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Kansas Applied Remote Sensing Program

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THE SPACE TECHNOLOGY CENTER
KARS Kansas Applied Remote Sensing Program

CROP-PHENOLOGY AND LANDSAT-BASED IRRIGATED LANDS INVENTORY IN THE HIGH PLAINS

SECOND INTERIM REPORT
Grant No. NAG 2-57

(Period: December 1, 1980 - January 31, 1981)

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NASA GRANT NO. NAG 2-57: SECOND INTERIM REPORT
(December 1, 1980 - January 31, 1981)

I. SUMMARY OF ACCOMPLISHMENTS

The second period's activity concentrated on:

a) preliminary identification of optimal Landsat image dates for 1980 based on the ESS Weekly Crop-Weather Reports;

b) completion of 1979 ESS agricultural statistics data entry to the computer;

c) final revision of the mail questionnaire and mailing of the questionnaires to ASCS county agents;

d) seeking approval of each of the state Extension Directors to mail the questionnaires to county agents;

e) tabulating data from the returning questionnaires; and

f) beginning to develop a set of computer programs to allow the preparation of computer-assisted graphic displays of much of the collected data.

II. DETAILS OF WORK ACCOMPLISHED

A. Preliminary Date Identification

During the month of November the KARS Program received a request from NASA and USGS to provide a preliminary identification of optimal Landsat image dates for 1980. This preliminary analysis was to be based solely on data contained in the Economics and Statistics Service (ESS) Weekly Crop-Weather Reports for each of the eight states in the study area. Copies of the Weekly Crop-Weather Reports were sent to the KARS Program by the USGS and the analysis was completed in late December.

The dates were chosen on the basis of crop phenology as indicated by the reports and inferred spectral characteristics. Since the ESS Reports are organized by Crop Reporting District (CRD) the dates are also organized by CRD. For each CRD three sets of dates were given: the optimal set of dates, the best single date and the best additional dates. The following general assumptions were made in choosing the dates:

1) Only those crops reported by ESS were considered. Other crops of potential significance will be included in the final report of crop identification dates.
2) The most useful phenological data for remote sensing purposes are those where the crops in each developmental stage have reached 95% completion.
3) The use of harvest dates for certain crops, such as corn, sorghum, and soybeans, was considered impractical due to the great variation in harvest dates within crop reporting districts. Some of each of these crops were harvested for hay as well as grain, depending on each grower's situation.
4) Due to the wide differences in crop calendar for the various crops in the area no single date will suffice for reliable identification. Thus, two or three dates in combination should provide the most complete and reliable discrimination. Should data-processing limitations or other factors prohibit the use of the optimal combination, the best alternatives for a single date discrimination are provided.

Several states (Nebraska and Oklahoma in particular) reported crop development status for the state as a whole and not by crop reporting district. Thus,

dates given for these states were based on the statewide averages and may not account for the wide range of local variations. However, the dates were chosen so as to provide the least amount of variation due to more local climatological influences.

On December 23 a listing of just the dates was sent to the requesting agencies (see Appendix I). This was followed on January 7 by a detailed explanation of the dates, the rationale for choosing each and the possible "confusion crops" which could cause errors (see Appendix II).

B. ESS Agricultural Statistics

Utilizing several computer routines developed during the first period of this study, 1979 ESS crop data for all 230 counties in the study area was entered into a computer file. It had been anticipated that the ESS crop data for 1980 would also be put on a file, but due to widely differing availability dates for the 1980 data, most of them well beyond the completion date for the work in this study, 1980 ESS data will not be able to be used (see Appendix III).

For 1980 crop data the primary source will have to be the questionnaire-derived data received from local county ASCS and Agricultural Extension agents. Even without this source however, it appears probable that the 1979 figures would, in most counties, be very good estimates for 1980 as well. Numerous knowledgeable sources have offered the opinion that there was not much, if any, difference between the proportions of crops in most areas, 4-5% being suggested as a maximum percent of change in any crop. It appears, then, that the lack of availability of 1980 ESS crop data will not be a problem.

C. Questionnaire Revision and Mailing to ASCS Agents

During the previous reporting period (September 1 - November 30, 1980) a significant period of time had been spent in developing a survey questionnaire to be sent to county ASCS and Agricultural Extension agents. After several revisions and refinements the questionnaire was tested on two local agents. Both could see the need for the data, but they felt that most agents would not bother to complete such a form. Their estimate was that a 10-20% return would be "the best" that we could expect.

With their comments in mind a reassessment of the technique and the specific questionnaire was undertaken. It was decided that, regardless of the pessimistic forecasts of the two local agents, the questionnaire was a necessary data collection device. A final revision of the questionnaire was undertaken that eliminated several questions that it was felt were not absolutely necessary, thus reducing the overall size of the questionnaire somewhat. At the same time the format of some of the questions was changed to make them appear easier to answer and to make the overall questionnaire look less imposing yet provide us with the same information (see Appendix IV).

On Wednesday, January 14, the questionnaire was sent to the 230 ASCS county agents in the study area. The first seven responses arrived on Monday, January 19. By January 31, 105 questionnaires had been returned for a 46% return rate.

D. State Extension Approval for the Questionnaire

During our preliminary research we had been told by each state's Extension Office that in order to obtain questionnaire data from County Extension agents it would be necessary to first get the approval of the State Extension Director. On January 14 a request was sent to the Extension Director of each of the eight states. It included a copy of the questionnaire and a letter (see Appendix V) providing background and requesting their assistance. To date seven states have approved of the questionnaire and have either sent or are sending lists of their local county agents' addresses.

E. Tabulating of Questionnaire Data

As the questionnaires are returned the data are tabulated by either manual recording or entry into a computer file (for crop planting and harvesting data and acreages). Separate files have been prepared for the ASCS and the Extension data. These data along with other data already on file will be utilized to assist in identifying phenological patterns, cropping regions and irrigation patterns in the study area and to assist in making final determination of optimal dates.

F. Graphic Display Development

Work was begun on the development of a set of computer graphic routines designed to prepare displays of much of the raw and analyzed data. It is anticipated that several different types of displays will be explored and presented in the final report. Some may be manually drawn, but it is anticipated that most of the final report graphics will be prepared with computer-assistance on the University's Calcomp Plotter.

III. PROBLEMS

The only problem of significance at the present time relates to the return of the questionnaire. Due to the unanticipated length of time required to get the questionnaire into its final form, it went out later than had been initially hoped. This is especially true for the Extension Agents since we had to first get state-level approval to survey them.

Given the high rate of return that we have had so far, especially in light of the pessimistic predictions of local agents, it would appear that the extra effort that was taken to revise the survey was well worth the delay in mailing it out. Nonetheless the problem may arise that the late returns will slow the final analysis and bring it uncomfortably close to the ending date of the study.

IV. PROJECTED WORK FOR THE FINAL PERIOD

Work for the final period will consist of:

a) mailing the last of the questionnaires to county Extension Agents;
b) tabulating the rest of the returned questionnaires;
c) final analysis of phenological and crop data;
d) production of crop calendars;
e) identification of optimal dates;
f) preparation of final graphics;
g) identification of alternate data collection techniques for irrigated lands information; and
h) completion of the final report.

APPENDIX I

PRELIMINARY LANDSAT DATES FOR CROP IDENTIFICATION IN THE HIGH PLAINS FOR 1980

PRELIMINARY LANDSAT DATES FOR CROP IDENTIFICATION IN THE HIGH PLAINS FOR 1980

TEXAS

Northern High Plains Crop Reporting District:
Optimal dates: May 20, June 30, August 11
Best single date: June 30
Best additional dates: May 20 and August 11

Southern High Plains Crop Reporting District:
Optimal dates: May 20, June 30, August 11
Best single date: June 30
Best additional dates: May 20 and August 11

Northern Low Plains Crop Reporting District:
Optimal dates: May 20, June 30, August 11
Best single date: June 30
Best additional dates: May 20 and August 11

NEW MEXICO

North East Crop Reporting District:
Optimal dates: April 1, June 30
Best single date: June 30
Best additional date: April 1

South East Crop Reporting District:
Optimal dates: April 1, June 30
Best single date: June 30
Best additional date: April 1

OKLAHOMA

All Crop Reporting Districts:
Optimal dates: May 1, June 30
Best single date: June 30
Best additional date: May 1

KANSAS

South West Crop Reporting District
Optimal dates: May 5, June 30, August 15
Best single date: August 15
Best additional dates: May 5, June 30

West Central Crop Reporting District:
Optimal dates: May 5, June 30, August 25
Best single date: August 25
Best additional dates: May 5, June 30

North West Crop Reporting District:
Optimal dates: May 5, June 30, August 15
Best single date: August 15
Best additional dates: May 5, June 30

KANSAS (contd.)

North Central Crop Reporting District:
Optimal dates: May 5, June 30, August 4
Best single date: August 4
Best additional dates: May 5, June 30

Central Crop Reporting District:
Optimal dates: May 5, June 30, August 18
Best single date: August 18
Best additional dates: May 5, June 30

South Central Crop Reporting District:
Optimal dates: May 5, June 30, August 4
Best single date: August 4
Best additional dates: May 5, June 30

COLORADO

East Central Crop Reporting District:
Optimal dates: June 9, July 15, September 1
Best single date: July 15
Best additional dates: June 9, September 1

Southern Crop Reporting District:
Optimal dates: June 9, July 15, September 1
Best single date: July 15
Best additional dates: June 9, September 1

North East Reporting District:
Optimal dates: June 9, July 15, October 1
Best single date: July 15
Best additional dates: June 9, October 1

NEBRASKA

All Crop Reporting Districts:
Optimal dates: May 1, June 15, September 1
Best single date: June 15
Best additional dates: May 1, September 1

WYOMING

South-Eastern Crop Reporting District:
Optimal dates: June 15, August 1, September 1
Best single date: September 1
Best additional dates: June 15, August 1

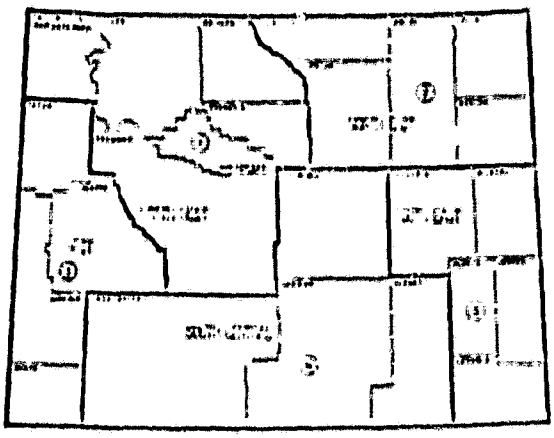
SOUTH DAKOTA

All Crop Reporting Districts:
Optimal dates: May 25, July 1, August 10
Best single date: August 10
Best additional dates: May 25, July 1

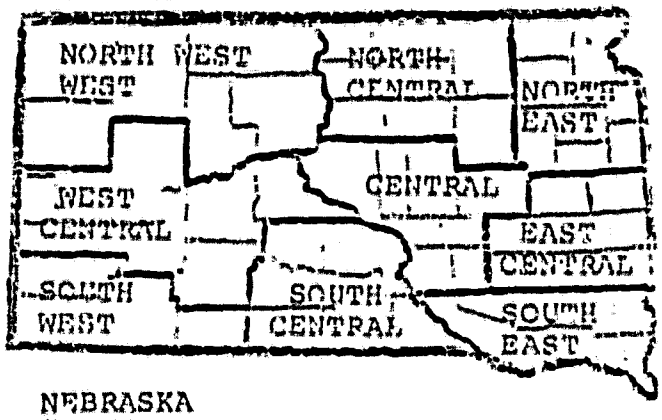
APPENDIX II

DETAILED EXPLANATION AND ANALYSIS OF PRELIMINARY LANDSAT DATES FOR 1980

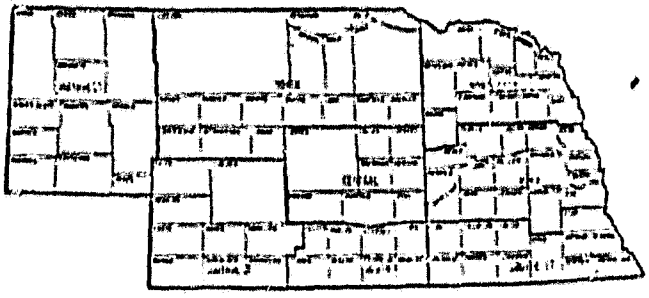
WYOMING



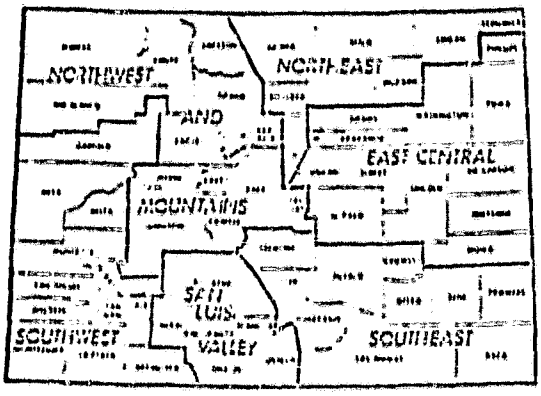
SOUTH DAKOTA



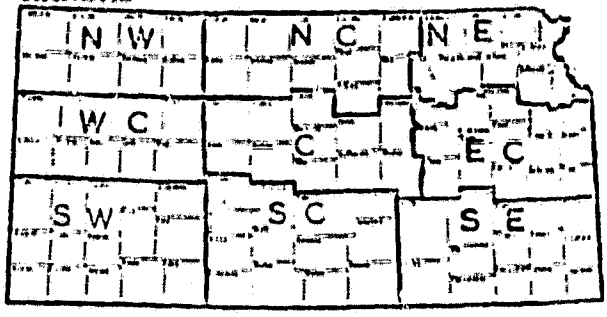
NEBRASKA



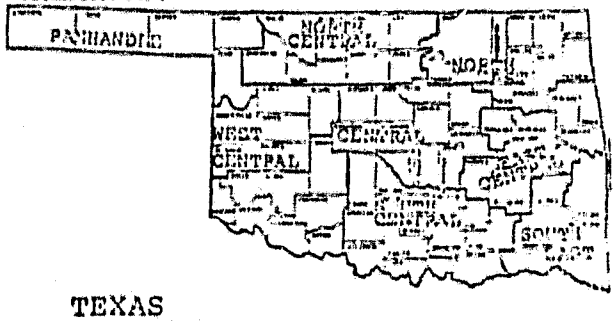
COLORADO



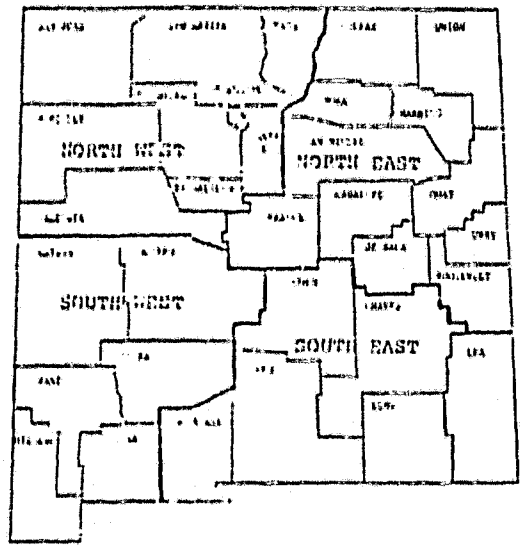
KANSAS



OKLAHOMA



NEW MEXICO



TEXAS

ANALYSIS OF OPTIMAL LANDSAT DATES

COLORADO - NORTHEAST CROP REPORTING DISTRICT

DATES FOR MAXIMUM CROP SEPARABILITY: June 9, July 15, October 1

Using the suggested dates combined, the crops should be separable into the following categories:

CATEGORY	CROPS
1	wheat, barley
2	oats
3	corn, dry beans
4	sorghum
5	sugar beets
6	potatoes
7	alfalfa

Information concerning crop separability for single dates follows.

BEST SINGLE DATE: July 15

On this date, the following categories of crop may be found:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat	stubble or bare soil
2	barley, oats	yellow
3	corn	medium green
4	sugar beets, potatoes	dark green with soil showing
5	sorghum, dry beans, alfalfa	light green

Wheat by July 15th has been harvested. This crop may be separated from other crop categories since it is the only crop which has been completely harvested, but it may be confused with fields which are fallow and weed-free from harvest in the previous year.

Barley and oats are primarily the only crops in the yellowing stage at this time; thus they may be separated from the other categories.

Corn height was reported to be an average of 18 inches tall, having a canopy well developed enough to be exhibiting a medium green color. It appears to be the only crop like this.

Sugar beets and potatoes should be exhibiting a rather dark green color, but some soil may be showing through the canopy. Since the sugar beets have been very recently thinned and potatoes have only been up for 2 weeks.

The fifth category is comprised of those crops which have recently emerged plus alfalfa, which has undergone a cutting by this date. Generally, these fields should be light green, but confusion could exist between this category and categories #3 and #4, depending on the actual planting and cutting dates.

BEST ADDITIONAL DATES:

(A) October 1

On October 1st, the crops can be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains	stubble or bare soil
2	alfalfa	medium green to light green
3	sugar beets	dark green
4	corn, potatoes, sorghum, drybeans	yellow or stubble

The small grain crops have all been harvested by this date. Although this category is separable from the other three categories, it may be confused with fallow fields which were harvested in the previous year.

Alfalfa is either exhibiting a medium green appearance, about to be cut for the third time, or a light green color, since about 66% of the crop is reported to have already been cut.

Sugar beets may or may not be separable from the second category. This crop should appear a darker green than the latter category and should have a good possibility of being isolated.

The fourth category is comprised of those crops which are either in the stage of maturity or have been harvested. Corn and sorghum intended for grain is ready for harvest, but actual harvest has been "limited." However, silage corn and forage sorghum are 75% and 47% (respectively) harvested. Dry beans have either been cut (74%), threshed (49%) or are still standing awaiting harvest. This category as a whole may be confused somewhat with the first category of small grains. However, 88% of the wheat fields had been planted by this date, thus providing a certain amount of separability since these wheat fields will appear as bare soil whereas the fields in category #4 will most likely appear as yellow or stubble. Again, the fields in category #4 which show as stubble may be confused with fallow fields that had been harvested the previous year.

(B) June 9

On this date, the crops can be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat, barley, alfalfa	green
2	oats, corn, sugar beets	bare soil to light green
3	sorghum, drybeans, potatoes	bare soil

BEST SINGLE DATE: July 5

Wheat, barley and alfalfa should be exhibting a medium green color with well developed canopies. These crops appear to be the only ones in this condition. Some confusion may occur between this category and surrounding lush pastures.

Oats, corn and sugar beets represent the category of crops which is in transition between planting and emergence. Ninety-seven percent of the corn was reported as planted, but 88% was reported to have already emerged. Oats were simply reported as 95% planted, but some amount of emergence should be assumed. Sugar beets were reported to have all been planted, but the following was also stated: "... the plants are in good condition. Thinning activities are rapidly increasing." It is therefore assumed that some amount of sugar beets have emerged. Thus this category could be seen as bare ground or light green.

Sorghum, dry beans and potatoes have very recently been planted with some of the acreage emerged (43%, 25% and 90%, respectively). Confusion between this category and category #2 is likely.

COLORADO - EAST CENTRAL CROP REPORTING DISTRICT

DATES FOR MAXIMUM CROP SEPARABILITY: June 9, July 15, September 1

Using the combined dates suggested, it should be possible to separate the crops into the following categories:

CATEGORY	CROPS
1	wheat
2	barley
3	oats
4	corn
5	sorghum
6	dry beans
7	sugar beets
8	alfalfa

These dates combined have the possibility of complete separability, but in the explanation of the information provided for each date, it will be seen that the possibility also exists for some confusion between these crops. The explanation follows:

BEST SINGLE DATE: July 15

On this date, the following categories of crops may be found:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat	stubble or bare soil
2	barley, oats	yellow
3	corn	medium green

CATEGORY	CROPS	APPEARANCE ON GROUND
4	sugar beets	dark green with soil showing
5	sorghum, dry beans, alfalfa	light green

Wheat by July 15th has been harvested. This crop may be separated from other crop categories since it is the only crop which has been completely harvested, but it may be confused with fields which are fallow and weed-free from harvest in the previous year.

Barley and oats are primarily the only crops in the yellowing stage at this time; thus they may be separated from the other categories.

Corn height was reported to be an average of 18 inches tall, having a canopy well developed enough to be exhibiting a medium green color. It appears to be the only crop like this.

Sugar beets should be exhibiting a rather dark green color, but some soil may be showing through the canopy since this crop has been very recently thinned.

The fifth category is comprised of those crops which have recently emerged plus alfalfa, which has undergone a cutting by this date. Generally, these fields should be light green, but confusion could exist between this category and categories #3 and #4, depending on the actual planting and cutting dates.

BEST ADDITIONAL DATES:

(A) September 1

On September 1st, the crops can be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains	stubble or bare soil
2	corn, sorghum, alfalfa, dry beans	green
3	sugar beets	dark green

The small grain crops have all been harvested on this date. This category is separable from the other two categories, but may be confused with fallow, weed-free fields which were harvested in the previous year.

The second category is made up of those crops which exhibit a medium value green.

Sugar beets may or may not be separable from the second category. This crop should appear a darker green than the latter category and thus has a good possibility of being isolated.

(B) June 9

On June 9th, the crops can be divided into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat, barley, alfalfa	green
2	oats, corn, sugar beets	bare soil to light green
3	sorghum, dry beans	bare soil

Wheat, barley and alfalfa should be exhibiting a medium green color with well developed canopies. These crops appear to be the only ones in this condition. Some confusion may occur between this category and surrounding lush pastures.

Oats, corn and sugar beets represent the category of crops which is in transition between planting and emergence. Ninety-seven percent of the corn was reported as planted, but 88% was reported to have already emerged. Oats were simply reported as 95% planted, but some amount of emergence should be assumed. Sugar beets were reported to have all been planted, but the following was also stated: "... the plants are in good condition. Thinning activities are rapidly increasing." It is therefore assumed that some amount of sugar beets have emerged. Thus this category could be seen as bare ground or light green.

Sorghum and dry beans have very recently been planted with only a small amount of the acreage emerged (43% and 25%, respectively). Confusion between this category and category #2 is likely.

COLORADO - SOUTHERN CROP REPORTING DISTRICT

DATES FOR MAXIMUM CROP SEPARABILITY: June 9, July 15, September 1

Using the combined dates suggested, it should be possible to separate the crops into the following categories:

CATEGORY	CROPS
1	wheat
2	barley
3	oats
4	corn
5	sorghum
6	dry beans
7	sugar beets
8	alfalfa

These dates combined have the possibility of complete separability, but in the explanation of the information provided for each date, it will be seen that the possibility also exists for some confusion between these crops. The explanation follows:

BEST SINGLE DATE: July 15

On this date, the following categories of crops may be found:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat	stubble or bare soil
2	barley, oats	yellow
3	corn	medium green
4	sugar beets	dark green with soil showing
5	sorghum, dry beans, alfalfa	light green

Wheat by July 15th has been harvested. This crop may be separated from other crop categories since it is the only crop which has been completely harvested, but it may be confused with fields which are fallow and weed-free from harvest in the previous year.

Barley and oats are primarily the only crops in the yellowing stage at this time; thus they may be separated from the other categories.

Corn height was reported to be an average of 18 inches tall, having a canopy well developed enough to be exhibiting a medium green color. It appears to be the only crop like this.

Sugar beets should be exhibiting a rather dark green color, but some soil may be showing through the canopy since this crop has been very recently thinned.

The fifth category is comprised of those crops which have recently emerged plus alfalfa, which has undergone a cutting by this date. Generally, these fields should be light green, but confusion could exist between this category and categories #3 and #4, depending on the actual planting and cutting dates.

BEST ADDITIONAL DATES:

(A) September 1

On September 1st, the crops can be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains	stubble or bare soil
2	corn, sorghum, alfalfa, dry beans	green
3	sugar beets	dark green

The small grain crops have all been harvested on this date. This category is separable from the other two categories, but may be confused with fallow, weed-free fields which were harvested in the previous year.

The second category is made up of those crops which exhibit a medium value green.

Sugar beets may or may not be separable from the second category. This crop should appear a darker green than the latter category and thus has a good possibility of being isolated.

(B) June 9

On June 9th, the crops can be divided into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat, barley, alfalfa	green
2	oats, corn, sugar beets	bare soil to light green
3	sorghum, dry beans	bare soil

Wheat, barley and alfalfa should be exhibiting a medium green color with well developed canopies. These crops appear to be the only ones in this condition. Some confusion may occur between this category and surrounding lush pastures.

Oats, corn and sugar beets represent the category of crops which is in transition between planting and emergence. Ninety-seven percent of the corn was reported as planted, but 88% was reported to have already emerged. Oats were simply reported as 95% planted, but some amount of emergence should be assumed. Sugar beets were reported to have all been planted, but the following was also stated: "... the plants are in good condition. Thinning activities are rapidly increasing." It is therefore assumed that some amount of sugar beets have emerged. Thus this category could be seen as bare ground or light green.

Sorghum and dry beans have very recently been planted with only a small amount of the acreage emerged (43% and 25%, respective). Confusion between this category and category #2 is likely.

KANSAS - NORTH CENTRAL AND SOUTH CENTRAL CROP REPORTING DISTRICTS

DATES FOR MAXIMUM SEPARABILITY: May 5, June 30, August 4

Using the combined dates suggested it may be possible to separate the crops into the following categories:

CATEGORY	CROPS
1	oats, barley
2	wheat
3	corn
4	soybeans
5	sorghum
6	alfalfa

Information regarding the maximum separability of crops for each date follows:

BEST SINGLE DATE: August 4

On this date, the following crop categories may be identified:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, wheat	stubble or bare soil
2	alfalfa	light green
3	soybeans	dark green
4	sorghum, corn	medium green

All small grains have been harvested by this date, thus these fields should appear as stubble or bare soil. Some confusion may occur between this category and fallow, weed-free fields that had been harvested in the previous year.

Alfalfa fields generally should appear a relatively light green since 40% has been cut for the third time and some of the other fields are reported to have undergone slow regrowth due to drought. However, irrigated, uncut alfalfa fields may appear a more medium green color and thus be confused with sorghum.

Soybeans may or may not be separable from category #4. This crop should appear a darker green than corn and sorghum however, so there is a possibility that the two categories are separable.

Corn and sorghum may appear the same medium green. However, since corn is mostly in the tassel stage, it may appear more of a yellowish-green than sorghum; this will depend on the uniformity of the tassel stage throughout the crop reporting districts. It is unlikely that the tassel stage is very uniform.

BEST ADDITIONAL DATES:

(A) June 30:

On this date the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, corn	medium green
2	wheat	yellow
3	alfalfa	light green
4	soybeans, sorghum	stubble or bare soil

The crops in this first category are all likely to be green on this date. It is possible that some oat and barley fields may have turned yellow and hence be confused with wheat fields.

Wheat is yellow on this date with a small percentage harvested - 10% in the North Central CRD and 25% in the South Central CRD. These harvested fields may

be confused with either or both category #4 and fallow, weed-free fields harvested in the previous year.

Alfalfa fields have either just been cut or are beginning to regrow from a fairly recent cutting, thus these fields should be showing a light green color.

Sorghum and soybeans have yet to be planted or have just been planted. Hence, most of the fields should appear as bare soil, though some may still be in stubble. Fields of stubble may be confused with harvested wheat fields and/or fallow, weed-free fields harvested in the previous year.

(B) May 5:

On this date the crops may be separated as follows:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat, alfalfa	green
2	oats, barley, corn, soybeans, sorghum	stubble or bare soil

Wheat and alfalfa are reported to be the only crops that are green on this date. Since wheat is still in the early stages of development, with about 60% of the acreage reported (statewide) to be in or past jointing, bare soil can probably be seen in these fields. Alfalfa, however, probably is about the same color green but with less soil showing.

All other crops have either just been planted or have yet to be planted and, hence, should be separable from the first category.

KANSAS - NORTHWEST, SOUTHWEST AND CENTRAL CROP REPORTING DISTRICTS

DATES FOR MAXIMUM SEPARABILITY: May 5, June 30, August 15

Using the combined dates suggested it may be possible to separate the crops into the following categories:

CATEGORY	CROPS
1	oats, barley
2	wheat
3	corn
4	soybeans
5	sorghum
6	alfalfa

Information regarding the maximum separability of crops for each date follows.

BEST SINGLE DATE: August 15

On this date, the following crop categories may be identified:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, wheat	stubble or bare soil
2	alfalfa	light green
3	soybeans	dark green
4	sorghum, corn	medium green

All small grains have been harvested by this date; thus these fields should appear as stubble or bare soil. Some confusion may occur between this category and fallow, weed-free fields that had been harvested in the previous year.

Alfalfa fields generally should appear a relatively light green since 45% in the Northwest CRD and 70% in the Southwest CRD has been cut for the third time and some of the other fields are reported to have undergone slow regrowth due to drought. However, irrigated, uncut alfalfa fields may appear a more medium green color and thus be confused with sorghum.

Soybeans may or may not be separable from category #4. This crop should appear a darker green than corn and sorghum however, so there is a possibility that the two categories are separable.

Corn and sorghum may appear the same medium green. However, since corn is mostly in the tassel stage, it may appear more of a yellowish-green than sorghum; this will depend on the uniformity of the tassel stage throughout the crop reporting districts. It is unlikely that the tassel stage is very uniform.

BEST ADDITIONAL DATES:

(A) June 30:

On this date the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, corn	medium green
2	wheat	yellow
3	alfalfa	light green
4	soybeans, sorghum	stubble or bare soil

The crops in this first category are all likely to be green on this date. It is possible that some oat and barley fields may have turned yellow and hence be confused with wheat fields.

Wheat is yellow on this date with a small percentage harvested - 2% in the Northwest CRD and 10% in the Southwest CRD. These harvested fields may be confused with either or both category #4 and fallow, weed-free fields harvested in the previous year.

Alfalfa fields have either just been cut or are beginning to regrow from a fairly recent cutting, thus these fields should be showing a light green color.

Sorghum and soybeans have yet to be planted or have just been planted. Hence, most of the fields should appear as bare soil, though some may still be in stubble. Fields of stubble may be confused with harvested wheat fields and/or fallow, weed-free fields harvested the previous year.

(B) May 5:

On this date the crops may be separated as follows:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat, alfalfa	green
2	oats, barley, corn soybeans, sorghum	stubble or bare soil

Wheat and alfalfa are reported to be the only crops that are green on this date. Since wheat is still in the early stages of development, with about 60% of the acreage reported (statewide) to be in or past jointing, bare soil can probably be seen in these fields. Alfalfa, however, probably is about the same color green but with less soil showing.

All other crops have either just been planted or have yet to be planted and, hence, should be separable from the first category.

KANSAS - WEST CENTRAL CROP REPORTING DISTRICT

DATES FOR MAXIMUM SEPARABILITY: May 5, June 30, August 25

Using the combined dates suggested it may be possible to separate the crops into the following categories:

CATEGORY	CROPS
1	oats, barley
2	wheat
3	corn
4	soybeans
5	sorghum
6	alfalfa

Information regarding the maximum separability of crops for each date follows.

BEST SINGLE DATE: August 25

On this date, the following crop categories may be identified.

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, wheat	stubble or bare soil

CATEGORY	CROPS	APPEARANCE ON GROUND
2	alfalfa	light green
3	soybeans	dark green
4	sorghum, corn	medium green

All small grains have been harvested by this date, thus these fields should appear as stubble or bare soil. Some confusion may occur between this category and fallow, weed-free fields that had been harvested in the previous year.

Alfalfa fields generally should appear a relatively light green since it has been cut for the third time.

Soybeans may or may not be separable from category #4. This crop should appear a darker green than corn and sorghum however, so there is a possibility that the two categories are separable.

Corn and sorghum may appear the same medium green. However, since corn is mostly in the tassel stage, it may appear more of a yellowish-green than sorghum; this will depend on the uniformity of the tassel stage throughout the crop reporting districts. It is unlikely that the tassel stage is very uniform.

BEST ADDITIONAL DATES:

(A) June 30:

On this date the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, corn	medium green
2	wheat	yellow
3	alfalfa	light green
4	soybeans, sorghum	stubble or bare soil

The crops in this first category are all likely to be green on this date. It is possible that some oat and barley fields may have turned yellow and hence be confused with wheat fields.

Wheat is yellow on this date with 2% harvested. These harvested fields may be confused with either or both category #4 and fallow, weed-free fields harvested in the previous year.

Alfalfa fields have either just been cut or are beginning to regrow from a fairly recent cutting, thus these fields should be showing a light green color.

Sorghum and soybeans have yet to be planted or have just been planted. Hence, most of the fields should appear as bare soil, though some may still be in stubble. Fields of stubble may be confused with harvested wheat fields and/or fallow, weed-free fields harvested the previous year.

(B) May 5:

On this date the crops may be separated as follows:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat, alfalfa	green
2	oats, barley, corn soybeans, sorghum	stubble or bare soil

Wheat and alfalfa are reported to be the only crops that are green on this date. Since wheat is still in the early stages of development, with about 60% of the acreage reported (statewide) to be in or past jointing, bare soil can probably be seen in these fields. Alfalfa, however, probably is about the same color green but with less soil showing.

All other crops have either just been planted or have yet to be planted and, hence, should be separable from the first category.

NEBRASKA - ALL CROP REPORTING DISTRICTS

The Nebraska ESS Office reported crop development status for the state as a whole and not by crop reporting district. Thus the optimal dates suggested here were based on the statewide averages and may not account for the wide range of local variations. These dates were chosen in order to provide the least amount of variation due to more local climatological influences on crop phenology.

DATES FOR MAXIMUM CROP SEPARABILITY: May 1, June 15, September 1

Using the combination of the 3 dates suggested it might be possible to identify the eight reported crops. These are:

CATEGORY	CROPS
1	wheat
2	oats
3	sugar beets
4	corn
5	sorghum
6	soybeans
7	dry beans
8	alfalfa

Information concerning the maximum separability for each date follows:

BEST SINGLE DATE: June 15

On this date the crops may be seperable into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains, alfalfa	medium green
2	sugar beets	dark green
3	corn	light green
4	sorghum, soybeans	very light green, mostly soil
5	dry beans	bare soil

The categories indicated above are separable only to a certain degree, since overlap between categories on this date is frequent. Hence, it is strongly suggested in this particular instance that additional dates be used for more reliable crop identification.

The wheat crop is reported to be mostly at or past the heading stage; hence it is primarily exhibiting a medium green color. However, a small percentage, 20%, is also reported as having reached the yellowing stage. The alfalfa is either a medium green color or a light green to yellowish-green color, with 75% of the first cutting complete.

Sugar beets may or may not be separable from the first category. This crop should be a darker green color, but at this early date, the leaves may still be a bit lighter than in later stages. Furthermore, since thinning has recently been initiated, some confusion may occur with category #4 since a considerable amount of bare soil should be evident.

The corn crop is up and beyond the emergent stage but should still be exhibiting a light green color rather than the medium green color of later stages.

Sorghum and soybeans are reported to be mostly emergent. However, some confusion will probably occur between this category and categories #2 which may look like an emergent crop and #4 since, as for corn, some fields may have grown beyond the emergent stage.

Dry beans have recently all been planted. Most of the fields should show as bare soil, but it is suspected that confusion may occur between this category and categories #2 and #4 since some of the beans have probably already emerged.

BEST ADDITIONAL DATES:

(A) September 1

On this date the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains	stubble or bare soil
2	sugar beets, soybeans, dry beans	dark green
3	alfalfa	medium green
4	corn, sorghum	yellow

All small grain crops have been harvested. Some fields will show as stubble and some as bare soil, having been plowed under and some planted to winter wheat. Some confusion may occur between the fields of stubble in this category and drought-damage corn cut for silage as well as fallow fields harvested in the previous year.

The crops in the second category should all be exhibiting a dark green color. Some confusion may occur between the 25% of the soybeans that have turned yellow and yellow dry beans and category #4 which is also mostly in the yellow stage.

Corn and sorghum are mostly in the yellow stage with some fields still showing green and others having already been harvested. Thus, overlap between this category and categories #1 and #3 may be evident.

(B) May 1

On this date the following categories of crops may be identified:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	wheat	green
2	alfalfa	light green
3	oats, sugar beets, corn, sorghum, soy ans, dry beans	stubble or bare ground

Wheat should be the only crop showing a green color on this date.

Alfalfa should be a lighter green than wheat, but it may not be. Wheat and alfalfa may or may not be distingulshable on this date.

All other crops have either just been planted or have yet to be planted; hence the fields of the third category should be either stubble or bare soil.

NEW MEXICO - ALL CROP REPORTING DISTRICTS

Analysis of both the crop reporting districts in the New Mexico portion of the study area resulted in the same set of dates. Therefore, both districts will be considered here together. It should be noted, however, that chiles are reported to be grown only in the South East crop reporting district and not in the North East district.

DATES FOR MAXIMUM CROP SEPARABILITY: April 1, June 30

Using the combined suggested dates, it should be possible to separate the crops into the following categories:

CATEGORY	CROPS
1	cotton, corn
2	small grains
3	sorghum
4	chile
5	alfalfa

The crop separability categories for each date follows.

BEST SINGLE DATE: June 30

On June 30th, the crops should be separable into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains	yellow
2	cotton, corn	light green
3	sorghum	very light green
4	chile	dark green
5	alfalfa	green

The small grain crops have generally turned yellow by June 30th and thus should be separable from the other categories. Furthermore, about 85% of the small grain harvest is complete. Fields in this first category may be confused with fallow, weed-free fields which were harvested during the previous year.

Cotton and corn are rated in "fair to good condition" on this date, with emergence for both crops reported to have been completed the 15th of June. Thus these crops have probably moved to a canopy somewhat fuller than that of emergence, particularly in those fields which were irrigated.

Sorghum, having planting completed on the 22nd of June may or may not be separable from category #2. Earlier planted fields may have developed the same amount of canopy as corn and cotton, with later planted fields still germinating or in the emergence stage.

Chiles should be a darker green than the crops in category #2, but probably have about the same amount of canopy development.

Alfalfa should be the only crop which is exhibiting a medium green color on this date. It may be confused with a small amount of corn and cotton fields and possibly chiles; however, less soil should be seen through the alfalfa canopy than

for other categories. The major confusion crop with the alfalfa category will probably be surrounding pastures predominated by warm-season grasses.

BEST ADDITIONAL DATE: April 1

The following crop categories should be evident on April 1st imagery:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains, alfalfa	green
2	corn, cotton, sorghum, chile	stubble or bare soil

Small grain crops and alfalfa should be green on this date and, thus, separable from the crops in the second category which have yet to be planted. Some confusion may occur between this first category and surrounding pastures predominated by cool-season grasses.

The crops in category #2 may be confused with fallow, weed-free fields which were harvested in the previous year.

OKLAHOMA - ALL CROP REPORTING DISTRICTS

DATES FOR MAXIMUM SEPARABILITY: May 1, June 30

Two dates are probably sufficient for providing the maximum separability of the mixture of crops reported to be grown in the Oklahoma portion of the study area. Using these two dates it should be possible to identify four crop categories. These are:

CATEGORY	CROPS
1	all small grains
2	corn
3	sorghum
4	alfalfa

An analysis follows which describes the maximum separability which may be derived from each date when used individually.

BEST SINGLE DATE: June 30

On this date, the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	all small grains	stubble or bare ground
2	corn	green
3	sorghum	bare soil
4	alfalfa	light green

All small grain crops on this date have been completely harvested except wheat, which has been 85% harvested. Fields of wheat, therefore, should appear as either stubble, bare soil or yellow, where the wheat is still standing. Fallow, weed-free fields from the previous year's small grain crops may cause confusion between land that was recently harvested and harvested in 1979.

Corn fields should appear green, with 100% emergence having occurred June 23rd and 15% in tassel by June 30th.

Some confusion may exist between early planted sorghum and corn and alfalfa since 75% of the sorghum crop had emerged; however, it is hard to say how much confusion will actually occur, since statewide planting of this crop only reached 95% completion on June 30th. Thus, sorghum fields appear to range from bare soil to light green to medium green.

Alfalfa is the only crop which should uniformly appear light green, with 95% of the fields having been cut by June 23 and 65% of the fields having gone through a second cutting by June 30th. Some confusion may occur between alfalfa fields, which were cut early for the first cutting but late for the second cutting, and corn. Both the corn and the alfalfa fields described are probably about the same green value.

BEST ADDITIONAL DATE: May 1

On this date, the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	all small grains, alfalfa	green
2	corn, sorghum	stubble or bare soil

Small grain crops and alfalfa are the only reported crops that are growing beyond emergence and therefore green at this time; thus, this group of crops should be distinguishable from the second category of crops, which have yet to be planted. This first category may be confused somewhat with surrounding cool-season grass pastures.

The corn crop by this date was only 25% planted with 10% emerged and no sorghum was reported to have emerged. Thus, the majority of fields used for these

crops are either bare soil or stubble and should be separable from the crops in the first category. However, fallow, weed-free fields may be confused with this category.

SOUTH DAKOTA - ALL CROP REPORTING DISTRICTS

DATES FOR MAXIMUM CROP SEPARABILITY: May 25, July 1, August 10

Using the combination of the three dates suggested it should be possible to identify seven different crop categories based on development patterns which appear to be unique. These are:

CATEGORY	CROPS
1	oats, barley, spring wheat
2	winter wheat, rye
3	sorghum, sunflowers
4	corn
5	flax
6	soybeans
7	alfalfa

Information concerning the maximum separability for each date follows.

BEST SINGLE DATE: August 10, 1980

On this date, the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	all small grains except flax	stubble or bare soil
2	corn	yellow-green
3	sorghum, sunflowers, flax	green
4	soybeans	dark green
5	alfalfa	light green

Small grains except flax may not be distinguishable from one another since they are all harvested at this time. However, these small grains should be separable at this time from all other crops.

Some corn fields may be distinguished from all other crops since tasseling is occurring. However, since the tassel period of individual plants is at its height for only 3 days and is reported to have occurred over four weeks for the area, the ability of corn separability at this time is questionable.

Sorghum, sunflowers and flax may not be separated from one another since they are all green at this time, but they may be distinguished from other crops, with the exception of some corn.

Soybeans should appear a darker green than all other crops at this time.

Alfalfa, having just been cut, should appear light green and thus is separable from all other crops.

BEST ADDITIONAL DATES:

(A) July 1, 1980

On this date, the following crops can be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, spring wheat, corn, flax	green
2	winter wheat, rye	yellow
3	soybeans, alfalfa	light green
4	sorghum, sunflowers	bare ground

Here, the small grain crops may have some separability. Oats, barley, spring wheat and flax are green, whereas winter wheat and rye are in the yellowing stage; however, corn is possibly a confusion crop because it is also green at this time.

Soybeans and alfalfa can be separated from all other crops but they probably are not distinguished from each other. Soybeans have been up for 1 week and most alfalfa has been cut; hence both of these crops may appear light green depending on the germination and vigor of the soybean crop.

Sorghum and sunflowers should be separable from all other crops since they are the only crops which have been recently planted; hence, the fields are primarily bare soil. However, they may not be distinguished from one another. Furthermore, since planting of sorghum and sunflowers occurred over a period of six weeks, some of each of these crops may have emerged. This presents the possibility of confusion between soybeans and alfalfa.

(B) May 25, 1980

On this date, the following crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, spring wheat	light green
2	winter wheat, rye, alfalfa	green
3	corn, sorghum, flax, sunflowers, soybeans	bare ground or stubble

Spring-planted small grains may be separated from all other crops since these crops are the only ones which have recently emerged; however they may not be separated from one another.

Winter wheat, rye and alfalfa may be distinguished from all other crops at this time since they are the only crops that are green. However, they may not be separated from one another and may be confused with surrounding pasture.

Fields which will be used for corn, sorghum, flax, sunflowers and soybeans are all either stubble or bare ground. Thus these crops are separable from small grains, but not from each other; furthermore, these fields may be confused with those fields which will remain fallow throughout the growing season.

TEXAS- ALL CROP REPORTING DISTRICTS

Although the phenology for crops in Texas was broken down into separate crop reporting districts, analysis of all the crop reporting districts in the Texas portion of the study area resulted in the same set of dates. Therefore, all of the crop reporting districts will be considered together here. It should be noted, however, that potatoes are reported to be grown only in the Northern and Southern High Plains crop reporting districts and not in the Northern Low Plains district.

DATES FOR MAXIMUM CROP SEPARABILITY: May 20, June 30, August 11

Using these combined dates it should be possible to separate the crops reported to have been grown in this area into the following categories:

CATEGORY	CROPS
1	oats, barley, flax
2	wheat
3	corn, sorghum
4	soybeans, peanuts
5	cotton
6	potatoes
7	sugar beets
8	all hay

An explanation of crop separability for each date of image acquisition follows.

BEST SINGLE DATE: June 30

The crops should be separable into the following categories on this date:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	oats, barley, soybeans flax, peanuts	stubble or bare soil
2	wheat	yellow
3	corn, hay	green
4	sorghum, sunflowers	light green
5	potatoes, sugar beets	dark green

The first category of crops comprises those crops which have been harvested with the exception of soybeans which have been recently planted. This group of crops should be separable from all of the other categories, but may be confused with fallow, weed-free fields that were harvested during the previous year.

All of the wheat fields were reported to have turned color by June 30th, but since 73% of the wheat fields were also reported to have been harvested. Thus, this category is more of a sub-category of the first category in that unharvested yellow fields may be clearly identified as wheat, but harvested fields will be confused with the crops in category #1.

Corn and hay are those crops which were green on this date. Some confusion may occur between this category and surrounding pastures.

Sorghum and sunflower plantings were virtually completed by this date. These fields could range from bare soil to light green on the High Plains. Thus, some confusion may occur between this category and category #1 if fields in the latter category have already been plowed.

Potatoes and sugar beets should be a rather dark green at this time and thus distinguishable from category #3 as well as the other categories.

BEST ADDITIONAL DATE:

(A) August 11

On this date, the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	small grains, potatoes	stubble or bare soil
2	corn, hay, sorghum	yellow with some green
3	soybeans, sugar beets	dark green
4	cotton, sunflowers, peanuts	medium green

Small grains and potatoes have been harvested by August 11th. These crops should be separable from all other crop categories on this date. However, these fields may be confused with fallow, weed-free fields which were harvested in the previous year.

The second category represents those crops which have turned yellow completely or partially (due to drought). The fields could appear anywhere from medium green to light green to yellow, depending on each grower's situation (i.e., crop variety, irrigation practice and/or local climatological conditions). Thus, this category is made up of crops which are not only confused between one another but also between category #4 and possibly even category #1 if any of the crops had been harvested for hay or silage or plowed into the ground.

Category #3 consists of those crops which generally are a darker green color relative to crops in the other categories and were reported to have withstood the stress of high temperatures and drying winds.

The fourth category comprises those crops which were reported to have withstood the stress of drought and are generally a medium green at this time of year in this area.

(B) May 20

The following three crop categories can be identified on this date:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	all small grains, hay	green
2	sugar beets, potatoes	light green
3	corn, soybeans, sorghum, cotton, sunflowers, peanuts	stubble or bare soil

All small grain crops should be exhibiting a medium green color since their canopies may be approximated at near the heading stage and, therefore, well developed.

Sugar beets and potatoes are still close to the emergence stage and should therefore appear a light green.

The crops in the third category are those crops which have yet to be planted or have been planted recently and have for the most part not yet emerged. These crops should be separable from the other two categories, but may be confused with fallow, weed-free fields which were harvested in the previous year.

WYOMING - ALL CROP REPORTING DISTRICTS

DATES FOR MAXIMUM CROP SEPARABILITY: June 15, August 1, September 1

Using the combined 3 dates suggested it should be possible to identify eight different crop categories based on developmental patterns which appear to be unique. These are:

CATEGORY	CROPS
1	sugar beets
2	winter wheat
3	barley, spring wheat, oats
4	corn
5	dry beans
6	alfalfa
7	other hay
8	potatoes

Information concerning the maximum separability for each date follows.

BEST SINGLE DATE: September 1, 1980

On this date, the crops may be separated into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	winter wheat	stubble or bare soil
2	spring wheat, barley, oats, dry beans	yellow
3	hay other than alfalfa	light green
4	corn, alfalfa	green
5	sugar beets, potatoes	dark green

Winter wheat should be distinguishable from all other crops since it is the only crop which has been completely harvested on this date. However, there may be confusion between the recently harvested wheat and the previous year's wheat fields if the 1979 fields have been kept fallow and weed-free.

Spring wheat, barley, oats and dry beans are all yellow at this this time. These crops may not be separated from each other, but may be separated from the other four crop categories to a degree. The separability of dry beans is most likely the highest. However, although maturity of the small grain crop in category #2 was reported to have reached completion on this date, 75% of the spring wheat, 62% of the oats and 80% of the barley was reported to have been harvested. Thus a certain amount of confusion may exist between the harvested spring planted small grains and the harvested winter wheat fields.

Hay, other than alfalfa, should be distinguishable from all other crops at this time since it is light green from a recent cutting and no other crops are either at this stage or any other corresponding light green stage (such as emergence).

Corn and alfalfa should be the only crops at this time exhibiting a medium green color and, thus, may be separable from other categories, though not separable from each other.

Sugar beets and potatoes both should be a rather dark green at this time. However, it is possible that some potato fields may be yellow or defoliated on this date, since potato digging began the next week. Harvest of potatoes extended through October 15th, so it is hard to say without supporting data exactly how the potato fields appeared.

BEST ADDITIONAL DATES:

(A) August 1, 1980

On this date, the crops may be grouped into the following categories:

CATEGORY	CROPS	APPEARANCE ON GROUND
1	spring wheat, corn, dry beans, other hay	green
2	winter wheat	yellow
3	alfalfa	light green
4	sugar beets, potatoes	dark green
*	barley, oats	yellow to green

Since spring wheat, corn, dry beans and other hay are all a medium green on this date, category #1 represents a rather large category of inseparable crops. However, this category should be separable from categories #2, #3 and #4.

Winter wheat at this time has turned to yellow and should be separable from most of the other crops.

Alfalfa, having just been cut, should appear as the only light green crop and hence be identified in its own category.

Sugar beets and potatoes should both be appearing a dark green at this time and thus should be separable from other categories, though not from each other.

Barley and oats at this time are in transition between green, light green and yellow. Thus some barley and oat fields may be confused with categories #1, #2 and #3.

(B) June 15

CATEGORY	CROPS	APPEARANCE ON GROUND
1	sugar beets, oats	light green
2	winter wheat, barley, spring wheat, all hay	green
3	corn, potatoes, dry beans	bare soil

This date represents the least optimal of all the chosen dates, but is useful for separating some crops which may be confused on other dates.

The first category of sugar beets and oats represents the group of recently planted crops that have emerged.

The second category represents those crops which are beyond the emergence stage but are not yet at the part of the reproductive stage where yellowing occurs.

The third category comprises the crops which have recently been planted but have probably not yet emerged.

APPENDIX III

SUMMARY OF AVAILABILITY OF ESS CROP DATA FOR 1980

AVAILABILITY OF ESS CROP DATA FOR 1980

Colorado	--	No preliminary estimates are made.
	--	Final crop data unavailable until July (opinion was offered that although total production may have been down in 1980, the proportions of various crops was similar to 1979).
Kansas	--	Preliminary estimates are available and have been obtained.
	--	Final data for wheat, available in February; corn, sorghum and soybeans, available in March.
Nebraska	--	Preliminary estimates available on Crop Reporting District level only -- have been obtained.
	--	No final data available until July 1981.
New Mexico	--	No preliminary crop estimates are made.
	--	Final data will be sent in late February as it becomes available on a crop-by-crop basis.
Oklahoma	--	Preliminary 1980 county estimates have been received.
	--	No final data available until July 1981.
South Dakota	--	No preliminary estimates are made.
	--	Final data not available until end of March.
Texas	--	Preliminary 1980 estimates by CRD have been received.
	--	No final data available until July 1981.
Wyoming	--	No preliminary county or CRD estimates are made.
	--	Final data will not be available until early March.

APPENDIX IV

FINAL VERSION OF THE QUESTIONNAIRE

HIGH PLAINS CROP STUDY QUESTIONNAIRE

The following information should be filled in by the person actually answering the questions asked in this form.

DATE: _____ # YEARS LIVED IN COUNTY: _____

NAME: _____

TITLE: _____

EMPLOYER: _____

BUSINESS ADDRESS: _____
Street or Box Number

_____
County

_____ _____
City State Zip Business Phone Number

In our study we are concerned with all crops grown in the 230 county High Plains region that (a) total at least 1000 acres in any county, or (b) may total less than 1000 acres in a county, but are found in fields of 160 acres or larger. The list below contains the crops that we have identified as being of concern in the region. In answering the following questions, please be sure to consider all of the crops on this list that are found in your county. If there are any other crops in your county that total 1000 acres, please list them as well.

ALFALFA
BARLEY, spring
BARLEY, winter
CHILES
CORN
COTTON
FIELD BEANS
FLAX
GUAR
HAY (other than alfalfa)
LESPEDEZA SEED
OATS
PEANUTS
PECANS
POTATOES
RED CLOVER SEED
RYE
SORGHUM
SOYBEANS
SUGAR BEETS
SUNFLOWERS
TALL FESCUE SEED
WHEAT, spring
WHEAT, winter

1. Please list any crops grown in your county that (a) total more than 1000 acres, or (b) may total less than 1000 acres, but occur in fields of at least 160 acres in size.

2. Please fill in the following information for the same crops that you listed in Question 1.

		1979		1980		1979		1980	
	CROP	DRYLAND ACREAGE	IRRIGATED ACREAGE	DRYLAND ACREAGE	IRRIGATED ACREAGE	PLANTING PERIOD	HARVESTING PERIOD	PLANTING PERIOD	HARVESTING PERIOD
EXAMPLE:	*Sugar cane*	*1500*	*2700*	*1700*	*3100*	*April 10-18*	*Oct 28 - Nov 10*	*Nov 3 - 12*	*Oct 20 - Nov 8*

3. If alfalfa and/or other hay is grown in your county, please indicate the approximate time periods of each cutting.

1979

CROP	1st CUTTING	2nd CUTTING	3rd CUTTING	4th CUTTING	5th CUTTING
DRYLAND ALFALFA					
IRRIGATED ALFALFA					
DRYLAND OTHER HAY					
IRRIGATED OTHER HAY					

1980

CROP	1st CUTTING	2nd CUTTING	3rd CUTTING	4th CUTTING	5th CUTTING
DRYLAND ALFALFA					
IRRIGATED ALFALFA					
DRYLAND OTHER HAY					
IRRIGATED OTHER HAY					

4. What % of the cropland in your county was multiple cropped in 1979? _____

Did 1980 differ and if so, how did it differ? _____

_____

In the table below please indicate the major crop sequences that occur during the growing season on multiple cropped land.

SEQUENCE	SPRING	SUMMER	FALL	WINTER
Example	*wheat*	*sorghum*	*fallow*	*fallow*
A.				
B.				
C.				
D.				

5. The following table concerns the sources of your information. For each type of data listed on the left, please check the column which most closely corresponds to the method by which data are recorded and the source of each type of data.

DATA TYPE	RECORDING METHOD			SOURCE OF INFORMATION						
	ON PAPER IN THE FIELD	IN THE OFFICE AFTER FIELD TRIP	NOT AT ALL; ESTIMATED	PERSONAL GROUND OBSERVATION AND EXPERIENCE	ESTIMATES BASED ON GENERAL WIND-SHIELD SURVEY	TABULATION FROM A STATISTICALLY PLANNED FIELD SURVEY	TABULATION FROM AERIAL PHOTO-GRAPHY	QUESTIONNAIRES FROM FARMERS	OTHER (please specify)
CROP TYPE									
CROP ACREAGE									
IRRIGATION ACREAGE									
PLANTING DATES									
HARVEST DATES									
HAY CUTTING DATES									
CROP SEQUENCE									

Comments:

6. Many counties show some regional variation and concentration in the kinds and amounts of crops grown, so that it is often possible to say, for example, that

   - most of the wheat in the county is grown in the northern third of the county.
   - corn is most important in the southern part of the county because of sandier soils and greater amounts of groundwater for irrigation.
   - all alfalfa in the county is in the west central part of the county, west of Butternut Creek.
   - sorghum is pretty scattered throughout the county.
   - the only sunflowers are found on about 1500 acres just south of Smithville.

   How would you describe the crop patterns in your county?

APPENDIX V

LETTER SENT TO STATE EXTENSION DIRECTORS

THE UNIVERSITY OF KANSAS SPACE TECHNOLOGY CENTER
Raymond Nichols Hall
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

Kansas Applied Remote Sensing (KARS) Program
(913) 864-4775
KANS A N 564-4775

Dear

The University of Kansas Applied Remote Sensing (KARS) Program has undertaken a research project with the National Aeronautics and Space Administration and the U.S. Geological Survey to investigate crop calendars for 1979 and 1980. This information will be used to assist in developing techniques for mapping the High Plains Aquifer region.

In the course of this study, we will be surveying and compiling data on the agricultural activities of your state. One of the groups that we wish to survey is the county extension agent in your state and we would like to ask for your support in this endeavor.

Enclosed you will find a copy of a survey questionnaire that we would like your agents to complete. The questionnaire should take about 30 minutes to finish.

Could you please provide us with a list of names, addresses and phone numbers for both the extension agronomist and the extension irrigation engineer for the counties listed on the accompanying sheet?

Your cooperation in this research effort is greatly appreciated. It is our hope that you will be able to supply the above list since, ultimately, our research will benefit your state. If you would like a copy of the survey results, please fill in your address on the enclosed mailing label and return it to the KARS Program.

Any comments or questions you may have would be welcome. Please do not hesitate to contact one of us.

Sincerely,

Joe Poracsky
Senior Remote Sensing
Applications Specialist

Liz Kipp
Graduate Research Assistant

LK:ak

Enclosures