THE FUTURE OF REMOTE SENSING

When we bring up the subject of remote sensing its easy to find diverging views within SRS regarding its value or its future. While the same can be said of many of our research projects, remote sensing is currently one of the most controversial. However, these views are no different than those expressed during the research and implementation of area frame sampling, objective yield or the list frame.

There are those in SRS, including some members of my Branch, that question why we are doing "operational remote sensing research" in seven states. These people think we are operating on too large a scale and moving too fast for such a new technology. There are those that believe the greatest gains from remote sensing may be in estimation and mapping of minor crops. These people question why we are wasting time and effort in the seven mid-western states when we already have the June Enumerative Survey. On the other hand, there are other individuals that believe the technology is proven. They are ready for us to begin moving the project to an "operational" mode. The agency's long range plan seems to support this belief since it challanges us to come up with a plan for implementation of remote sensing on an operational basis in the 1984 - 1986 time frame.

Which of these groups is right? Each of them can come up with some valid arguments. We became involved in researching the uses of digital satellite data in 1972 when Landsat 1, was launched. Over the years we have made various claims about the potential benefits and uses of landsat data to SRS such as:

a) improved precision of acreage estimates without an increase in respondent burden
b) probability estimates for small areas
c) current coverage of land areas for construction of area sampling frames
d) monitor changes in land use
e) keep abreast of technology

The question is are they still valid? It would be hard to argue against improving the precision of our estimates without increasing respondent burden. The goal of generating indications for county or crop reporting districts also seems worthwhile. County data are one of our most demanded series but some of our weakest estimates. The desire to be able to use current materials to construct land use sampling frames and monitor changes in land use is also reasonable. Our Fairfax sampling frame group will tell you ASCS photography does not always meet their needs. This effects the final quality of our new area frame samples. Monitoring changes in land use and making changes in our area sampling frames to account for conversion of forest land to soybeans or rangeland to irrigated cropland also presents problems for our commodity people. Since becoming involved in remote sensing last fall, I have been amazed at the number of researchers from private companies, universities and government agencies that think satellite data may be the answer to everything. There are some private firms that have surfaced proposals to provide all the cheap, reliable agricultural data from remote sensing techniques anyone could ever need. I don't think we want to leave this technology to others if we plan to remain the source of official agricultural estimates for the U.S. Therefore, SRS should be involved with remote sensing.

Prepared by Bill Pratt for presentation at the SRS National Conference, May 1984.

Let's look at the progress that's been made in the application of remote sensing in SRS. I would be the first to admit that there are a lot of things we don't know about remote sensing. However, if we look back to 1964 when researchers at the University of California at Davis were climbing the water tower to take pictures of various crops and farm animals, its evident that a lot of progress has been made. The Remote Sensing Branch staff spent two years getting the 1975 corn and soybean estimates for Illinois. Our procedures have progressed a long way since then. Most of our research efforts to date have been spent developing procedures for making crop acreage estimates. Results from these efforts look promising. Tables 1, 2 and 3 show some comparisons of the June Enumerative Survey and Remote Sensing for corn, soybeans and wheat estimates. Figures 1, 2 and 3 give a visual representation of these data.

Table 1: ACRES OF CORN PLANTED (000)

Year & States	JES		Remote Sensing		Board
	Expansion	C.V.	Estimate	C.V.	Estimate
1981					
Iowa	14,400	2.2	14,382	1.8	14,600
Missouri	2,298	8.6	1,914	6.5	2,100
TOTAL	16,698		16,296		16,500
1982					
Illinois	11,884	2.4	11,558	2.3	11,600
Iowa	13,841	2.1	13,759	2.0	13,700
TOTAL	25,725		25,317		25,300
1983					
Illinois	8,604	3.2	8,353	3.0	8,200
Iowa	9,163	3.0	9,059	2.2	9,100
Missouri	1,873	7.9	1,555	7.0	1,700
TOTAL	19,640		18,967		19,000

Table 2: ACRES OF SOYBEANS PLANTED (000)

Year & States	JES: Expansion	JES: C.V.	Remote Sensing: Estimate	Remote Sensing: C.V.	Board Estimate
1981					
Iowa	8,056	3.2	8,093	2.5	8,200
Missouri	5,699	5.4	4,852	4.4	5,180
TOTAL	13,755		12,945		13,330
1982					
Illinois	9,553	3.1	9,309	2.9	9,360
Iowa	8,746	3.0	8,482	2.9	8,470
TOTAL	18,299		17,791		17,830
1983					
Arkansas	4,105	4.7	3,867	4.4	3,950
Illinois	9,133	2.9	9,065	2.7	8,900
Iowa	7,795	3.1	7,907	2.8	8,000
Missouri	5,622	5.6	4,961	4.8	5,300
TOTAL	26,655		25,800		26,150

Table 3: ACRES OF WINTER WHEAT PLANTED (000)

Year & States	JES: Expansion	JES: C.V.	Remote Sensing: Estimate	Remote Sensing: C.V.	Board Estimate
1981					
Kansas**	12,883	2.9	13,091	2.0	12,200
Oklahoma**	6,455	4.5	6,136	4.1	6,400
TOTAL	19,338		19,227		18,600
1982					
Colorado	3,422	7.0	3,023	4.5	3,480
Kansas	14,344	2.9	14,187	2.1	14,200
Oklahoma	8,156	3.9	7,507	3.3	8,000
TOTAL	25,922		24,717		25,680
1983					
Colorado	4,050	10.5	3,767	7.8	4,000
Kansas	13,528	3.0	13,200	2.7	13,200
Missouri	2,239	7.8	2,314	5.7	2,200
Oklahoma	7,939	3.8	7,832	3.3	7,800
TOTAL	27,756		27,113		27,200

** Harvested

FIGURE 1: PLANTED ACREAGE FOR CORN, SOYBEANS, AND WHEAT

REMOTE SENSING VS CROP REPORTING BOARD
MILLION ACRES

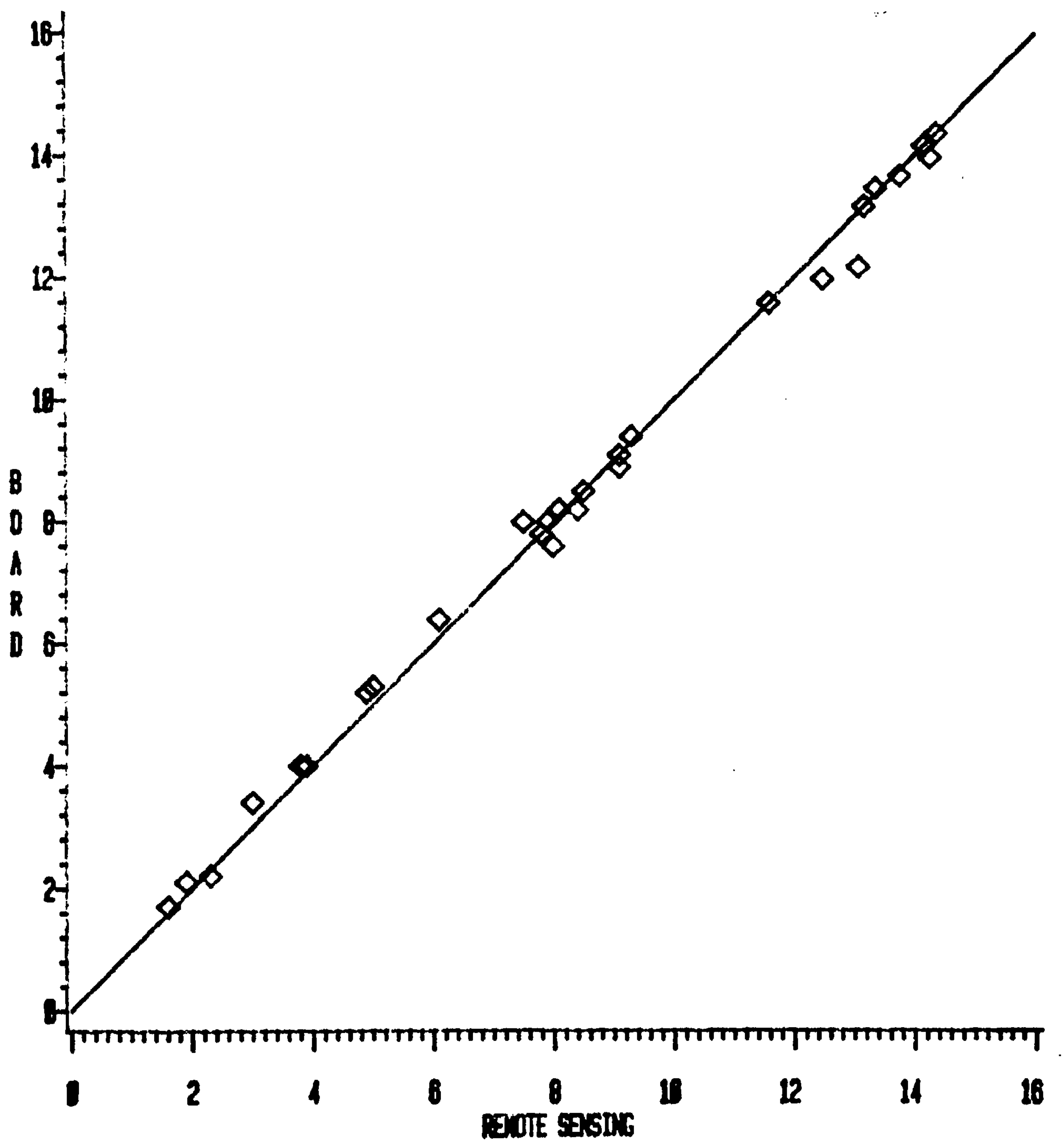


FIGURE 2: PLANTED ACREAGE FOR CORN, SOYBEANS, AND WHEAT

JUNE ENUMERATIVE SURVEY VS CROP REPORTING BOARD
MILLION ACRES

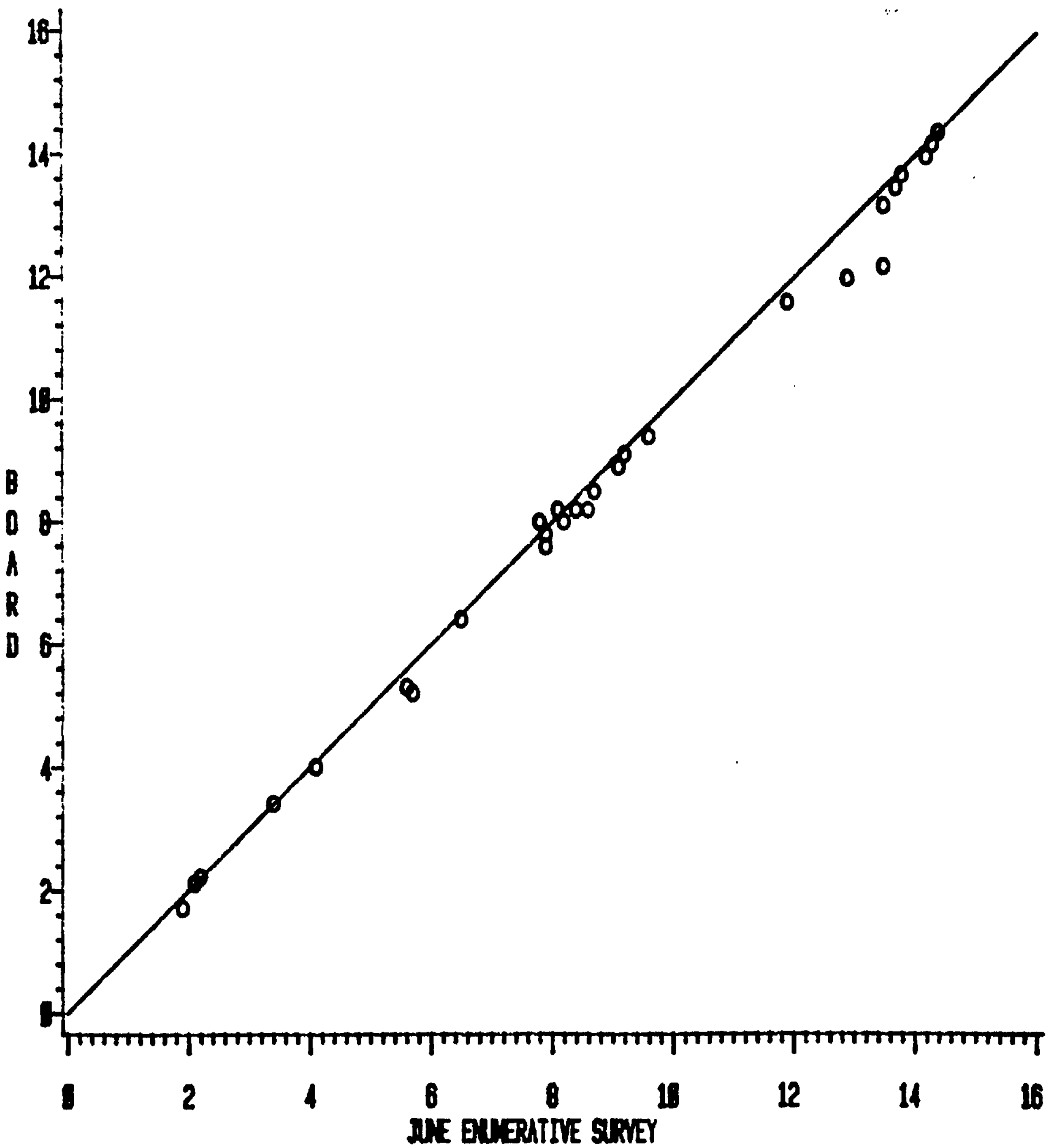
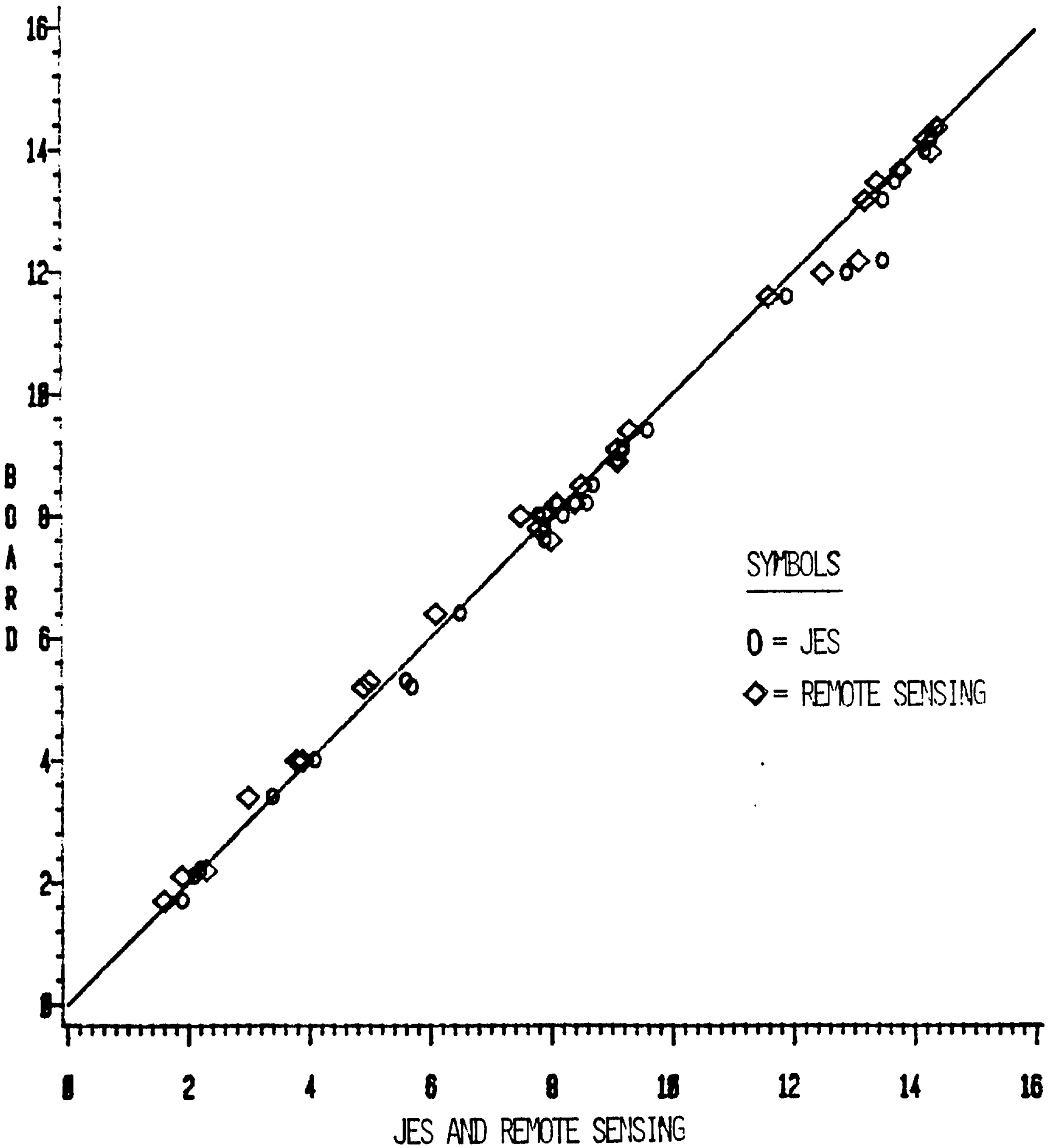


FIGURE 3: PLANTED ACREAGE FOR CORN, SOYBEANS, AND WHEAT

REMOTE SENSING AND JUNE ENUMERATIVE SURVEY
VS CROP REPORTING BOARD
MILLION ACRES



These results show that remote sensing estimates have been within 1 to 2 standard errors of the Board in most cases. Deviations between remote sensing estimates and the Board are about the same as those between the JES and the Board. This indicates remote sensing techniques apparently work but it does not necessarily say we should use remote sensing for every crop in every state.

In addition to the work on estimates of major crops in the midwest we are involved in cooperative projects in California, Idaho and New York exploring the use of remote sensing for mapping and estimation of specialty crops. We will know more about the utility of remote sensing for these kinds of applications by the end of 1985. The major problem we have had with crop estimation is incomplete satellite coverage. Our experience indicates that 75 percent coverage of a state during the 6 week prime window is about the best we can do with data from only one satellite.

Progress on the use of remote sensing for county estimates is less dramatic. County indications were generated during the first two years of the AgRISTARS project. It became evident that our state level regression techniques had some problems for county estimates. We have done some additional research and it appears we have solved most of our earlier problems. We plan to use the new estimator on an operational basis in 1984. We are also planning a county estimate research project with Sampling Frames and Survey Research Branch in 1985.

SRS began using a visual interpretation of false color satellite imagery in 1978 to assist in stratification of our area sampling frames. A project involving NASA/NSTL and the Fairfax unit is underway to see if we can use computer classification of digital Landsat data to give better results. This approach should have several advantages. Computer classification eliminates the subjectivity of visual interpretation and it does not require that an individual be familiar with specific crops in an area. It will also allow us to combine satellite data from two different time periods in order to do a better job of separating cropland from pasture. A pilot project in Arizona last year was very encouraging. A disadvantage, however, is that digital Landsat data is considerably more expensive than Landsat images.

There are several issues which must be addressed before we can recommend a long range plan for the use of remote sensing in SRS. A big unknown is the availability of satellite data and the effect of commercialization of the satellites. Landsat 4 which was launched in July 1982, was expected to have a lifetime of three years. It developed problems shortly after launch and its successor, Landsat 5, was put in orbit in March 1984. Landsat 5 appears to be functioning properly. Landsat 5 is the last Landsat satellite officially planned by the government so our supply of Landsat data in the late 1980's is unknown. However, we learned recently that Secretary of Commerce Baldridge has proposed that the Federal government begin funding long lead time components for a follow on satellite to replace Landsat 5. There is also talk of using the space shuttle to repair Landat 4. These are certainly a favorable developments for the future of land remote sensing. An RFP was issued for commercialization of the Landsat satellites in January. The outcome of this transfer to the private sector or its possible effects on data availability and costs will not be known until mid-May. This effort will require legislation for implementation.

The best prospects for future satellite data availability may be from foreign sources. The French SPOT satellite is scheduled to be launched in 1985 with a follow on satellite in 1986. SRS is involved in a cooperative project with the French to determine whether or not this data will meet our needs. The Japanese will launch similar satellites in 1986 and 1987 and several other nations also have satellites planned. Satellite data will be available in the late 1980's but it may not be American and costs are uncertain.

Another problem that we will continue to face is obtaining cloud free coverage during our critical 6 week windows. This will be a problem as long as we only have single satellite coverage on a 16 day cycle.

We have heard a lot of talk about the benefits of Thematic Mapper data. This sensor has 30 meter resolution vs. 80 meters for MSS data and measures reflectance in seven bands instead of four from MSS data. The smaller resolution should improve classification results in areas of small or irregular fields and the additional spectral bands and narrower band width should improve separability between crops. One problem with TM data is that the volume of data is 7 times greater than the MSS data we are currently using. It is also about 5 times as expensive. We should know a little more about the benefits and problems of TM data by this fall when we complete our analysis of a TM scene in Iowa. However, preliminary results look very encouraging.

I see our research on remote sensing broadening in scope in the next few years. The original goal of the research was to determine how SRS could use Landsat data. We have identified several areas that look promising and have made good progress. Our new emphasis is to learn how to handle satellite data more efficiently, make remote sensing fit into the operational program and to improve our techniques. We will also continue to search for new applications within SRS.

We have started to address some of these problems in 1984. We are currently refining our ADP systems to make them work in a batch processing environment. This should enable us to lower processing costs and make our people more productive. We need to review our whole data processing approach. We are using five computer sites for various stages of our processing. The transfer of data between these systems causes delays in processing and is probably more costly than necessary since we don't do enough business on any center to obtain a volume discount. This issue needs to be addressed before we expand remote sensing to a truly operational program.

One of the big questions to be answered in 1984 is can we use a "cook book or standardized approach" for analysis and still obtain meaningful results. In the past, Remote Sensing Branch analysts have rerun parts of the analysis to see if results could be improved. This kind of experimentation has no place in an operational program. In general, we probably know enough about procedures to determine a reasonable approach before processing begins. We are also refining our documentation so the processing and analysis can be turned over to other people within the agency.

We must continue to simplify tasks performed by the SSO for the remote sensing project. Over the past few years SSO manpower requirements for presurvey preparation, enumeration, follow-up of JES intentions fields and digitizing have been simplified. However, I think we can continue to reduce the time required for these tasks.

Cartographic support during peak periods, is a factor that will limit future expansion of remote sensing. A review of cartographic work performed in the Remote Sensing Branch and the Fairfax Sampling Frame Unit is planned to establish common techniques and eliminate duplication. This will allow us to increase efficiency, reduce costs and avoid delays in getting materials to the SSO's.

We are taking steps in 1984 to separate the costs of the seven state project from the pure research activities. The time is fast approaching when we must evaluate the possible benefits and costs of remote sensing in terms of our operational program. This technology is terrific for public relations but we should make a commitment to use it in our estimating program before expanding to additional states.

If remote sensing is considered useful in an operational sense we should begin getting our commodity people involved in processing and analysis of these data. SRS commodity statisticians should also take a look at the System used by FAS for crop condition assessment. ASCS is involved with this effort and will be expanding their crop condition assessment activities for the United States based on remote sensing. Using different satellites it is now possible to look at crop development for an entire state many times during a growing season. In the long term, the applications part of the program should be transferred out of the Statistical Research Division.

The argument is made that we should not be using remote sensing because it is more costly than the JES. Some might suggest improving the precision of our corn estimates (assuming we want more precision) by increasing the size of the JES. However, I don't agree. We would probably find it hard to get OMB to support large increases of the JES sample size because of respondent burden. Increasing the size of the JES sample will also increase our problems with nonsampling errors, data collection, training and SSO work load. I think we could view remote sensing estimates as an insurance policy. We currently compute tract, farm, weighted and multiple frame estimates for cattle and hogs. Isn't this the same thing? This isn't to say that we don't need to reduce costs or improve the efficiency of these estimates. It does say that two probability acreage estimates of the same crop from different sources could be useful.

I think this technology has a place in our "bag of tools" for making estimates. I am not proposing that we use remote sensing in all fifty states. A more reasonable approach would be to use remote sensing for estimating acreages in major states to account for about 75 or 85 percent of the major crops and limited applications for minor or specialty crops. We realize that most of the expansion of the remote sensing program will need to be accomplished by increased efficiency. The Remote Sensing Branch is ready for that challenge.