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IRRIGATED RICE AREA ESTIMATION USING REMOTE SENSING TECHNIQUES:
PROJECT'S PROPOSAL AND PRELIMINARY RESULTS.

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ABSTRACT

The objective of this work is to propose the development of a methodology for annual estimates of irrigated rice crop areas in the State of Rio Grande do Sul, Brazil, using remote sensing techniques. The proposed project involves interpretation, digital analysis, and sampling techniques of LANDSAT imagery. This paper also presents an experimental phase with the objective of developing a methodology for the identification and evaluation of irrigated rice crop areas in four counties of the State, for the crop year 1982/83. This first phase has involved just visual interpretation techniques of MSS/LANDSAT images.

1. INTRODUCTION:

The rice crop (*Oryza sativa* L.) is one of the most important foods, for it presents the largest consumption and occupies the greatest cultivated area in the world. Considering the economical importance of this culture both for Brazil and the State of Rio Grande do Sul, several researches have been developed to achieve greater yields through the selection of more productive rice cultivars.

Another important point of view is the need to seek more accurate methods to evaluate rice production in order to provide means for better trade actions.

The use of remote sensing techniques for crop identification and area assessment has been proved to be an effective tool and of great potentiality. Due to multispectral, synoptic, repetitive and global coverage properties provided by land remote sensing systems, it is possible to monitor the expansion of crop areas and to evaluate periodically the area of a crop of interest.

The objective of this work is to propose the development of methodologies for annual estimate of irrigated rice area cultivated in the State of Rio Grande do Sul, using remote sensing techniques through visual interpretation of MSS/LANDSAT images, computerized techniques for LANDSAT data management and through a sampling system.

2. STUDY AREA.

This project proposes to analyze the whole irrigated rice crop area of the State of Rio Grande do Sul. (FIGURE 1).

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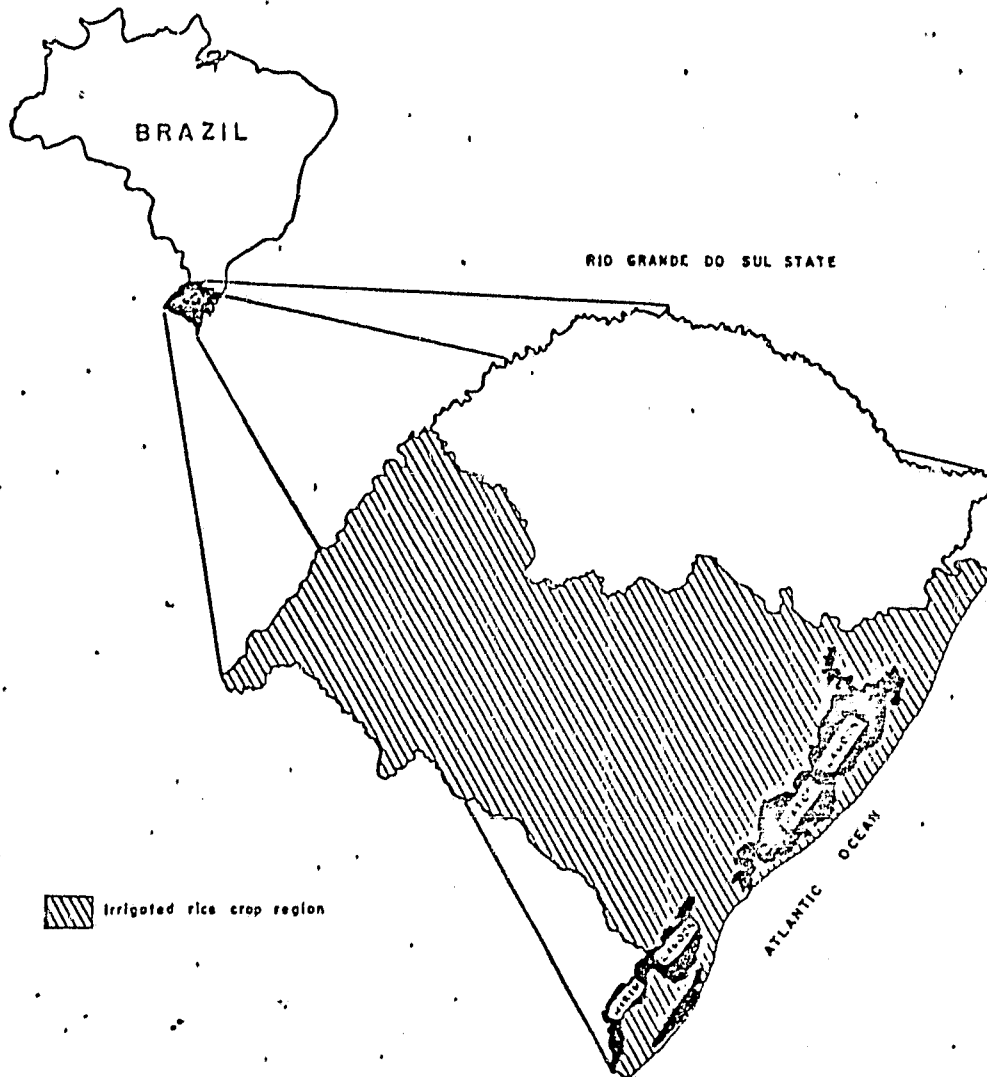


FIGURE 1 - Irrigated rice crop region of the State of Rio Grande do Sul.

3. PHASES OF THE PROJECT

For the development of the proposed methodology, this project will be divided into 5 distinct phases presented in the flow diagram that follows.

4. DESCRIPTION OF THE ACTIVITIES

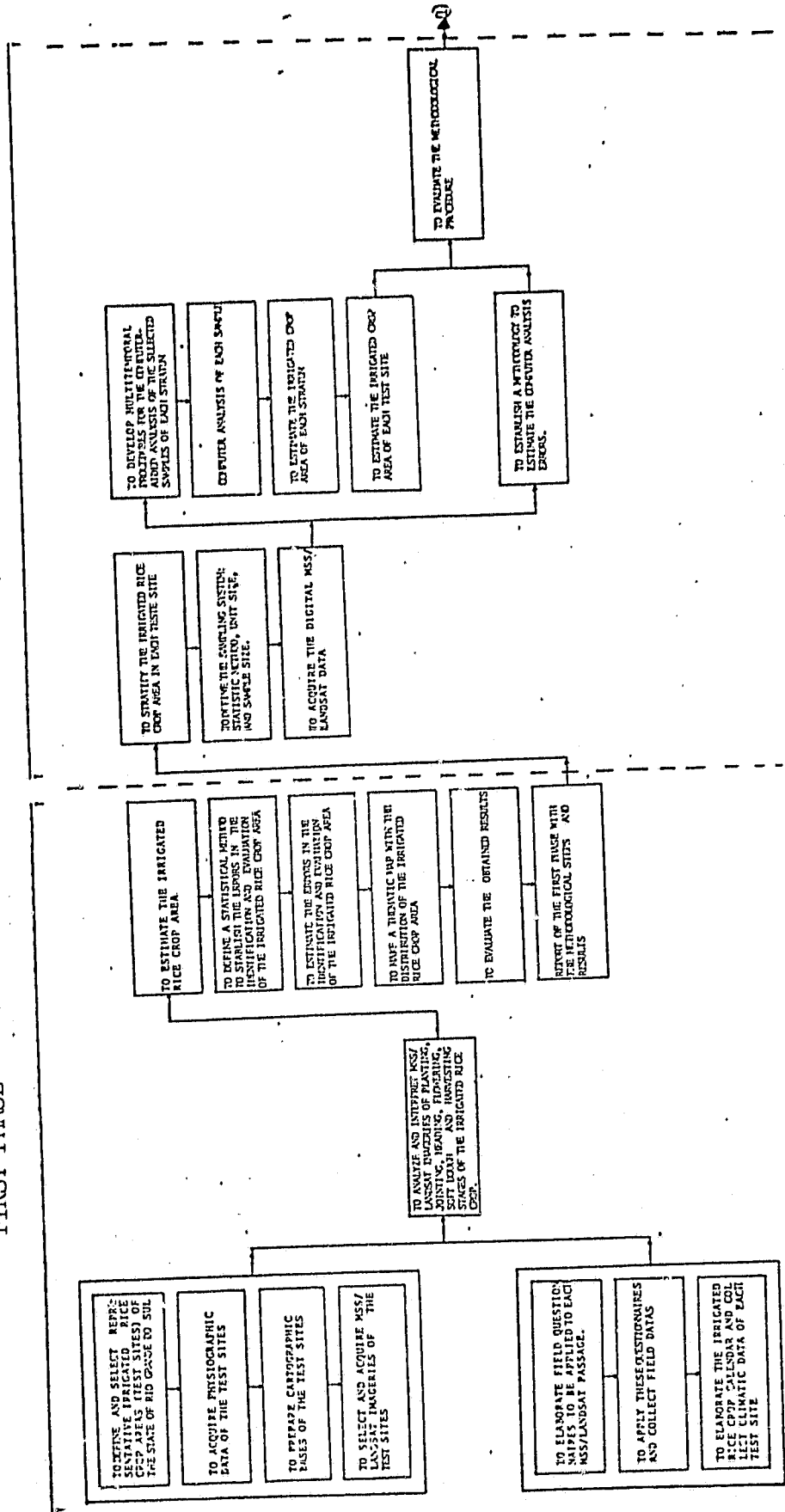
4.1 - FIRST PHASE - IRRIGATED RICE CROP IDENTIFICATION AND AREA MAPPING THROUGH VISUAL INTERPRETATION OF LANDSAT DATA

In this phase, visual interpretation methodology will be applied using the following MSS/LANDSAT products: black and white imageries (channels MSS-5 and MSS-7) and color infrared composite imageries, all at the scale of 1:250.000. The spectral criterion will be utilized as well as the rice crop seasonal variation.

PHASES OF THE PROJECT - FLOW DIAGRAM

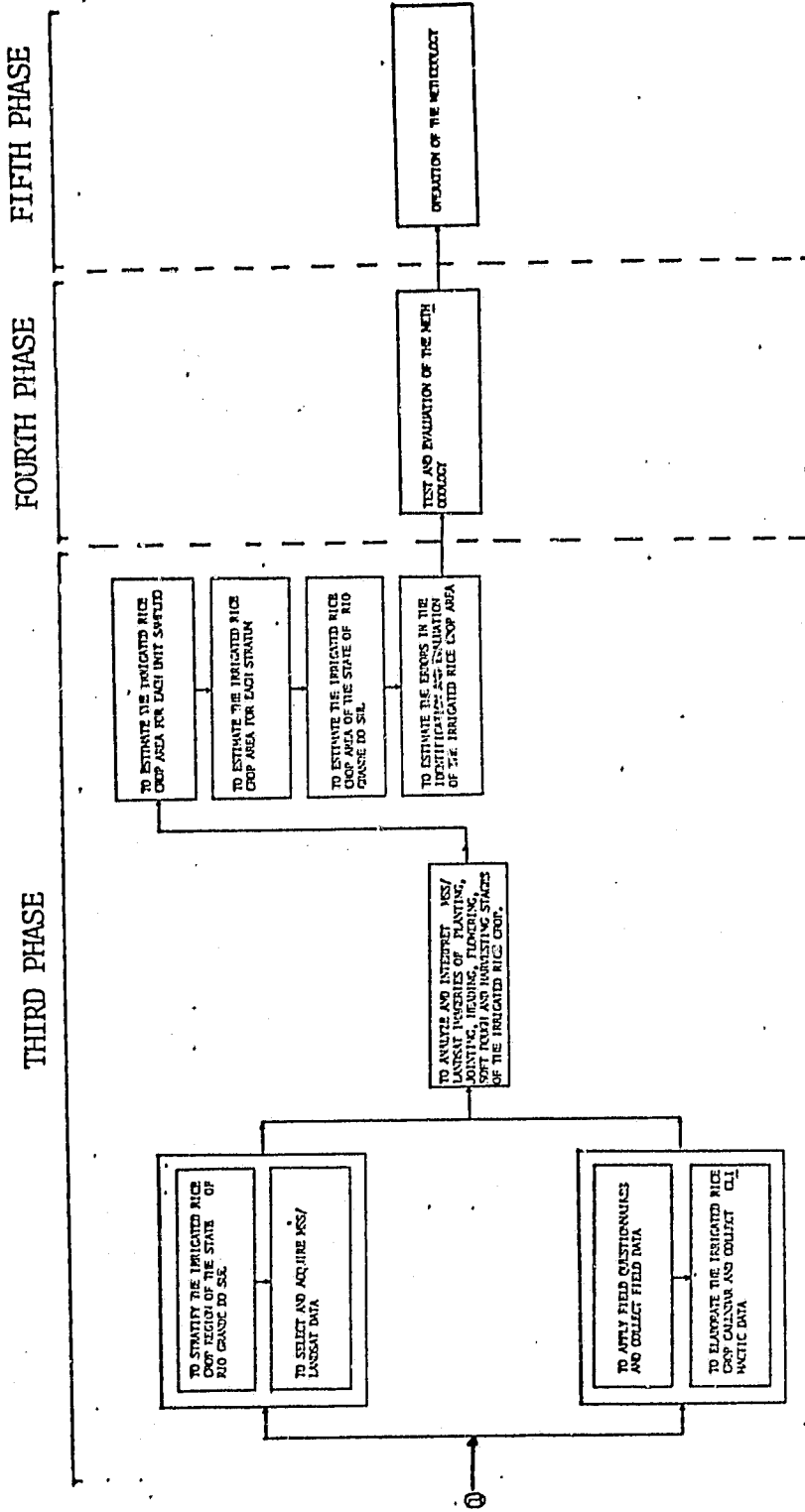
SECOND PHASE

FIRST PHASE



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PHASES OF THE PROJECT - FLOW DIAGRAM (continuation)



The objectives of this phase will be:

- a) to define the dates for better identification and evaluation of the irrigated crop area in that region;
- b) to develop methodologies for estimating the accuracy and precision of the visual interpretation.

To reach these objectives, representative areas will be defined in all the rice crop regions of the State of Rio Grande do Sul in order to observe the possible variations between the irrigated rice crops and neighbouring targets. These variations include mainly the size and shape of crop fields, the different spectral signatures of the rice crops, the soil influences and the phytosanitary conditions.

Firstly, a bibliographic research will be made to obtain physiographic data of these areas and a field information collection.

In order to obtain cloud-free LANDSAT data of the study areas, a survey of all the passages over those regions will be made during the following rice crop stages: planting, jointing, heading, flowering, soft dough and harvesting.

For each stage of the crop, LANDSAT data from at least one satellite passage will be acquired. For each acquired data a visual interpretation will be made. Subsequently the results will be analyzed quantitatively to define the best dates for the rice crop identification. During this phase two fields checks will be realized to settle uncertainties of interpretation and to evaluate the utilized methodology.

4.2 - SECOND PHASE - DIGITAL PROCESSING AND SAMPLING SYSTEM FOR RICE CROP AREA ESTIMATION

The objectives of this phase are:

- a) development of a methodology for rice crop identification and classification through computer-aided techniques;
- b) definition of a sampling system for rice crop area estimation;
- c) comparison of the results of this phase with the results of the first phase.

Initially each study area will be stratified, considering that care should be taken for large areas with considerable variations in growth stage, field size, field shape, soil types, etc. Certainly a stratification of these areas into homogeneous strata should provide better accuracy and precision of the obtained results.

The next step is the LANDSAT data acquisition for these study areas.

For the establishment of one digital classification methodology, a study with several classification approaches (supervised and unsupervised classifications) will be realized using different classifiers implemented in INPE's (Institute for Space Research) Image-100 System.

Subsequently the definition of a sampling system (a statistic method, a unit size and a sample size) must also be investigated

The results of the irrigated rice crop area estimation obtained both through the computer-aided procedure and the sampling system will be compared with the results obtained in the first phase of the project. The objective of these comparisons is to quantify aspects of costs, expendend time, precision and accuracy.

The methodologies obtained in the first and second phases must be developed with MSS/LANDSAT data acquired in the same crop year, in order to achieve a comparison basis between the visual and automatic methods.

4.3 - THIRD PHASE - RICE CROP AREA ESTIMATION THROUGH SAMPLING SYSTEM USING VISUAL INTERPRETATION AND COMPUTER-AIDED ANALYSIS OF THE MSS/LANDSAT DATA

The objective of this phase is the rice crop area estimation on all the State of Rio Grande do Sul, through the sampling system defined in the second phase.

In this phase, a stratification of the irrigated rice crop region of the State of Rio Grande do Sul must be made. For each stratum a representative sample will be extracted through a simple random procedure without reposition. The irrigated rice area of each sampled unit will be obtained using the visual interpretation and the computer-aided methodologies defined in the first and second phases.

The results obtained from each sampled unit will be input to the statistic method for the irrigated rice crop area estimation for each stratum.

The total irrigated rice crop area estimation for the State of Rio Grande do Sul will be obtained through the aggregation of the estimated area for each stratum.

The performance of the utilized methodologies (visual interpretation, computer-aided analysis and sampling system) will be indicated by the precision and the accuracy that will also be calculated in this phase.

4.4 - FOURTH PHASE - TEST AND EVALUATION OF THE METHODOLOGY

In order to get operational, any methodology must be tested and evaluated. For that, this phase will consist of several applications of the procedures established anteriorly, in order to turn the irrigated rice crop area estimator system in the State of Rio Grande do Sul feasible.

During this phase, other precision and accuracy indexes will be obtained in order to evaluate the established methodology.

4.5 - FIFTH PHASE: OPERATION OF THE METHODOLOGY

This phase will consist in transferring this methodology to governmental and private organs, in order to provide parameters to the rice crop yield estimation for the State of Rio Grande do Sul.

5. FIRST PHASE RESULTS

In August 1982, the Instituto de Pesquisas Espaciais - INPE in collaboration with the Instituto Rio Grandense do Arroz - IRGA, elaborated a study plan for irrigated rice crop identification, mapping and area evaluation on four municipalities, and considered test sites selected in different rice crops regions of the State of Rio Grande do Sul. This study was considered an experimental project.

Several MSS/LANDSAT imageries were used for this study, and the Table 1 shows the path/row of these data.

TEST SITE	PATH	ROW	DATE
Santa Vitória do Palmar	222	83	11/10/82 12/11/82 20/03/83 05/04/83
Dom Pedrito	223	81 & 82	18/10/82 22/01/83
Itaqui	224	80	09/10/82 28/12/82
Cachoeira do Sul	222	81	12/11/82 30/12/82 20/03/83

TABLE 1 - Path, row and acquisition dates of the MSS/LANDSAT data for the test sites studied.

The Table 2 shows the obtained results employing the methodology proposed in the first phase, using visual interpretation, where MSS/LANDSAT data for the 1982/1983 crop year were utilized. This table also shows information about the irrigated rice crop area provided by the Centro de Estatística do IRGA (IRGA Statistic Center) and by the Banco do Brasil (Brazilian Bank).

TEST SITES	RICE CROP AREA FOR THE 1982/1983 CROP YEAR (IN HECTARES)		
	MSS/LANDSAT	BANCO DO BRASIL	IRGA
S. Vitória do Palmar	67,065	64,000	57,000
Itaqui	36,537	34,000	42,800
Dom Pedrito	26,100	UNAVAILABLE	24,520
Cachoeira do Sul	29,987	21,282	25,000

TABLE 2 - Rice crop area obtained through visual interpretation of MSS/LANDSAT data, Centro de Estatística do IRGA and Banco do Brasil, for the 1982/1983 crop year.

6. FIRST PHASE CONCLUSIONS

Considering that the first phase objectives were to study the rice crop spectral signature patterns in the State of Rio Grande do Sul and to estimate the cultivated rice crop area for each test site established in the 1982/1983 crop year, the following conclusions were reached:

- 1) The MSS/LANDSAT imageries present attributes that make possible to identify and to evaluate the irrigated rice crop area for the State of Rio Grande do Sul conditions.
- 2) Considering that it was not possible to obtain MSS/LANDSAT data for every rice crop growing stages, due to the great cloud incidence over the test sites in the 1982/1983 crop year, a new research is recommended in order to define the best dates for the rice crop identification.