.5/ which indicate that the field was tilled during recent years
 - c. a cluster of minute specks which is a herd of cows /2.8 - 0.7/
 - d. a fine light line which is a cow path /2.0 - 0.4/ leading from the field to the farmstead
4. PP1 -- a forage crop because the field lacks soil mottling. It is permanent pasture rather than hay or rotation pasture because it has:
 - a. a medium gray tone (10 on the tone scale)
 - b. relatively smooth texture
 - c. paths and lanes leading toward the buildings of the farmstead
 - d. trees /2.0 - 0.5/ and water holes /1.8 - 1.7/ which preclude identification of this field as a regularly tilled field.

The Identification of Winter Wheat on the May 28 Photograph

Fields of winter wheat (W in Plate 84) can be identified primarily by closely-spaced parallel lines superimposed on a distinctly mottled background. The one winter wheat field in the photograph has:

- a. medium to dark gray tone (7 to 13 on tone scale)
 - b. closely-spaced parallel lines superimposed on a mottled background
 - c. heavy, widely-spaced, parallel lines which extend across the field at intervals of one-tenth inches
- (See Part V, pp. 10-13)

The Identification of Spring Planted Crops
on the May 28 Photograph

Fields of spring planted crops (C, O, and B. in Plate 84) possess one outstanding photographic property. Within each field tonal values vary from light to dark (7 to 12 on the tone scale). The fields are all marked by faint parallel lines superimposed on mottled backgrounds. These crops cannot be distinguished one from the other so early in the spring. C1 which is a field of corn, has the same properties as those of B which is a field of barley and those of O1 which is a field of oats. (See Part IV, pp. 5-6, and Part V, pp. 9-10).

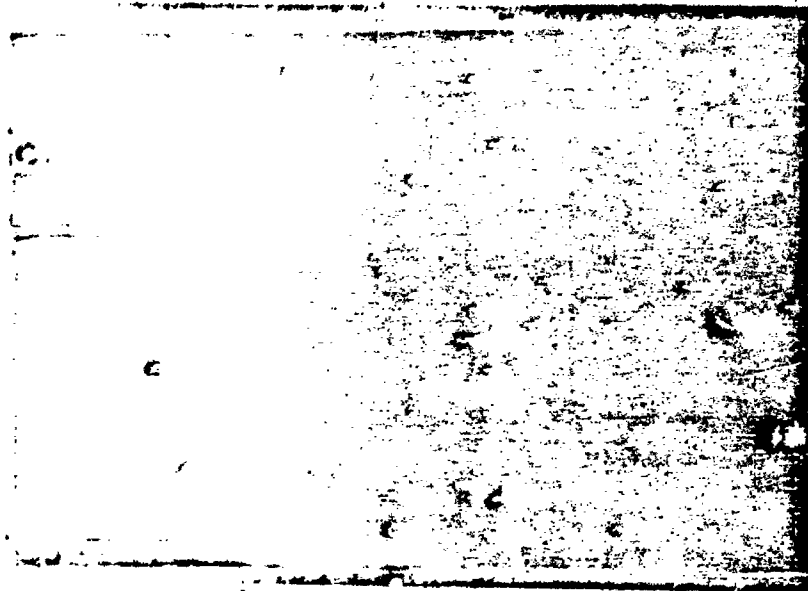


Plate 85. Stereopair: selected from July 8 photographs (Scale 1:12,000)

The Identification of Farm Crops on a July 8 Photograph¹

For aerial identification, fields on the July 8 photograph (Plate 85) can be divided readily into three groups: (1) forage crops -- hay, rotation pasture, and permanent pasture (H, RP, and PP); (2) row crops -- corn (C) and soybeans (not represented on Plate 85); and (3) small grain crops -- oats, barley, and winter wheat (O, B, and W). Difficulty is encountered when trying to distinguish between some oats and barley fields; neither can corn fields be distinguished from soybean fields at this time.

¹ Z1 in Plate 85 is an orchard; Z2 is a poorly drained area seeded to canary grass.

The Identification of Forage Crops on the July 8 Photograph

Fields of forage crops (H, RP and PP in Plate 85) are distinct in their photo appearance on July 8 because they lack soil mottling. Their tonal values range from medium to dark gray, and the fields have a smooth texture or are marked by swath markings. Fields having these crops can be identified as follows:

1. H2 -- a forage crop because the field lacks soil mottling. It is uncut hay because the field has:
 - a. dark tone (12 on the tone scale)
 - b. smooth to faintly lined textureSee Part III, pp. 6-11
2. H3 -- a forage crop because the field lacks soil mottling. It is recently harvested hay because the field has:
 - a. medium gray tone (9 to 10 on tone scale)
 - b. swath marksSee Part III, pp. 6-11
3. RP -- a forage crop because the field lacks soil mottling. It is rotation pasture rather than a hay field because the field has:
 - a. a medium gray tone (11 on the tone scale)
 - b. smooth to faintly lined texture
 - c. a cluster of minute specks /1.1 - 0.5/ which represents a herd of cows
 - d. fine white lines /1.5 - 1.2/ which are cow paths
 - e. a lane connecting the field with the farmstead /1.7 - 1.5/ and /1.9 - 1.6/
 - f. a white band adjacent to the trees along the southern edge of the field /1.0 - 0.5/ caused by cattle wearing away the forage cover as they congregate in the shade of the trees during the hottest part of each day.
4. PP3 -- a forage crop because the field lacks soil mottling. It is ~~permanent pasture~~ because the field has:
 - a. a medium gray tone (10 to 11 on the tone scale)
 - b. trees
 - c. relatively smooth texture where there are no trees
 - d. a lane which leads from the field to the buildings of the farmstead /0.6 - 1.3/

The Identification of Row Crops on the July 8 Photograph

Corn fields (C in Plate 85) can be identified on the July 8 photograph by their light to medium gray tones, faint line markings, and distinct soil mottling. Some fields also have striped texture created by crop intertillage. No soybeans are present in Plate 85, but where fields of soybeans do occur on other photographs taken at this time, they are indistinguishable from fields of corn, since they have the same photographic properties. Identification of row crops on the July 8 photography proceeds as follows:

1. C1 -- a row crop because the field has light to medium gray tone (8 to 11 on the tone scale), faint parallel lines, and distinct soil mottling. The crop is either corn or soybeans. See Part IV, pp. 6-8
2. C2 -- a row crop because the field has a light to medium gray tone (8 to 11 on the tone scale), faint parallel lines in the north half of the field and a striped appearance in the south half, and distinct soil mottling. The north end of the field has not yet been cultivated. A cultivator is at $2.2 - 0.9$, working in the middle of the southern half. The portion of the field immediately to the north of the cultivator has been cultivated during the day on which the photograph was taken. This portion of the field is slightly darker than the portion of the field to the south of the cultivator which was probably cultivated the day before. This crop is either corn or soybeans. The photo analyst might reason that this is a corn crop because of the size of the field, approximately twenty-five acres. Some corn fields in the area measure forty acres whereas the largest soybean field in the area measures only fifteen acres. See Part IV, pp. 6-8.

The Identification of Small Grain Crops on the July 8 photograph

The small grain crops (O, B, and W in Plate 85) are readily distinguished from row crops or forage crops by their tonal values which range from medium to dark gray; fine, closely-spaced parallel lines; distinct, widely-spaced secondary lines which extend across fields at intervals of one-tenth inches; and subdued soil mottling. Some fields of the oats and barley crops have similar properties and cannot be distinguished one from the other. Other oats and barley crops and all of the winter wheat crops have tonal distinctions and can be identified one from the other. Identification proceeds as follows:

1. W1 -- a small grain crop because the field has medium to dark gray tone; fine, closely-spaced parallel lines; distinct, widely-spaced secondary lines; and subdued soil mottling. The crop is winter wheat because in comparison with other small grain crops the field has:
 - a. relatively light tone (9 on the tone scale)
 - b. relatively indistinct lines and soil mottlingSee Part V, pp. 21-23.
2. O1 -- a small grain crop because the field has the lines and subdued soil mottling of small grain fields. The crop is oats because in comparison with other small grain crops the field has:
 - a. relatively dark tone (11 on the tone scale)
 - b. lines are prominent against mottled backgroundThis field might easily be confused with field of barley, represented by B2. See Part V, pp. 13-21.
3. B2 -- a small grain crop because the field has the lines and subdued soil mottling of small grain fields. The crop is barley because in comparison with other small grain crops the field has:
 - a. tones of intermediate value (10 on the tone scale)
 - b. tonal contrast of intermediate distinction in the mottled background of the field.This field could easily be confused with field of oats, as represented by O1. See Part V, pp. 13-21.
4. B1 -- a small grain crop because of its lines and subdued soil mottling. This crop is barley which is likely to be identified as oats because it has a darker tone than most barley fields.

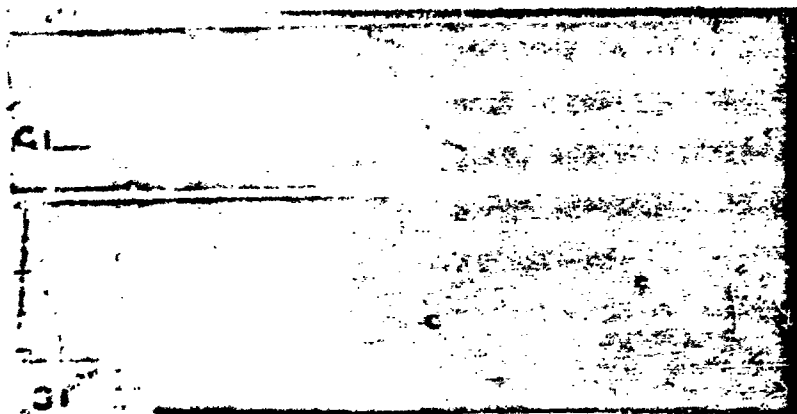


Plate 86. Stereopair: selected from July 13 photographs (Scale 1:14,400)

The Identification of Farm Crops on a July 13 Photograph¹

As on the July 8 photograph, fields can be divided readily into three groups on the July 13 photograph (Plate 86). These fields contain (1) forage crops; (2) row crops; and (3) small grain crops. Limitations to the identification of oats, barley, corn and soybeans on the July 8 photograph hold also for the identification of these crops on the July 13 photograph. Neither photograph is of great value to one engaged in the aerial photographic identification of farm crops.

¹I represents idle land on Plate 86; Z represents an orchard.

The Identification of Forage Crops on the July 13 Photograph

Hay, rotation pasture,¹ and permanent pasture (H and PP in Plate 86) can be identified as forage crops on the July 13 photograph primarily by the absence of soil mottling. They can be identified also by their medium to dark gray tonal values; by their smooth texture; or by their swath markings. All fields in forage crops can be identified as follows:

1. H2 — a forage crop because the field lacks soil mottling. It is uncut hay because the field has:
 - a. a dark gray tone (13 on the tone scale)
 - b. a smooth texture with only faint linesSee Part III, pp. 6-11
2. H3 — a forage crop because the field lacks soil mottling. It is a recently harvested hay field because the photo has:
 - a. a medium gray tone (11 on the tone scale)
 - b. swath marksSee Part III, pp. 6-11
3. PP2 — a forage crop because the field lacks soil mottling. It is permanent pasture because the field has:
 - a. a medium gray tone (10 to 11 on the tone scale)
 - b. trees
 - c. smooth texture where there are no trees
 - d. a lane 1.4 - 2.0 leading from the field to the buildings of the farmstead

¹Rotation pasture (RP) is not represented in Plate 86.

The Identification of Row Crops on the July 13 Photograph

The row crops, corn and soybeans (C and S in Plate 86), are marked by medium to dark gray tones, distinct soil mottling, and either parallel stripes or faint parallel lines. There is no basis for distinguishing between corn and soybeans. Identification proceeds as follows:

1. C1 -- a row crop because within the field the tone varies from medium to dark gray tone (8 to 12 on the tone scale), soil mottling, stripes in the northern four-fifths of the field, and faint parallel lines in the southern one-fifth of the field. The crop is either corn or soybeans (See Part IV, pp. 6-8).
 2. S2 -- a row crop because it has medium to dark gray tone (10 to 12 on the tone scale), distinct soil mottling, and faint parallel lines. The crop is either corn or soybeans.
-

The Identification of Small Grain Crops on July 13 Photograph

Small grain crops, oats, barley, and winter wheat (O, B, and W in Plate 86), are recognized by medium to dark gray tone; fine, closely-spaced, parallel lines; distinct, widely-spaced, secondary lines which extend across the fields at intervals of one-tenth inches; and subdued soil mottling. Most of the small grain crops can be distinguished one from the other. Difficulty is encountered in distinguishing only a few oats and barley fields. Identification proceeds as follows:

1. W2 -- a small grain crop because it has medium to dark gray tone. It has the lines and subdued soil mottling which mark small grain fields. It is winter wheat because in comparison with other small grain fields it has:
 - a. a relatively light tone
 - b. relatively indistinct lines and soil mottlingSee Part V, pp. 21-23
2. O1 -- a small grain crop because the field has a medium to dark gray tone and the characteristic lines and subdued soil mottling of small grain crops. It is oats because in comparison with other small grain crops it has:
 - a. relatively dark tones
 - b. relatively distinct lines and soil mottlingSee Part V, pp. 13-17
3. B2 -- a small grain crop. The crop is barley because in comparison with other small grain crops the field has:
 - a. tones of intermediate value
 - b. lines and soil mottling of intermediate distinctionSee Part V, pp. 17-21
4. B1 -- a small grain crop. It is barley which is likely to be identified as oats because in comparison with other small grain crops it has a relatively dark tone.

The Identification of Farm Crops
on July 21 and July 29 Photographs

The July 21 and July 29 photographs (Plates 87 and 88) are of maximum value to the photo interpreter engaged in farm crop identification. Fields of crops on these photographs can be classified into three groups. Optimum criteria are available for precise identification of each crop within a specific group.

The three groups on the July 21 and July 29 photographs are: (1) fields of forage crops; (2) fields of row crops; and (3) fields of small grain crops. Each group registers distinct differences in texture. These differences can be recognized easily with the aid of a stereoscope. Each of the three forage crops can be identified as on earlier photographs; each of the two row crops can be identified by textural differences; and with few exceptions each of the three small grain crops can be distinguished from each other by tonal differences.

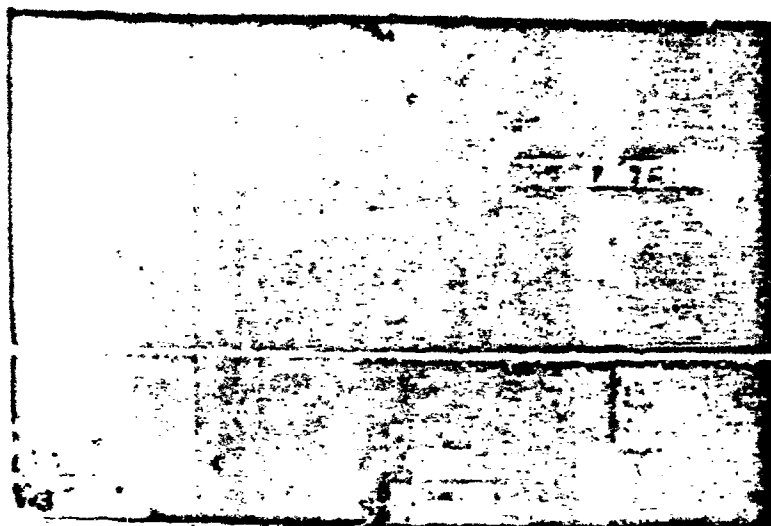


Plate 87. Photo selected from the July 21
photographs (Scale 1,14,400)

The Identification of Forage Crops on the July 21 Photograph

Most fields containing forage crops, hay, rotation pasture, and permanent pasture (H, HP, and PP in Plate 87) are characterized by relatively smooth texture and medium to dark gray tones on the July 21 photograph. A few hay crops, however, have fragments of swath marks. Each of the three forage crops may be identified as follows:

1. H1 -- a forage crop because the field has medium to dark gray tone and smooth texture (in part). The crop is uncut hay because the field has:
 - a. a dark gray tone (12 on the tone scale)
 - b. fragments of swath marks left over from the previous year's harvest of small grainSee Part III, pp. 11-13
2. H3 -- a forage crop because the field has a medium to dark gray tone and a relatively smooth texture. The crop is hay which has been harvested because the field has:
 - a. a medium gray tone (11 on the tone scale)
 - b. fragments of swath marksSee Part III, pp. 11-13
3. HP1 -- a forage crop because the field has medium to dark gray tone and relatively smooth texture. This crop is rotation pasture because the field contains:
 - a. a cluster of minute specks which represent a herd of cows /2.1 - 3.0/
 - b. a fine white line which is a cow path /1.4 - 3.0/
4. PP1 -- a forage crop because the field has a medium to dark gray tone and relatively smooth texture. This crop is permanent pasture because the field contains:
 - a. trees which preclude identification of the field as a regularly tilled field
 - b. paths and lanes leading toward the buildings of the farmstead.

The Identification of Row Crops on the July 21 Photograph

Fields containing row crops, corn (C in Plate 87) and soybeans (not represented in Plate 87), can be recognized by coarse lines, medium to dark gray tone, and relatively distinct soil mottling causing wide ranges in tonal values. The row crops can be identified by type as follows:

1. C2 -- a row crop because the field has coarse lines, medium to dark gray tone, and relatively distinct soil mottling. The crop is corn because the field has a rough corduroy-like property. The rows appear to stand up from the surface of the photograph when viewed with a stereoscope.
See Part IV, pp. 8-10
 2. If a crop of soybeans were represented in Plate 87, it would be identified as a row crop because of its medium to dark gray tone, coarse lines, and relatively distinct soil mottling. It would be identified as soybeans by corduroy-like property which is finer and more closely woven than that of corn crops.
 3. C1 -- a corn crop is likely to be identified as a soybean crop because it lacks the rough corduroy-like property of corn crops. The appearance of this crop is an exception to that of all other corn crops in the area. It was seeded late in the season after a rotation pasture in the field failed to produce enough forage to make the field profitable.
-

The Identification of Small Grain Crops on the July 21 Photograph

The small grain crops, oats, barley and winter wheat (O, B, and W in Plate 87), are marked by fine lines, subdued soil mottling, and light to medium gray tone on the July 21 photograph. Some small grain fields also have storm-damage patches on this photograph (02). Most of the small grain crops can be distinguished one from the other as follows:

1. 01 -- a small grain crop because the field has fine lines and subdued soil mottling. This field also has more distinct secondary lines spaced at intervals of one-tenth inches as seen in small grain crops on earlier photographs. The crop is oats because in comparison with other fields of small grain crops this field has a relatively dark tone (12 on the tone scale). See Part V, pp. 25-28.
2. 02 -- a small grain crop because it has somewhat faint fine lines. This crop is nearly lacking in soil mottling but has storm-damage patches. The crop is oats because in comparison with other small grain crops the field has a relatively dark tone (12 on the tone scale). See Part V, pp. 25-28. Because this particular field lacks soil mottling, and is relatively dark it might be identified as an uncut hay field. It differs, however, from H2 by its textural qualities which are not so smooth and by the storm damage areas within the field at 1.2 and 1.3.
3. B1 -- a small grain crop because it has fine lines and subdued soil mottling. This crop is barley in comparison with other small grain crops. It has tone of intermediate value (11 on the tone scale). See Part V, pp. 28-31.
4. W1 -- a small grain crop because the field has fine lines and subdued soil mottling. The crop is winter wheat because in comparison with other small grain crops the field has:
 - a. a relatively light tone (9 to 10 on tone scale)
 - b. relatively indistinct linesSee Part V, pp. 31-35.
5. 03 -- a small grain crop. This is a field of oats which might be confused with barley because in comparison with other small grain fields its tone is of intermediate value (11 on the tone scale). See Part V, pp. 25-28.

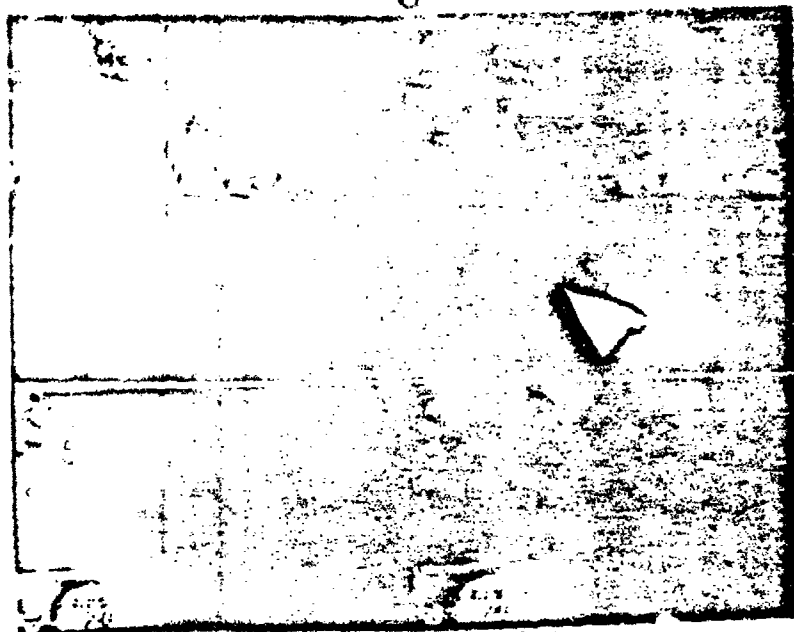


Plate 88. Photo selected from the July 29¹
photographs (Scale 1:14,400)

¹I is Islo Land in Plate 88

The Identification of Forage Crops on the July 29 Photograph

The forage crops, hay, rotation pasture, and permanent pasture (H, RP, and PP in Plate 88), can be identified on the July 29 photograph as on the July 21 photograph. Fields of forage crops have relatively smooth texture and a medium to dark gray tone. A few hay fields have swath marks. The forage crops can be distinguished from each other as follows:

1. H4 -- a forage crop because the field has a relatively smooth texture and medium to dark gray tone. The crop is uncut hay because the field has:
 - a. a dark gray tone (12 on the tone scale)See Part III, pp. 11-13.
2. H3 -- a forage crop because the field has swath marks and a medium to dark gray tone. The hay crop has recently been harvested because the field has:
 - a. a medium gray tone (10 on the tone scale)
 - b. swath marksSee Part III, pp. 11-13
3. RPI -- a forage crop because the field has a relatively smooth texture and a medium to dark gray tone. It is rotation pasture because the field has:
 - a. a faint light line which is a cowpath at 2.0 - 3.7
 - b. faint parallel lines which indicate tillage during recent years.

The Identification of Row Crops on the July 29 Photograph

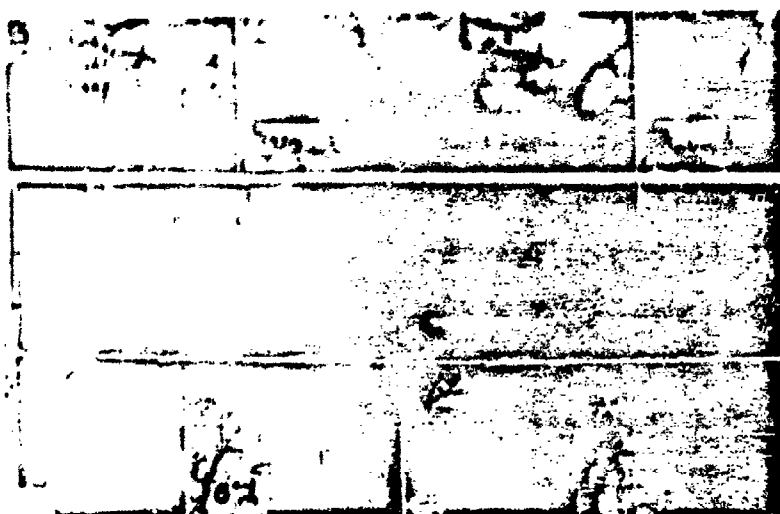
Row crops, corn and soybeans (C and S in Plate 88), can be identified readily on the July 29 photograph by subdued soil mottling, medium to dark gray tones, and coarse lines which give a corduroy-like appearance to the fields. The crops can be distinguished from each other as follows:

1. C2 -- a row crop because the field has subdued soil mottling, medium to dark gray tone, and coarse lines which give a corduroy-like appearance to the field. The crop is corn because in comparison with soybeans the field has:
 - a. relatively rough and sharply defined corduroy-like texture
 - b. also the crop is of relatively great height. Individual rows seem to stand up from the surface of the photographSee Part IV, pp. 8-10.
2. S2 -- a row crop because the field has a subdued soil mottling, medium to dark gray tone, and coarse lines which give a corduroy-like appearance to the field. The crop is soybeans because in comparison with corn the field has:
 - a. relatively fine and less sharply defined corduroy-like texture
 - b. also the crop possesses relatively little height. Individual rows seem to stand up only slightly from the surface of the photograph.
3. C1 -- a row crop which is corn but which is likely to be identified as soybeans because the field lacks the rough, sharply-defined corduroy-like texture of corn crops. This crop was seeded late in the season after failure of a rotation pasture which occupied the field during the early part of the growing season.

The Identification of Small Grain Crops on the July 29 Photograph

The small grain crops, oats, barley, and winter wheat (O, B, and W in Plate 88), are marked by fine lines, subdued soil mottling, and light to medium gray tones on the July 29 photograph. Some small grain fields also have storm-damage patches on this photograph. Crops belonging to this group can be distinguished from each other on the basis of their tonal quality:

1. O3 -- a small grain crop because the field has fine lines, subdued soil mottling, and light to medium gray tone. The crop is oats because in comparison with other small grain crops it has a relatively dark tone. See Part V, pp. 25-28.
2. B -- a small grain crop because the field has fine lines, subdued soil mottling, and light to medium gray tone. The crop is barley because in comparison with other small grain crops its tone is of intermediate value. See Part V, pp. 28-31.
3. W -- a small grain crop because the field has fine lines, subdued soil mottling, and light to medium gray tone. The crop is winter wheat because in comparison with other small grain crops the field has:
 - a. a relatively light tone
 - b. relatively indistinct linesSee Part V, pp. 31-35.



Plato 89. Photo selected from the September 7 photographs (Scale 1:14,400)

The Identification of Farm Crops on a September 7 Photograph

The outstanding photo properties of forage crops and row crops on the September 7 photograph (Plato 89) are like those on the July 29 photograph. The photo properties of small grain crops on the September 7 photograph, however, differ from those on the July 29 photograph. These crops have been harvested and the fields are either in stubble or are fall plowed. Fields in stubble can be recognized readily by relatively light gray tone, swath marks, and mottling. Fall-plowed fields are distinguished by variation of tones ranging from light to dark gray within a specific field, and distinct soil mottling. There is no basis for determining the type of small grain which occupied either the fields in stubble or the fall-plowed fields. This photo and the remaining photos taken at later times during the growing season are of less value to one engaged in farm crop identification than are the July 21 and July 29 photographs.

The Identification of Forage Crops on the September 7 Photograph

Fields of forage crops, hay, rotation pasture, and permanent pasture (H, RP, and PP, in Plate 89), can be recognized on the September 7 photograph by their medium to dark gray tones, relatively smooth texture, or by swath marks, and a lack of soil mottling. These crops can be distinguished from each other as follows:

1. H4 -- a forage crop because the field has a relatively smooth texture and lacks soil mottling. The crop is hay because it has:
 - a. a dark gray tone (tones on this photograph could not be measured quantitatively)
 - b. fragments of swath marks
 - c. a minute object which resembles a railroad box car and which is a stack of baled hay /0.8 - 0.9/
See Part III, pp. 13-17
2. RP -- a forage crop because the field has a relatively smooth texture and lacks soil mottling. The crop is rotation pasture because the field has:
 - a. a medium gray tone
 - b. fine light lines which are cowpaths converging at a barn in the farmstead /0.2 - 0.7/
 - c. faint parallel lines which indicate that the field has been tilled in recent years
3. PP -- a forage crop because the field has smooth texture and lacks soil mottling. The field is in permanent pasture because it has:
 - a. a medium gray tone
 - b. a cow path /0.8 - 2.3/
 - c. no parallel lines to indicate that the field has been tilled in recent years
 - d. trees and a poorly drained area /0.9 - 2.3/ which would handicap regular tillage of this field

The Identification of Row Crops on the September 7 Photograph

The row crops, corn (C in Plate 89) and soybeans (not represented in Plate 89), can be identified on the September 7 photograph by the medium to dark gray tone, soil mottling, and coarse lines which give a corduroy-like texture to the fields. In comparison with soybean crops, corn crops have a rougher and more nubby quality. Fine black lines which are shadows also appear along the northern edges of corn fields.

Corn crops in Plate 89 can be identified as follows:

1. C2 -- a row crop because the field has medium to dark gray tone, soil mottling, and coarse lines which give a corduroy-like texture. The crop is corn because the field has:
 - a. a rough, nubby texture
 - b. a thin black line which is a shadow along the northern edge of the field /0.3 - 1.7/
- See Part IV, pp. 10-11

The Identification of Small Grain Fields on September 7 Photograph

The small grain fields, oats, barley, and winter wheat (O, B, and W in Plate 89), differ in two ways on the September 7 photograph. Some are in stubble and some are fall plowed. The fields which are in stubble can be recognized by relatively light gray tones, swath marks, and mottling. Some of these fields also have rows of fine dots where shocks of grain stood before being threshed, straw stacks, and implements tracks which converge at straw stacks or at lanes leading to the buildings of the farmstead. Fall-plowed fields can be recognized by the variations of tone ranging from light to dark gray within a specific field, and distinct soil mottling. The fields can be identified as follows:

1. O4 -- a small grain field in stubble because it has:
 - a. a relatively light gray tone
 - b. swath marks
 - c. mottlingSee Part V, pp. 36-40
2. O6 -- a small grain field in stubble because it has:
 - a. a relatively light gray tone
 - b. swath marks
 - c. mottling
 - d. rows of fine dots
 - e. a straw stack /1.2 - 0.7/
 - f. implement tracks converging at the straw stack and at the gate which opens onto the public roadSee Part V, pp. 36-40
3. W1 -- a small grain field which has been fall plowed because it has:
 - a. light to dark gray tone
 - b. distinct soil mottling
 - c. fine parallel linesSee Part V, pp. 46, and Plate 80.

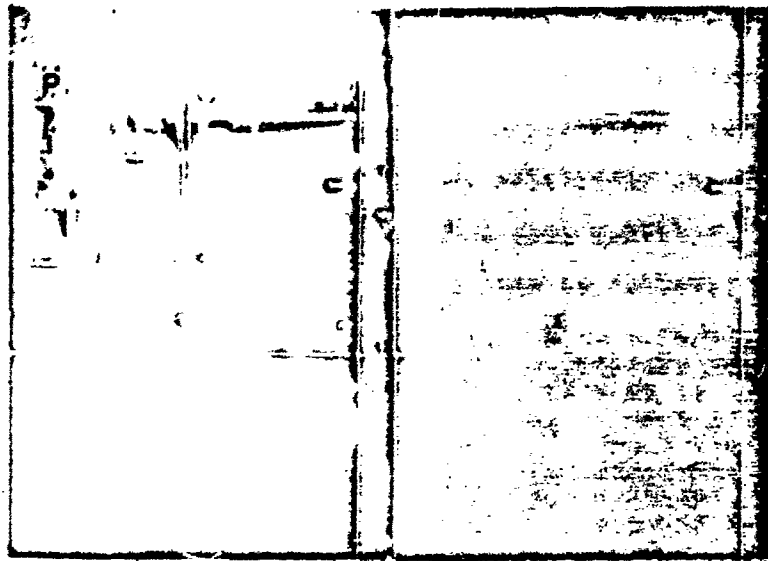


Plate 90. Photo selected from September 26 photographs (Scale 1:14,400)

The Identification of Farm Crops on a September 26 Photograph¹

The photo properties by which crops can be identified on photographs taken on September 26 (Plate 90) differ only slightly from those on photographs taken on September 7. The slight differences result from (1) the harvest of a few corn fields; (2) the growth of new hay in some of the small grain fields; and (3) the seeding of a few fall-plowed fields to winter wheat.

¹2 in Plate 90 is canary grass.

The Identification of Forage Crops on the September 26 Photograph

Fields of forage crops, hay, rotation pasture, and permanent pasture (H, RP, and PP on Plate 90) can be recognized on the September 26 photograph by their medium gray tone (10 to 11 on the tone scale), absence of soil mottling, and by their smooth texture or swath markings. The forage crops can be distinguished from each other as follows:

1. RPl -- a forage crop because the field has a medium gray tone, swath markings, and lacks soil mottling. This crop might be identified, however, as hay because its relatively distinct swath marks indicate recent harvest. The crop, however, is rotation pasture because it has:
 - a. a cluster of minute specks which is a herd of cows /0.4 - 2.9/
 - b. fine light lines which are cowpaths /1.0 - 2.9/
 - c. a lane extending from the field to the buildings of the farmstead /1.1 - 2.8/
2. H1 -- a forage crop because the field has a medium gray tone, faint swath marks, and lacks soil mottling. The crop is hay because the swath markings are light and because there are no herds, cowpaths, and lanes.
See Part III, pp. 17-18
3. PP1 -- a forage crop because the field has a medium gray tone, smooth texture, and lacks soil mottling. The field is used for permanent pasture because it has:
 - a. trees and drainage features which would be a handicap to regular tillage, and
 - b. fine light lines which are cow paths /1.7 - 1.3/
4. H2 -- a forage crop. The field is a recently harvested hay field because it has distinct swath markings.
See Part III, pp. 17-18

The Identification of Row Crops on the September 26 Photograph

Fields of row crops, corn (C in Plate 90) and soybeans (not represented in Plate 90), can be identified on September 26 photographs by their medium to dark gray tones (9 to 12 on the tone scale); coarse, corduroy-like texture; and subdued soil mottling. A few corn fields also have swath markings. In comparison with soybean crops, corn crops have a more rough and nubby texture; the rows seem to stand up higher from the surface of the photograph. Thin black lines made by shadows of the corn plants also appear along the northern edges of corn fields. The fields can be identified as follows:

1. C4 -- a row crop because the field has a medium to dark gray tone; coarse, corduroy-like texture; and subdued soil mottling. It also has swath marks $\angle 1.8 - 0.8 \angle$, $\angle 1.8 - 0.6 \angle$ and $\angle 1.8 - 0.4 \angle$. The crop is corn because the field has:
 - a. a rough and nubby texture
 - b. thin black lines which represent shadows along the northern edges of uncut portions of the field

See Part IV, pp. 11-12

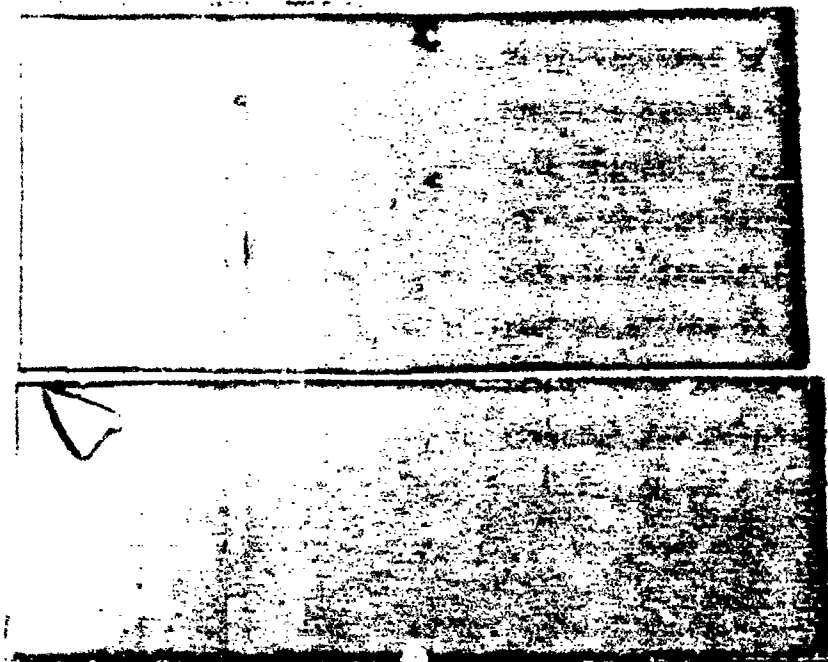
The Identification of Small Grain Fields on September 26 Photograph

The small grain fields containing oats, barley, and winter wheat (O, B, and W in Plate 90), can be recognized on the September 26 photograph primarily by their medium to dark gray tones, swath markings, and faint soil mottling. Some of the field, however, have been fall plowed and have light to dark gray tones, faint parallel lines, and distinct soil mottling. (None of the fields in Plate 90 have been fall plowed). The small grain fields can be identified as follows:

1. O1 -- a small grain field because it has a medium to dark gray tone, swath marks, and faint soil mottling. This field is in small grain stubble without a new stand of hay because in comparison with other small grain fields it has:
 - a. a relatively light tone
 - b. relatively distinct swath marks and soil mottlingSee Part V, pp. 40-48
2. O3 -- a small grain field because it has medium to dark gray tone, lined texture, and faint soil mottling. This field is a small grain field which has a new stand of hay because in comparison with other small grain fields it has:
 - a. a relatively dark tone
 - b. relatively indistinct swath marks and soil mottlingSee Part V, pp. 40-48

The Identification of Farm Crops
on October 5 and October 19 Photographs

The outstanding photo properties by which crops can be identified on the September 26 photographs carry over with little change to the October 5 and October 19 photographs (Plates 91 and 92). Fields of hay, rotation pasture, and permanent pasture (H, RP, and PP. in Plates 91 and 92) can be distinguished by their medium to dark gray tones, lack of soil mottling, and relatively smooth texture. Fields of row crops (C and S in Plates 91 and 92) can be recognized primarily by their coarse, corduroy-like texture and faint soil mottling. These fields have a dark gray tone on October 5 photographs and either a dark or medium gray tone on October 19 photographs. Depending on farm practices, small grain fields, oats, barley, and winter wheat (O, B, and W in Plates 91 and 92), are characterized by medium to dark gray tones, swath markings, faint mottling, or by light to dark gray tones, distinct soil mottling, and fine parallel lines.



Plato 91. Photo selected from the October 5
photographs (Scale 1:14,400)

The Identification of Forage Crops on the October 5 Photograph

Fields containing forage crops can be identified on October 5 photographs (Plate 91) as follows:

1. H1 -- a forage crop because the field lacks soil mottling and has a relatively smooth texture. The crop is hay because the field has:
 - a. a relatively dark tone (12 on tone scale)
 - b. faint swath marksSee Part III, pp. 17-18
2. RP2 -- a forage crop because the field lacks soil mottling and has a relatively smooth texture. The crop is in rotation pasture because the field has:
 - a. faint parallel lines which indicate crop tillage in recent years
 - b. a cluster of minute specks which is a herd of cows /1.3 - 3.4/
 - c. fine light lines which are cow paths /1.8 - 3.3/

The Identification of Row Crops on the October 5 Photograph

Fields of corn and soybeans can be identified on October 5 photographs (Plate 91) as follows:

1. C2 -- a row crop because the field has a dark gray tone (11 to 12 on the tone scale); coarse, corduroy-like texture; and faint soil mottling. It also has parallel swath marks which indicate that the crop has been partially harvested. The crop is corn because the field has:
 - a. rougher texture than that of soybean crops
 - b. a thin black line which indicates a shadow along the northern edge of the uncut portion of the field /1.0 - 1.1/See Part IV, pp. 12-13.
2. S -- a row crop because the field has a dark gray tone, corduroy-like texture, and faint soil mottling. It also has swath marks. The crop is soybeans because the field has:
 - a. a finer corduroy-like texture than that of corn fields
 - b. concentric rather than parallel swath marks¹.

¹ Concentric swath marks are found in soybean fields rather than in corn fields. Parallel swath marks are found in both corn and soybean fields.

The Identification of Small Grain Fields on October 5 Photograph

The small grain fields can be identified on October 5 photographs (Plate 91) as follows:

1. O1 -- a small grain field which has been fall plowed. It has light to dark gray tone, fine parallel lines, and distinct soil mottling. See Part V, pp. 45-47.
2. B1 -- a small grain field which has been partially plowed. The unplowed portion has medium gray tones, faint mottling, and concentric swath marks. See Part V, pp. 40-43. The plowed portion has a light to dark gray tone, fine parallel lines and distinct soil mottling. See Part V, pp. 45-47.
3. O3 -- a small grain field because it has medium to dark gray tone, swath marks, and faint soil mottling. The field has a crop of new hay because in comparison with other small grain fields it has:
 - a. a relatively dark tone
 - b. relatively indistinct swath marksSee Part V, pp. 43-45.
4. O2 -- a small grain field because it has a medium to dark gray tone, swath marks, and faint soil mottling. This field is in small grain stubble without a new crop of hay because in comparison with other small grain fields it has:
 - a. a relatively light tone
 - b. relatively distinct swath marksSee Part V, pp. 40-43.

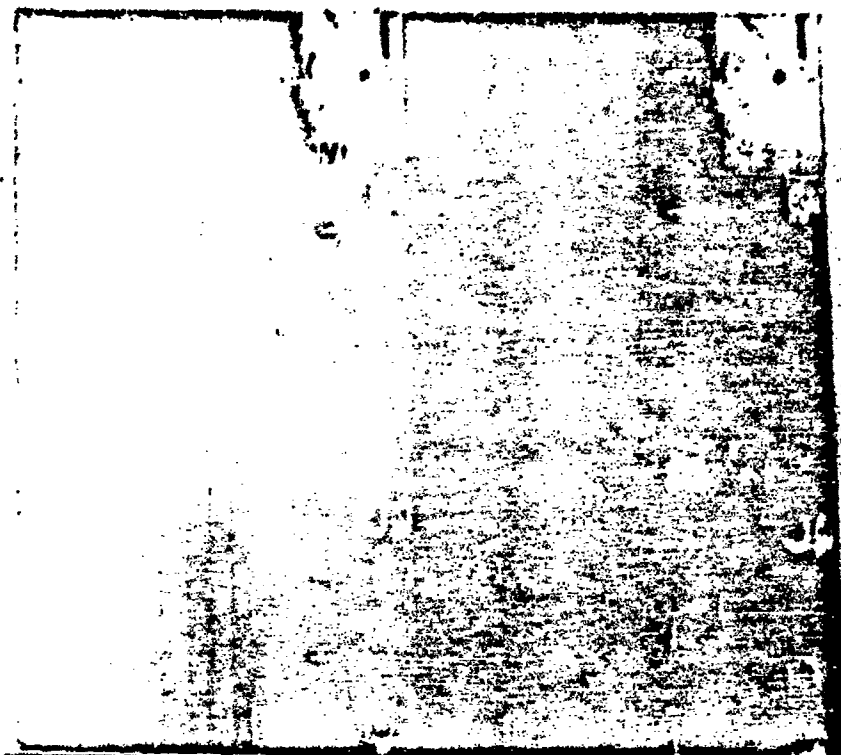


Plate 92. Photo selected from the October 19¹
photographs (Scale 1:10,000)

¹I in Plate 92 above is Idle. Idle land commonly has a scabby appearance on aerial photographs. Z in Plate 92 is planted to rows of young trees.

The Identification of Forage Crops on October 19 Photograph

The forage crop can be identified by type on October 19 photographs (Plate 92) as follows:

1. H -- a forage crop because the field lacks soil mottling and has relatively smooth texture. The crop is hay because the field has:
 - a. a relatively dark tone (12 on the tone scale)
 - b. faint concentric swath marksSee Part III, pp. 17-18
2. RP -- a forage crop because the field lacks soil mottling and has a relatively smooth texture. The field is in rotation pasture because it has:
 - a. scattered minute specks which are cows
/0.6 - 0.5/ and /0.6 - 1.0/
 - b. faint parallel lines which indicate crop tillage in recent years

Identification of Row Crops on October 17 Photographs

The row crops can be identified by type on October 17 photographs (Plate 92) as follows:

1. C2 -- a row crop because the field has a coarse corduroy-like texture and faint soil mottling. The crop is corn because the field has:
 - a. a medium gray tone (10 on the tone scale)
 - b. a rough and mubby texture
 - c. a thin black line which represents a shadow along the northern edge of the fieldSee Part IV, pp. 13-15
2. C1 -- a row crop because the field has a coarse, corduroy-like texture and faint soil mottling. The crop is corn because the field has:
 - a. a medium gray tone (10 on the tone scale)
 - b. a rough and mubby texture
 - c. a thin black line which represents a shadow along the northern edge of the field. Along the western side of this field, fine dark gray bands of soybeans alternate with bands of corn.See Part IV, pp. 13-15
3. S5 -- a row crop because the field has a coarse, corduroy-like texture and faint soil mottling. The crop is soybeans because the field lacks a thin black shadow along its northern edge and because in comparison with corn fields it has:
 - a. a darker gray tone (12 on the tone scale)¹
 - b. a finer textural quality

¹Corn turns to a light silver beige color after frost whereas soybeans turn dark brown or black.

The Identification of Small Grain Fields on October 19 Photographs

Small grain fields can be identified on the October 19 photographs (Plate 92) as follows:

1. O1 -- a small grain field which is in stubble without a crop of new hay because it has a medium to dark gray tone, distinct swath marks, and faint mottling. See Part V, pp. 40-43.
2. O2 -- a small grain field which has been fall plowed because it has tones varying from light to dark, fine parallel lines, distinct dead-furrow lines spaced at intervals of one-tenth inches, and distinct soil mottling. See Part V, pp. 45-47.
3. W2 -- a small grain field which has been fall plowed and reseeded to winter wheat because it has tones varying from light to dark, fine parallel lines, faint dead furrow lines spaced at intervals of one-tenth inches, distinct soil mottling, and a band of parallel lines crossing the main body of parallel lines at right angles at the northern and southern edges of the field. See Part V, pp. 47-50.

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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 VII

CONCLUSIONS REGARDING THE AERIAL PHOTO IDENTIFICATION OF
FARM CROPS IN NORTHERN ILLINOIS

By

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Technical Report No. 3, Part VII

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CONCLUSIONS REGARDING THE AERIAL PHOTO IDENTIFICATION OF
FARM CROPS IN NORTHERN ILLINOIS

Farm crops in Northern Illinois, like most other features of the natural and cultural landscape, can be identified on aerial photographs. Unlike other features of the natural and cultural landscape, however, farm crops change in their photo appearance during the growing season as a result of growth, maturation, cultivation, and harvest. These changes affect photo identification. All crops of the research area can be identified on aerial photographs some time during the growing season; some crops can be identified on all aerial photographs taken throughout the growing season; on some aerial photographs, it is possible to identify every crop grown in the area. Photographs taken at some intervals of growth are, however, of greater value to the photo interpreter engaged in farm crop identification than are photographs taken at other intervals of growth.

Farm crops in the research area can be identified on aerial photographs primarily by unique tonal and textural properties of their photographic images and by objects which are commonly found in association with them. Shadows are of some value in the identification of corn fields during late intervals of growth. Other properties are shared in common

by nearly all crops in the area and are of little aid to their identification. These properties are form and size of tilled fields and the pattern of distribution of particular crops.

Most variations in physical conditions and in farm practices employed in the growth of given crops in the research area have no effect on the photo appearance of those crops. A few variations, however, affect both the photo appearance and photo identification of certain crops and provide a basis for inferences concerning the ultimate uses of those crops. The inferred uses of crops, moreover, along with the crop associations on individual farms provide a basis for determining the types of farm economy pursued in the area.

Time of Photography Most Favorable in the
Identification of Farm Crops in Northern Illinois

The July 21 and July 29 photographs, taken just before small grain harvest, are most favorable in the identification of farm crops in Northern Illinois. On these photographs, textural differences enable the photo analyst to distinguish between corn and soybeans which are indistinguishable on earlier photographs. On these photographs, also, tonal differences provide a basis for distinguishing oats, barley and winter wheat from each other. In areas having crop associations similar to those of Northern Illinois, these crops are indistinguishable on both earlier and later photographs. It is recommended, therefore, that aerial photographs to be used in the identification of farm crops should be taken just prior to small grain harvest.

Conclusions Regarding Criteria for Identification of Farm Crops
on Aerial Photographs in Northern Illinois

The photo properties of individual farm crops in Northern Illinois and their use as photo identification criteria may be summarized in terms of textural properties, tonal values, associated objects, shadows, and other properties shared in common by all tilled crops.

Conclusions Regarding Texture

In analyzing photo properties of individual farm fields in order to identify crops on aerial photographs taken in northern Illinois, the following conclusions regarding textural properties may be drawn:

1. There is a difference in the texture of individual farm crops on aerial photographs taken at different times during the growing season.
2. There is a difference in texture among different crops on aerial photographs taken at particular times during the growing season.
3. Individual farm crops can be identified on aerial photographs in part by their textural properties.
4. Texture serves primarily as a basis for classifying farm crops on aerial photographs according to groups, such as (a) forage crops; (b) row crops; and (c) small grain crops.
5. To a lesser extent, texture can be used to distinguish particular crops within a group, especially row crops, corn and soybeans, on aerial photographs taken between mid-July and the end of the growing season.

Conclusions Regarding Tonal Values

In analyzing photo properties of individual farm fields in order to identify crops on aerial photographs taken in northern Illinois, the following conclusions regarding tonal values may be drawn:

1. There is a difference in the tonal values of individual farm crops on aerial photographs taken at different times during the growing season.

2. There is a difference in tonal values among different crops on aerial photographs taken at particular times during the growing season.

3. Tones of gray can be graded quantitatively by use of a densitometer so that tones of one set of aerial photographs are relative to those of other sets regardless of variations in conditions of photography (weather, camera equipment and photo processing).

4. Particular crops go through a definite progression of tonal values on aerial photographs taken at different times during the growing season.

5. Individual farm crops can be identified on aerial photographs in part by their tonal values.

6. Tone serves as a basis for classifying crops on aerial photographs according to crop groups.

7. Tone is the only basis for distinguishing particular crops within groups on aerial photographs taken at certain critical times during the growing season (especially the three small grains on aerial photographs taken during July).

Conclusions Regarding Associated Objects

In analyzing photo properties of individual farm fields in order to identify crops on aerial photographs taken in northern Illinois, the following conclusions regarding associated objects may be drawn:

1. Farm implements and other objects which commonly appear in association with certain farm crops can be seen in the aerial photographs.
2. These objects serve in part as a basis for identifying particular farm crops on aerial photographs.

Conclusions Regarding Shadows

In analyzing photo properties of individual farm fields in order to identify crops on aerial photographs taken in northern Illinois, the following conclusions regarding shadows may be drawn:

1. Corn crops cast shadows which appear on aerial photographs taken during the latter part of the growing season.
2. Shadows serve primarily as a basis for distinguishing corn crops from soybean crops.

Conclusions Regarding Other Properties

In analyzing photo properties of individual farm fields in order to identify crops on aerial photographs taken in northern Illinois, the following conclusions regarding other properties may be drawn:

1. Nearly all tilled fields are rectangular in form.

2. Sizes of tilled fields on aerial photographs with a scale of 1:12,000 vary from those measuring two-tenths by five-tenths inches to those measuring 1.2 inches square.

3. There is no apparent pattern of distribution of particular crops in the area studied.

4. Form and size of fields serve primarily as a basis for distinguishing tilled from untilled land.

5. Form and size of fields and their distribution within an area are of little aid in the aerial photographic identification of particular crops.

The Effect of Physical Conditions and Farm Practices
on the Aerial Photo Identification of Farm Crops
in Northern Illinois

Two physical conditions and four farm practices associated with crop growth affect the aerial photo appearance and the photo identification of farm crops in Northern Illinois. These conditions are: (1) soils; (2) storms; (3) plowing; (4) planting; (5) cultivation; and (6) harvest. All six affect the texture of certain crops at particular times during the growing season. Differences in the moisture content of soils and degree of soil erosion within field boundaries give row crops and small grain crops a mottled texture. Storms in late July give small grain crops a patchy appearance. Plowing and planting give row crops and small grain crops a lined texture. Cultivation (intertillage) gives row crops a striped texture. Harvest leaves fields of hay, row crops, and small grain crops with swath marks. Such markings can be used in part to identify individual crops on aerial photos.

Variations in physical conditions and farm practices among the fields of a given crop cause little difference in the photo appearance of these crops. A major exception is the distinctive difference between fields of a given crop when that crop is harvested for different purposes. For example, hay and corn crops which are harvested for the silo take on harvest markings on earlier photographs than do hay crops which are harvested for the hay mow or hay stack and corn crops which are harvested for the corn crib. Corn crops which are harvested for the silo also lack the corn-shecks characteristic of fields in which the corn is harvested for the crib. Minor differences are found among fields of small grain crops as a result of variations in planting and in the use of small grains as nurse crops for new hay. Those fields planted at right angles to plow lines have plaid-like texture whereas those planted parallel to plow lines have a lined texture. Those fields of small grain stubble having new crops of hay are less distinctly lined and mottled and are darker in tone on the September and October photographs than are those fields of small grain stubble without new crops of hay.

Among fields of a given crop, aerial photographs give no indication of variation in (1) land forms; (2) soil types; (3) weather conditions; (4) plowing practices; (5) cultivation; (6) use of the fields during the previous year; (7) season of plowing and disking (fall or spring); (8) seed varieties; (9) date of planting; and (10) fertilization practices.

Inferences Which Can Be Made From Aerial Photographs
Regarding Types of Farm Economy
In Northern Illinois

The ability to identify farm crops on aerial photographs enables the photo identifier to infer the type of farm economy pursued on individual farms in Northern Illinois. This is accomplished in part by noting the crop association found on individual farms and in part by noting the different uses which are made of hay and corn crops. Inferences are based on the following:

1. Dairy farms contain fields of hay, corn, oats, and rotation pasture. Some of the hay and much of the corn is harvested for the silo. Fields of cash grain crops of winter wheat, barley, or soybeans and permanent pasture may appear but such fields are not common to dairy farms in the area.
2. Hog farms and hog and beef farms contain fields of corn, oats, hay, and pasture. None of the hay and relatively little corn are harvested for the silo; and pastures, especially rotation pastures, are small (5 to 10 acres).
3. Cash grain farms are marked by the presence of small grain crops in half or more of the tilled fields. Corn crops on cash grain farms are harvested for the crib.

Further Studies Needed

This study, undertaken to devise a speedy and accurate technique for identifying farm crops and mapping their distribution from aerial photographs, increases the applicability of aerial photographs to geographic inventory. These findings, however, apply only to crop identification in Northern Illinois. Similar projects must be pursued in other areas before

appreciable use can be made of the technique. Such projects should provide for: (1) testing the findings of this study in areas having similar crop associations; and (2) extending the identification technique to areas having different crop associations. Through such studies, geographers can make real contributions to research in problems of land management, soil conservation, crop control, and to any problems in which field crops must be identified. Such research is vital to the all important problem of feeding the world in our age of rapidly increasing population and decreasing resources.