General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)
YIELD MODEL DEVELOPMENT
PROJECT IMPLEMENTATION PLAN

PREPARED BY:
Russell A. Ambroziak
Project Manager

APPROVED BY:

Charles E. Caudill
U.S. Department of Agriculture
DATE: 11-9-52

William E. Rice
National Aeronautics and Space Administration
DATE: 11-5-52

Kenneth Hadeen
U.S. Department of Commerce
DATE: 11-13-52

Allen Watkins
U.S. Department of the Interior
DATE: 11-3-52
TABLE OF CONTENTS

I. INTRODUCTION
   A. Background ........................................... I-1
   B. Project Summary ....................................... I-1
   C. Project Organization ................................. I-3
   D. Project Interfaces .................................... I-6

II. YMD PROJECT OBJECTIVES
   A. FY83 Objectives ........................................ II-1
   B. Agency Responsibilities ............................... II-2

III. RESOURCE SUMMARY
   A. Dollar Resources ...................................... III-1
   B. Staffing Resources - FY 83 ............................. III-2

IV. SUMMARY OF TASKS TO BE COMPLETED .................. IV-1

V. MAJOR PROJECT ELEMENT #1: EVALUATION OF CROP YIELD MODELS - 5 TASKS
   A. Task 1: Criteria and Procedures for Evaluating Crop Yield Models .. V-1
   B. Task 2: Review Crop Yield Models and Identify Candidate Models for Acquisition and Testing . V-5
   C. Task 3: Acquire Detailed Documentation, Computer Programs and Necessary Data Sets for Candidate Models . V-9
   D. Task 4: Conduct Test and Evaluation of Candidate Crop Yield Models ........................................... V-12
   E. Task 5: Monitor Application Testing Activities ................................................................. V-17

VI. MAJOR PROJECT ELEMENT #2: CROP YIELD MODEL RESEARCH AND DEVELOPMENT - 7 TASKS
   A. Task 1: Conduct Research to Quantify the Impact of Technological and Economic Factors on Crop Yields ................................................................. VI-1
   B. Task 2: Conduct Research to Develop and Document Additional or Modified Empirical Crop Yield Models ................................................................. VI-7
   C. Task 3: Investigate Stratification Alternatives for Empirical Crop Yield Models ............................ VI-12
   D. Task 4: Wheat Yield Model Development ................ VI-16
   E. Task 5: Soybean Yield Model Development ............... VI-30
   F. Task 6: Cotton Growth and Yield Model Development ................................................................. VI-32
   G. Task 7: Corn and Sorghum Growth and Yield Model Development .................................................. VI-34
VII. MAJOR PROJECT ELEMENT #3 - DATA ACQUISITION, PROCESSING AND STORAGE - 3 TASKS

A. Task 1: Acquire and Process Daily Historical Synoptic Meteorological Station Data for Foreign Countries. 
   VIII-1
B. Task 2: Maintain, Update, Acquire and Build Historic Agricultural Data Bases. 
   VIII-3
C. Task 3: Meteorological Data Base Preparation. 
   VIII-8

VIII. MAJOR PROJECT ELEMENT #4: RELATED YIELD RESEARCH - 3 TASKS

A. Task 1: Define Spectral and/or Remote Sensing Data Requirements and Develop Input That Can Be Used To Drive or Test Crop Growth/Yield Models. 
   IX-1
   IX-4
   IX-8

IX. MAJOR PROJECT ELEMENT #5: PROJECT MANAGEMENT AND SUPPORT - 3 TASKS

   IX-1
B. Task 2: Liaison with and Monitoring of Research Activities in Other AgRISTARS Projects. 
   IX-3
   IX-6
I. INTRODUCTION

A. BACKGROUND

Yield Model Development is one of the eight projects of the AgRISTARS (Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing) Program, a cooperative effort of five Federal agencies: Department of Agriculture (USDA); National Aeronautics and Space Administration (NASA); Department of Commerce (USDC); Department of Interior (USDI); and Agency for International Development (USAID).

The Yield Model Development (YMD) Project has supported the priority areas of the Secretary of Agriculture's initiatives described in February 1978. Tasks within the YMD project that have been completed on April 1, 1983, will be reevaluated, redefined where necessary, and integrated into the project implementation plan of either the Domestic Commodity Assessment Research (DCAR) or the Foreign Commodity Assessment Research (FCAR) project. Plant process yield model development will be assigned to the DCAR project.

This Yield Model Development Project Implementation Plan focuses on tasks to be done in FY83. Task funding shown herein covers the entire fiscal year even though all tasks will be reassigned to one of the three (3) AgRISTARS projects by April 1, 1983. Task funding will be redistributed at that time.

B. PROJECT SUMMARY

The Yield Model Development Project (YMD) will continue to support USDA crop production forecasting and estimation by:

1. Testing, evaluating and selecting crop yield models for application testing.
2. Identifying areas of feasible research for improvement of models.
3. Conducting research to modify existing models and to develop new crop yield assessment methods.

FY83 activity in YMD is not a termination of yield model development, test, evaluation, and improvement, but a reemphasis on this activity in support of Foreign Agricultural Service (FAS) and Statistical Reporting Service (SRS) in USDA.

The five tasks identified in Project Element 1, Crop Yield Model Test and Evaluation, will be completed as described by April 1, 1983. New tasks for T&E yield models will be described for emphasis on foreign or domestic use and included in the appropriate project plan. Real time T&E of plant process models will be an integral part of this activity.

Ten tasks made up Project Element 2 in FY82. Crop Yield Model Research and Development, will be continued and/or distributed as
follows. Research to quantify the impact of technology and economics on crop yields (Task 1) will continue as part of the domestic activity. Development of empirical crop yield models under Task 2 will be completed by April 1, 1983. Additional requirements under this task will be included in the DCAR project as required. Stratification alternatives (Task 3) will be included in the DCAR project. Episodic events (FY82 Task 4) is concluded. The cooperators report will be submitted before April 1, 1983. Wheat, soybean, cotton, corn and sorghum plant process model development (Tasks 4-7) will be continued by ARS under the DCAR project. Data analysis support to ARS researchers (FY82 Task 9) is deleted. The evaluation of gridded met data (FY82 Task 10) is complete with the report published by mid-December 1982.

The eight FY82 tasks included in Project Element 3, Data Acquisition, Processing and Storage, have been distributed as follows. ADP procedures (Task 1) and data dictionary (Task 6) are being documented and will only continue as a part of NOAA data processing activities. The historical monthly met data assimilation (Task 2) is complete. As monthly data sets are required, they will be assembled by the group requiring the data as part of a model development or testing task. Historical daily meteorological data assimilation (FY82 Task 3, FY83 Task 1) will continue under the FCAR project. Historical agricultural data base acquisition (FY82 Task 4, FY83 Task 2) will continue as required under the domestic project. Objective precipitation estimates incorporating satellite data (Task 5) will be complete with a final report by March 1983. Current delivery of station meteorological data (FY82 Task 7, FY83 Task 3) in real time will continue throughout the AgRISTARS project. Software for gridded agromet data extraction (Task 8) has been completed and a users guide has been published and distributed.

Of the six tasks in Project Element 4, Related Yield Research, the NOAA/NESS tasks relating to solar radiation and temperature extremes (FY82 Tasks 2, 3, and 4) are now included in the Early Warning plan. The investigation of satellite data integration into a regression estimator (FY82 Task 1) is complete. The definition of spectral data requirements for driving and testing crop growth models (FY82 Task 5, FY83 Task 1) and the evaluation of spectral information for crop yield estimation (FY83 Task 2) will continue as a part of FCAR.

Project management and support tasks under Project Element 5 will continue to April 1, 1983. Similar tasks as required will be a part of both FCAR and DCAR projects.

The YMD project is a joint agency activity supported by funds and staff from USDA, USDC and NASA. The Joint Modeling Center (USDA, NOAA, NASA) established for YMD work is located in Columbia, Missouri. USDA staff from SRS also support YMD work in Houston, Washington, D.C. and at a few ARS research sites. USDA ARS staff support YMD work at numerous research centers. USDC staff from EDIS support YMD work at JSC, Houston, Texas.
C. PROJECT ORGANIZATION

The organizational structure within the AgRISTARS Yield Model Development project is illustrated in Figure I-1. The management structure includes a project manager, participating agency line managers, user evaluation team, project liaison leader, task coordinators, and task managers within each program area. Functional responsibilities of the project management personnel are as follows:

1. Project Manager

The project manager is responsible to the Program Management Group (PMG) through his line organization for planning and managing activities within his project. To ensure that project objectives will be met within allotted resources, these responsibilities include defining project content, identifying problems, making change recommendations, planning and defining tasks, and participating with other project managers in the integration of the various projects. Specifically, the project manager is responsible for:

a. Preparing and maintaining a project implementation plan for his project.

b. Supporting program planning, including the coordination and integration of inputs from all participating agencies or project elements.

c. Identifying resource requirements to the PMG.

d. Coordinating with other project managers to ensure appropriate flow of requirements, status information, and results among projects.

e. Assessing the need for changes in the project implementation plan, submitting to the PMG those changes requiring PMG approval, and coordinating and implementing those changes as necessary.

f. Reporting overall status to the PMG and identifying need for management guidelines.

2. Agency Line or Staff Managers

These managers have budget and/or management control of those responsible for carrying out the research identified in the tasks of this implementation plan. They interface with agency resources and are responsible for the conduct of the research. Specific responsibilities are to:

a. Develop the program of research.

b. Assess the technical integrity and adequacy of work performed.
YMD PROJECT ORGANIZATION

Figure I-1

1-4
c. Prepare agency budget submissions for AgRISTARS.

d. Provide inputs for preparing and maintaining project implementation plans.

e. Provide inputs for status reporting.

3. **Task Coordinators**

The task coordinators are the focal point to assure efficient, nonoverlapping research for multiphased tasks; in particular, where there are several sub-tasks. Specific responsibilities are:

a. Provide technical and/or supervisory leadership for task research within the participating agency line or staff management structure.

b. Provide agency line or staff managers with status reports, updates and other changes to the project implementation plan.

c. Ensure coordination with other task managers.

4. **Task and Sub-task Managers**

Each task or sub-task manager supplies technical leadership and is responsible for conducting tasks within the organizational structure of the participating agency line management. Specific responsibilities are:

a. Support of higher level management in technical task planning and participating in all updating of the overall plan as requested.

b. Development of the technical approach, procedures, schedules, and implementation of the plans, assuring technical validity.

c. Preparation of reports as requested by management.

5. **Project Liaison Leader**

The project liaison leader is responsible for:

a. Preparing and maintaining interface control documents with other AgRISTARS projects.

b. Reviewing agronomic and plant growth modeling research and preparing integration plans for use in plant process models.

c. Supporting the project manager in coordinating with other project managers to ensure appropriate flow of requirements, status information, and results among projects.
d. Coordinating and assisting task managers in ensuring that requirements and results are appropriately exchanged among other projects.

e. Preparing reports as requested by management.

f. Supporting task, project, and agency managers as requested.

D. PROJECT INTERFACES

Interfaces between projects in AgRISTARS are specifically defined by Interface Control Documents (ICD) jointly approved by the respective project leaders. A separate ICD exists defining interfaces between YMD and each project which requires interfaces.

1. Intraproject Interfaces

Several interfaces between the participating organizations within YMD will be required and accomplished during the project life. USDA ARS will develop and test techniques to estimate soil moisture, crop growth stages, and heat-moisture stress. The model development group will integrate these estimates into model forms. As model evaluation occurs, additional requirements will be isolated and referred to ARS for research and development.

2. Interproject Interfaces

Within the total AgRISTARS endeavor, there are many technical and information interfaces between the several projects.

The Supporting Research (SR) project will develop and test technology for crop growth models, soils, and crop stress effects. Techniques developed will be provided to YMD for integration into yield models.

The Early Warning/Crop Condition Assessment (EW) project will develop techniques for relating leaf area, bio-mass, crop species, plant pests and disease, winterkill, and moisture stress to biological yield. These techniques will be provided to YMD for integration into yield models. Techniques developed to estimate solar radiation, temperature ranges, and estimation techniques for precipitation amounts from satellite data will be provided to YMD by EW.

The Soil Moisture (SM) project expects to model and predict soil moisture throughout the soil profile. Algorithms and model components estimating soil profile and root zone soil moisture...
will be furnished to YMD for evaluation and possible inclusion in yield models. Techniques developed in EN for precipitation, solar radiation, and temperature range estimation will be made available to SM for its use. YMD will assist in an analysis of sensitivity of yield models and crop growth to soil moisture.

Interfaces to other AgRISTARS projects will be identified and developed as project plans progress.

3. JAWF Interface

Current meteorological data for operating yield models and crop calendars, and for evaluating techniques developed will be provided by the Joint Agricultural Weather Facility (JAWF). Continuing interface with JAWF will be required to maintain current meteorological data requirements.
II. YMD PROJECT OBJECTIVES

The Yield Model Development (YMD) Project, through the AgRISTARS USDA and NOAA management, is responsible for the development, testing, and evaluation of crop yield models to support USDA's objective of improved crop production forecasting and estimation. The YMD project will be directed toward improving existing crop yield models, developing new models and incorporating satellite and other non-standard data into the model process.

The YMD project will utilize data acquired from USDA ground collection, WMO ground stations, NOAA meteorological and environmental satellites, NASA Landsat satellites, aircraft and other existing published sources.

The prime objective of YMD is to test, evaluate, and develop mathematical and/or plant process models using environment and plant measurement characteristics and their interactions to represent the yield potential of a crop at a given level (point, state, region, nation). Yield models will be recommended for the specific crop/country combinations required by the Early Warning/Crop Condition Assessment and Inventory Technology Development Projects of AgRISTARS and for direct consideration by USDA agencies having program responsibilities in crop yield forecasting and estimation.

A. FY83 Objectives

1. Application of a subjective addition of NOAA series vegetative indices to existing crop yield models.

2. Provide a quality controlled source of current station and gridded meteorological data.

3. Develop and implement procedures to acquire and organize ancillary data for subjective adjustment of crop models.

4. Establish and document a historical daily meteorological data base of worldwide WMO stations containing maximum-minimum temperatures, precipitation, snow cover, average dew point depression, cloud amount, and type (hi, lo, mid) and average wind speed.

5. Integrate direct/indirect technological and economic variables into at least one empirical yield model for barley, corn, soybeans, and wheat.

6. Install a feedback loop (reset capability) in at least one plant process model for each of four crops.

7. Prepare specifications for a yield model using spectral inputs and satellite derived meteorological variables.
B. Agency Responsibilities

1. General Responsibilities

The general agency responsibilities are as follows:

a. USDA

- Lead responsibility for plant process oriented yield model development (foreign and domestic)
- Yield model acquisition, development, testing, and evaluation. Select yield models for application tests
- Develop and verify agricultural data bases
- Coordinate or provide needed ground data collection

b. USDC

- Lead responsibility for statistical regression-type yield model development
- Yield model acquisition, development, testing and evaluation
- Develop and verify meteorological data bases
- Develop or refine meteorological measurements from environmental satellites
- Participate in adapting spectral data for model input

c. NASA

- Assist in yield model development and evaluation
- Provide Landsat data acquisition and RD&T data base development
- Provide RD&T spectral inputs to yield models

d. USDI

- Provide Landsat data storage, retrieval and dissemination
III. RESOURCE SUMMARY

A. DOLLAR RESOURCES

1. By Agency

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA</td>
<td></td>
</tr>
<tr>
<td>USDC NOAA-EDIS</td>
<td>1196</td>
</tr>
<tr>
<td>USDC NWS-CAC</td>
<td>450</td>
</tr>
<tr>
<td>USDA SRS</td>
<td>750</td>
</tr>
<tr>
<td>USDA ARS</td>
<td>2500</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4896</td>
</tr>
</tbody>
</table>

2. By Agency and Location

<table>
<thead>
<tr>
<th>Agency/Location</th>
<th>FY83($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA-Columbia</td>
<td></td>
</tr>
<tr>
<td>USDC NOAA</td>
<td></td>
</tr>
<tr>
<td>EDIS-Columbia</td>
<td>784</td>
</tr>
<tr>
<td>EDIS-Washington</td>
<td>322</td>
</tr>
<tr>
<td>EDIS-Houston</td>
<td>90</td>
</tr>
<tr>
<td>NWS-Washington</td>
<td>450</td>
</tr>
<tr>
<td>SUBTOTAL</td>
<td>1646</td>
</tr>
<tr>
<td>USDA</td>
<td></td>
</tr>
<tr>
<td>SRS-Washington</td>
<td>390</td>
</tr>
<tr>
<td>SRS-Columbia</td>
<td>311</td>
</tr>
<tr>
<td>SRS-Houston</td>
<td>49</td>
</tr>
<tr>
<td>ARS Sites</td>
<td>2500</td>
</tr>
<tr>
<td>SUBTOTAL</td>
<td>3250</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4896</td>
</tr>
</tbody>
</table>

3. By Category (FY83) $K

<table>
<thead>
<tr>
<th>Civil Servants</th>
<th>University</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NOAA</td>
<td>846</td>
<td>580</td>
<td>220</td>
</tr>
<tr>
<td>USDA</td>
<td>3049</td>
<td>181</td>
<td>20</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3895</td>
<td>761</td>
<td>240</td>
</tr>
</tbody>
</table>
### B. STAFFING RESOURCES - FY83

<table>
<thead>
<tr>
<th></th>
<th>Civil Servants</th>
<th>University/ Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAA</td>
<td>18.8</td>
<td>9.0</td>
</tr>
<tr>
<td>USDA</td>
<td>42.1</td>
<td>5.4</td>
</tr>
<tr>
<td>NASA</td>
<td>4.0</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>61.9</strong></td>
<td><strong>14.4</strong></td>
</tr>
</tbody>
</table>
IV. SUMMARY OF TASKS TO BE COMPLETED

TASKS AND FUNDING BY AGENCY

<table>
<thead>
<tr>
<th>ELEMENT 1 - EVALUATION OF CROP YIELD MODELS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1 Evaluation Criteria</td>
<td>28</td>
</tr>
<tr>
<td>Task 2 Identify Models</td>
<td>25</td>
</tr>
<tr>
<td>Task 3 Acquire Models</td>
<td>35</td>
</tr>
<tr>
<td>Task 4 T&amp;E of Models</td>
<td>48</td>
</tr>
<tr>
<td>Task 5 Monitor Test Activity</td>
<td>50</td>
</tr>
<tr>
<td>Subtotal</td>
<td>186</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELEMENT 2 - MODEL RESEARCH AND DEVELOPMENT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1 Technology Economics</td>
<td>-</td>
</tr>
<tr>
<td>Task 2 Empirical Models</td>
<td>46</td>
</tr>
<tr>
<td>Task 3 Stratification Alternatives</td>
<td>-</td>
</tr>
<tr>
<td>Task 4 Wheat</td>
<td>-</td>
</tr>
<tr>
<td>Task 5 Soybeans</td>
<td>-</td>
</tr>
<tr>
<td>Task 6 Cotton</td>
<td>-</td>
</tr>
<tr>
<td>Task 7 Corn and Sorghum</td>
<td>-</td>
</tr>
<tr>
<td>Subtotal</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELEMENT 3 - DATA ACQUISITION PROCESSING &amp; STORAGE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1 Historical Met Data</td>
<td>322</td>
</tr>
<tr>
<td>Task 2 Historic Ag Data</td>
<td>-</td>
</tr>
<tr>
<td>Task 3 Met Data Base</td>
<td>450</td>
</tr>
<tr>
<td>Subtotal</td>
<td>772</td>
</tr>
<tr>
<td>Task 1</td>
<td>Define Spectral Inputs</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Task 2</td>
<td>Spectral Info for Yield Estimation</td>
</tr>
<tr>
<td>Task 3</td>
<td>Real Time Model Test</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
</tr>
</tbody>
</table>

### ELEMENT 5-SUPPORT PROGRAMS

<table>
<thead>
<tr>
<th>Task 1</th>
<th>Support Personnel</th>
<th>USDc</th>
<th>USDA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 2</td>
<td>AgRISTARS Liaison</td>
<td>13</td>
<td>49</td>
<td>62</td>
</tr>
<tr>
<td>Task 3</td>
<td>New Tasks for FY83-85</td>
<td>11</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>37</td>
<td>106</td>
<td>143</td>
</tr>
</tbody>
</table>

**TOTAL PROJECT**

<table>
<thead>
<tr>
<th>USDc</th>
<th>USDA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1646</td>
<td>3250</td>
<td>4896</td>
</tr>
</tbody>
</table>
V. MAJOR PROJECT ELEMENT #1: EVALUATION OF CROP YIELD MODELS
5 TASKS

WBS: 03-01-01-00-32-(28)-04-(28)-01-(08)
-37-(20)
12-(70)-01-(56)-01-(50)
-86-(06)
-04-(14)-01-(14)

Yield models from the literature, developed by various scientists for other users, and developed within the AgRISTARS will be evaluated for specific applications within AgRISTARS and/or USDA. Models selected for evaluation will be described in terms of their capabilities and limitations, as defined by the YMD yield model evaluation criteria. Evaluations will also attempt to identify areas in which model deficiencies may be corrected by additional research.

A. TASK 1: CRITERIA AND PROCEDURES FOR EVALUATING CROP YIELD MODELS

1. Objective

To establish evaluation criteria and procedures which will enable evaluators to provide useful and meaningful information to potential models users, both in USDA and/or in AgRISTARS, about the models evaluated.

2. Scope

Criteria and evaluation procedures will be completed for all crop yield models to be evaluated in the YMD.

3. Duration

To be completed by April 1, 1983.

4. Anticipated Results and Products

Documents which identify the evaluation criteria and procedures to be used.

5. Subtasks

a. Subtask 1: Development of Improved Evaluation Procedures

(1) Objective

To develop improved procedures for use in the crop yield model evaluation process.
(2) Technical Approach

In cooperation with the Statistics Dept. of the University of Missouri, determine the feasibility of developing the new or improved evaluation procedures. Where such procedures are feasible, develop specifications for their use.

(3) Anticipated Results and Products

Determinations as to whether or not indicated lines of research are feasible, and specifications for the use of new or improved evaluation procedures where feasible.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD
Subtask Manager: Jeanne Seabaugh
USDA SRS/SRD-Columbia

b. Subtask 2: Sensitivity Analysis

(1) Objective
To investigate various types of sensitivity analysis

(2) Technical Approach
TBD

(3) Anticipated Results and Products
TBD

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD
Subtask Manager: Fred Baker, USDA SRS/SRD Washington

c. Subtask 3: Revisions of YMD Yield Model Evaluation Criteria and Procedures

(1) Objective
Update the YMD yield model evaluation criteria and procedures as indicated by (a) user needs, (b) experiences in evaluating yield models with the existing criteria and procedures, (c) evaluations of different types of crop yield models, and/or (d) the development of new or improved evaluation procedures.

(2) Technical Approach

As indicated by any of the factors listed above, review and update the YMD yield model evaluation criteria and procedures.

(3) Anticipated Results and Products

Documented evaluation criteria and procedures which will be more effective in the evaluation of crop yield models and which will lead to evaluations which will be more useful to potential users in determining which candidate models have the most potential for particular applications.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: Fred Warren, USDA SRS/SRD Washington

6. Task Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Task Coordinator: Fred Warren, USDA SRS/SRD Washington

7. Funding Requirements

a. Agency Funding

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83($)K</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>14</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>56</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>28</td>
</tr>
<tr>
<td>NASA*</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
</tr>
</tbody>
</table>

*Funding for NASA personnel not included.
b. Manyear Equivalents

(1) Civil Servants

USDA SRS-Washington 0.3
USDA SRS-Columbia 1.0
USDC NOAA-Columbia 0.3
NASA-Columbia 0.1
Total 1.7

(2) University

USDA SRS, Univ. of Georgia 0.2
USDC NOAA, Univ. of Missouri 0.2
Total 0.4

8. Task Schedule and Milestones

Publish new evaluation criteria--April 1983

9. Interfaces

Other AgRISTARS projects--ITD

Other major Project Elements--Element #2, Methods for Identifying Feasible Research Areas

Within Project Element #1--all other tasks

10. Data Acquisition, Preprocessing, Processing, Distribution, and Retention Requirements.

Documents will be available for distribution to related AgRISTARS projects and for use and retention by YMD.
B. TASK 2: REVIEW CROP YIELD MODELS AND IDENTIFY CANDIDATE MODELS FOR ACQUISITION AND TESTING.

WBS#: 03-01-02-01-00-32-(25)-04-(25)-01-(05)
       -37-(20)
       12-(15)-01-(10)-01-(10)
       -04-(05)-01-(05)

1. **Objective**

   Review potentially useful crop yield models and identify the most promising models for acquisition and subsequent testing.

2. **Scope**

   All potential crop yield models for crops under investigation by the YMD project.

3. **Duration**

   April 1, 1983

4. **Anticipated Results and Products**

   Listing of the potentially useful crop yield models and identification of most promising models. Decision on selection of candidate models for testing and evaluation.

5. **Subtasks**

   a. **Subtask 1: Describe Model Applications in Detail**

      (1) **Objective**

         Describe applications for which crop yield models are needed in detail. Define both domestic and future foreign aspects of each application.

      (2) **Technical Approach**

         Determine requirements for each application and mutually determine objectives of the application.

      (3) **Anticipated Results and Products**

         Document describing each application for which crop yield models are needed.
(4) Test Sites
AgRISTARS regions for application tests

(5) Organization and Responsibilities
Lead Organization: USDA SRS/SRD
Subtask Managers: William Arends, USDA SRS/SRD-Washington
Tom Barnett, NASA-Columbia

b. Subtask 2: Identify Potential Models

(1) Objective
Identify models with a potential for meeting the requirements described in Subtask 1.

(2) Technical Approach
From a literature review of empirical and plant process oriented models using either monthly or daily inputs, prepare a concise description of each model that meets the criteria for test and evaluation.

(3) Anticipated Results and Products
A document describing each model or model component with an evaluation of the potential the model or component has of fulfilling the user requirements.

(4) Test Sites - NA

(5) Organization and Responsibilities
Lead Organization: USDC NOAA/EDIS
Subtask Managers: Tom Hodges, USDC NOAA/EDIS-Columbia
Fred Baker USDA SRS/SRD-Washington

c. Subtask 3: Select Candidate Models for Testing and Evaluation

(1) Objective
Select candidate models to be evaluated for each application.
(2) Technical Approach

Utilize internal project document, "Criteria for Identifying Candidate Yield Models" to select models for testing and evaluation with full consideration of application descriptions.

(3) Anticipated Results and Products

Selection of candidate models for testing and evaluation.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Managers: Wendell Wilson, USDA SRS/SRD-Columbia

Clarence Sakamoto, USDC NOAA-EDIS-Columbia

6. Task Organization and Responsibility

Lead Organization: USDA SRS/SRD

Task Coordinators: Wendell Wilson, USDA SRS/SRD-Columbia

Clarence Sakamoto, USDC NOAA/EDIS-Columbia

7. Resource Requirements

a. Agency - Funding

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83($)K</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>5</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>10</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>25</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

b. Manyear Equivalents

(1) Civil Servants

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>.1</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>.2</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>.2</td>
</tr>
<tr>
<td>NASA</td>
<td>.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>.7</strong></td>
</tr>
</tbody>
</table>
8. **Task Schedule and Milestones**

List of candidate models - February 1983

9. **Interfaces**

Other AgRISTARS Projects - EW and SR.
Other Major Project Elements - None
Within Project Element #1 - Task 1, 3 and 4.

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements.**

Documents will be maintained within YMD Project.
C. TASK 3: ACQUIRE DETAILED DOCUMENTATION, COMPUTER PROGRAMS AND NECESSARY DATA SETS FOR CANDIDATE MODELS.

WBS#: 03-01-03-01-00-32-(35)-04-(35)-01-(5)
     -37-(30)
     12-(34)-04-(15)-01-(15)
     -01-(19)-01-(19)

1. Objective
   Acquire documentation, computer programs and data sets needed to allow testing and evaluation of candidate yield models.

2. Scope
   All candidate models identified in Task 2

3. Duration
   April 1, 1983

4. Anticipated Results and Products
   The detailed documentation, computer programs and necessary data sets for use by YMD in testing and evaluating crop yield models will be available.

5. Subtasks
   a. Subtask 1: Survey Literature and/or Contact Developers to Assemble Complete Model Documentation, Including Computer Programs.
      (1) Objective
          Obtain documentation and computer programs for each candidate model.
      (2) Technical Approach
          Survey available literature and as necessary contact model developers for additional information. Assemble documentation and computer programs for each model selected for testing.
      (3) Anticipated Results and Products
          Complete descriptions of each candidate model.
      (4) Test Sites - NA

(1) Objective

Obtain data sets needed to test each candidate crop yield model.

(2) Technical Approach

Using information obtained by surveying the literature or that provided by model developers, identify and obtain additional data sets needed. With help of model "sponsors" or independently, if necessary, prepare specifications for test and evaluation.

(3) Anticipated Results and Products

Data sets and specifications for testing candidate models will be available (Task 4).

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Managers: Wendell Wilson, USDA SRS/SRD-Columbia
                Fred Baker, USDA SRS/SRD-Washington
                Tom Hodges, Univ. of Missouri-Columbia

6. Task Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Task Coordinators: Galen Hart, USDA SRS/SRD-Washington
                  Clarence Sakamoto, USDC EDIS-Columbia
7. **Resource Requirements**

a. **Agency - Funding**

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>15</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>19</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>35</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>69</strong></td>
</tr>
</tbody>
</table>

b. **Manyear Equivalents**

(1) **Civil Servants**

<table>
<thead>
<tr>
<th>Agency</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>0.3</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>0.4</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>0.9</strong></td>
</tr>
</tbody>
</table>

(2) **University and Others**

<table>
<thead>
<tr>
<th>Agency</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Univ. of Missouri</td>
<td>0.2</td>
</tr>
</tbody>
</table>

8. **Task Schedule and Milestones**

Models Identified - December 1982
Request Documentation and Software - January 1983
Receive and Review Model Documentation - February 1983

9. **Interfaces**

Other AgRISTARS Projects - EW and SR.
Other Major Project Elements - None
Within Project Element #1 - Task 2 and 4.

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements**

Acquisition of model descriptions, documentation, computer programs and necessary data sets. Information and data sets for each model are retained for use in model testing and evaluation and for future use in model development.
D. TASK 4: CONDUCT TEST AND EVALUATION OF CANDIDATE CROP YIELD MODELS

WBS#: 03-01-04-01-00-12-(114)-01-(64)-01-(14)
       -37-(30)
       -99-(20)
       -04-(50)-01-(50)
       -32-(48)-04-(48)-01-(08)
       -37-(40)

1. Objective
Select crop yield models for various application tests in the AgRISTARS program, describe the capabilities and limitations of models evaluated and identify areas of feasible research for improvement of both selected and non-selected models.

2. Scope
Test and evaluation of all candidate models for each application.

3. Duration
July 1, 1983

4. Anticipated Results and Products
Selection of models for application tests. Reports describing tests, evaluation, and selection of models which also provide a description of each model’s limitations and capabilities and identify feasible research areas.

5. Subtasks

      (1) Objective
      For each candidate model, carry out tests as described in the project document, "Crop Yield Model Test and Evaluation Criteria," and apply other methods developed in Task 1.

      (2) Technical Approach
      Utilize the project document developed in Task 1 and additional specifications, to carry out tests for each individual candidate model.
(3) Anticipated Results and Products

Test results for each candidate model.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Managers: Jeanne Sebaugh, USDA SRS/SRD-Columbia
Fred Baker, USDA SRS/SRD-Washington
Vikki French, Univ. of Missouri-Columbia
Tom Barnett, NASA-Columbia

b. Subtask 2: Comparatively Evaluate Candidate Yield Models for Each Application and Provide Recommendations

(1) Objective

Evaluate candidate models for each application and recommend the best model(s) for use in application testing. Describe model capabilities and limitations.

(2) Technical Approach

Using test results developed in Subtask 1 compare the results for each candidate model and comparatively determine the best model for an application. Prepare written reports which summarize test and evaluation results and recommend model(s) for further testing.

(3) Anticipated Results and Products

Reports on test and evaluation results. Recommendation of models to use in application tests. Descriptions of model capabilities and limitations.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA/SRS/SRD
Subtask Managers: Fred Baker, USDA SRS/SRD-Washington
Jeann Sebaugh, USDA SRS/SRD-Columbia
Vikki French, Univ. of Missouri Columbia
Tom Barnett, NASA-Columbia

c. Subtask 3: Identify Areas of Feasible Research Based Upon Test and Evaluation Activities.

(1) Objective
Identify areas for feasible research

(2) Technical Approach
Based upon test and evaluation results developed in Subtasks 1 and 2, summarize findings about individual models and identify most promising possibilities for future research. The areas identified will be those that seem to have the greatest potential for improving model capabilities by modifications related to current model form and use.

(3) Anticipated Results and Products
Areas of feasible future research identified.

(4) Test Sites - NA

(5) Organization and Responsibilities
Lead Organization: USDA SRS/SRD
Subtask Managers: Wendell Wilson, USDA SRS/SRD-Columbia
Fred Baker USDA SRS/SRD-Washington
Tom Hodges, Univ. of Missouri-Columbia

6. Task Organization and Responsibilities

Lead Organization: USDA SRS/SRD
Task Coordinators: Wendell Wilson, USDA SRS/SRD-Columbia
Sharon LeDuc, USDC, NOAA/EDIS-Columbia

7. Resource Requirements

a. Agency - Funding

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>50</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>64</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>48</td>
</tr>
<tr>
<td>NASA</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>162</strong></td>
</tr>
</tbody>
</table>

b. Manyear Equivalents

<table>
<thead>
<tr>
<th>Civil Servants</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>1.0</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>0.3</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>0.3</td>
</tr>
<tr>
<td>NASA</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.8</strong></td>
</tr>
</tbody>
</table>

(2) University and Others

<table>
<thead>
<tr>
<th>University</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Univ. of Missouri</td>
<td>0.7</td>
</tr>
<tr>
<td>USDA SRS-Univ. of Columbia</td>
<td>0.4</td>
</tr>
<tr>
<td>USDA SRS-TBD</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.4</strong></td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

a. Test Corn Model-October 1982
   Test Soybean Model-February 1983
   Evaluate and Select Applicable Models - July 1983

b. Document Requirements for Improvements - July 1983
c. List Research Areas - July 1983

9. Interfaces

Other AgRISTARS Projects - EW, SR, SM and for ITD, selected models for use in application tests identified.

Other Major Project Elements - Element #2, feasible research areas

Within Project Element #1 - All tasks.
10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements**

Selected data on test and evaluation retained by YMD for possible additional testing and model development.
E. TASK 5: MONITOR APPLICATION TESTING ACTIVITIES

WBS#: 03-01-05-01-00-12-(10)-04-(10)-01-(10)-32-(50)-04-(50)-01-(30)-37-(20)

1. Objective

Monitor application testing activities and compare results with initial yield model tests (in YMD) and consider the potential impact of these results on other tasks in Major Project Element #1.

2. Scope

Application use of models by SRS and ARS.

3. Duration

Will be completed by July 1, 1983.

4. Anticipated Results and Products

Comparisons between application test results and yield model tests conducted in YMD. Identification of potential impact of application test results on other tasks in Project Element #1.

5. Subtasks


   (1) Objectives

   Review and evaluate reports provided by ITD and other on application tests results. Determine potential impact of application tests results on other Project Element #1 tasks.

   (2) Technical Approach

   Receive reports on application test results and review. As necessary, request additional information. Based on the results of Subtask 2, consider the potential impact on other tasks in the project element.

   (3) Anticipated Results and Products

   Reports on application testing activities reviewed and evaluated. Results available for further
analysis. Potential impact of application test results identified.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Managers: Wendell Wilson, USDA SRS/SRD-Columbia

Clarence Sakamoto, USDC NOAA EDIS-Columbia

b. Subtask 2: Identify Points of Consistency/Inconsistency Between Yield Model Evaluation and Comparison Results

(1) Objective

Identify the extent of agreement between yield model evaluation, comparison, and application test results.

(2) Technical Approach

Based on the review of application tests results and results from yield model evaluation and comparison activities, identify areas of agreement and disagreement.

(3) Anticipated Results and Products

Points of consistency/inconsistency identified.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS

Subtask Managers: Jean Sebaugh, USDA SRS-Columbia

Sharon LeDuc, USDC NOAA EDIS-Columbia

6. Task Organization and Responsibilities

Lead Organization: USDA SRS

Task Coordination: Wendell Wilson, USDA SRS-Columbia
7. Resource Requirements

a. Agency Funding

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83 (SK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>10</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

b. Manyear Equivalents

(1) Civil Servants

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83 (MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>0.2</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.3</strong></td>
</tr>
</tbody>
</table>

(2) University

<table>
<thead>
<tr>
<th>Agency</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Univ. of Missouri</td>
<td>0.1</td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

Schedule based on reports on production error estimates due to area of yield components.

9. Interfaces

Other Major Project Elements - none
Within Project Element #1 - all other tasks

10. Data Acquisition, Preprocessing, Processing, Distribution, and Retention Requirements

None, except as identified in this task.
VI. MAJOR PROJECT ELEMENT #2: CROP YIELD MODEL RESEARCH AND DEVELOPMENT - 7 TASKS

Research will be conducted to improve existing models and to develop alternative modeling concepts. As deficiencies are noted and research is conducted, those topics requiring further research support will be identified. Basic model components known to need further research efforts include work on the impact of production inputs (technology), soil moisture and heat stress, insect and plant diseases; and the use of crop calendar and spectral imagery information. The utilization of advanced statistical methods in variable selection of model development will be emphasized. Model development will progress from less complex forms which can be readily assembled from available data to more complex forms which will require extensive research and the collection of detailed plant observations for a wide range of growing conditions. Refinement of each model form will continue as new variables, improved measurement procedures and additional processes are understood.

A. TASK 1: CONDUCT RESEARCH TO QUANTIFY THE IMPACT OF TECHNOLOGICAL AND ECONOMIC FACTORS ON CROP YIELDS.

WBS#: 03-02-01-01-01-12-(89)-04-(89)-01-(64) 37-(25)

1. Objective

Develop procedures for measuring and forecasting the impact of technological and economic factors on crop yields, identify important factors by crop and area which impact on yield and acquire data on these factors, analyze the relationship between crop yields and technological and economic factors, and develop procedures which incorporate these factors into crop yield models.

2. Scope

Efforts will be concentrated on factors affecting corn, soybean and barley yields in the U.S. Midwest and adjoining areas. Foreign areas will be considered based upon progress and need.

3. Duration

To be transferred to DCAR.

4. Anticipated results and products

Reports which provide (a) a definition of technology as related to crop yield models and a summary of pertinent literature, (b) a theoretic basis for measuring and forecasting technological change, and (c) an
identification of technical and economic factors by crop and area. A procedure to estimate and indicator(s) of technological change and a pilot test in a yield forecasting model. Data sets acquired, edited, and ready for use and further analysis.

a. Subtask 1: Develop and refine procedures for measuring and forecasting the impact of technological and economic factors on crop yields.

(1) Objective

To continue to develop and refine procedures which measure and forecast the impact of technological and economic factors on crop yields.

(2) Technical Approach

Based on the technical and theoretical literature reviewed, contact with agricultural specialists and discussions with others concerned about technological and economic impacts on yields, develop draft research proposals; review proposed concepts and alternative measurement approaches and revise and refine as experience is gained; and prepare final report outlining concepts and approaches for measuring and forecasting the impact of these factors on yields.

(3) Anticipated Results and Products

Report on approaches and procedures for modeling the impact of technological and economic factors on crop yields.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: Merritt Padgitt, USDA SRS/SRD-Columbia

b. Subtask 2: Through literature reviews, professional contacts, and other means, identify important technological and economic factors impacting on yields, being crop and geographic specific where appropriate, and make arrangements to acquire or access relevant data sets.
(1) Objective

To identify and obtain data on relevant economic and technological factors.

(2) Technical Approach

Review agronomic crop production literature for regional information on yield responses to technological inputs and practices and review economic and farm production literature for information on adoption and yield contribution of various inputs and practices. Also, from reviewed literature and professional contacts, identify potential data and make necessary arrangements to obtain relevant data sets for further analysis and/or inclusion in yield models.

(3) Anticipated Results and Products

A report on identifying technological and economic factors by crop, time periods, and geographic areas; reference lists of potential data sets and on-line documented data sets available for use in other modeling tasks.

(4) Test Sites - Major U.S. corn, soybean, and barley production areas based on progress and need.

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD
Subtask Manager: Merritt Padgitt, USDA SRS/SRD-Columbia

(1) Objective

Based on analyses, determine relationships between crop yields and technological and economic factors, and develop indices or other means of incorporating these factors into crop yield models and pilot test in a specific areas.

Based on analyses, determine relationships between crop yields and technological and economic factors, and develop indices or other means for incorporating these factors into crop yield models. Make pilot tests of the technological indicator in a weather yield model.
(2) Technical Approach

Based on products of Subtask 1 and using data sets developed in Subtask 2 (Task 4, Element 3), perform analyses of relationships between economic and technological factors and crop yields.

Identify and quantify the most important relationships, conduct in-depth research to enhance understanding of the impact of critical factors and develop methods for including their effect in crop yield models.

(3) Anticipated Results and Products

Report of research findings and enhanced understanding of the relationship of crop yields to various technological and economic factors. Potential substitute variable(s) for use in other YMD tasks.

(4) Test Sites - To be determined from the major producing states.

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: Merritt Padgitt, USDA SRS/RD-Columbia

6. Task Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Task Coordinator: Merritt Padgitt, USDA SRS/RD-Columbia

7. Resource Requirements

a. Agency - Funding FY83($K)

USDA SRS-Columbia 89

b. Manyear Equivalents

(1) Civil Servants FY83(MYE)

USDA SRS-Columbia 1.3

(2) University and Others

USDA SRS-Univ. of Columbia 1.0
8. Task Schedule and Milestones

See page VI-6

9. Interfaces

Other AgRISTARS Projects - EW, SR and SM.
Other Major Project Elements - Element #3
Within Project Element #2 - Related to all research and development.

10. Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements

All data will be collected by the investigators or by cooperating institutions working with YMD. Processing, distribution and retention requirements will be coordinated within YMD.
### MPE Milestones and Schedules

<table>
<thead>
<tr>
<th>CY1982</th>
<th>CY1983</th>
</tr>
</thead>
<tbody>
<tr>
<td>JFMAMJASOND</td>
<td>JFMAMJASOND</td>
</tr>
</tbody>
</table>

1. **Evaluate Analysis Software**

2. **Develop Technology for:**

3. **Corn**

4. **Soybeans**

5. **Barley**

6. **Test Technology Indices and Techniques for:**

7. **Corn**

8. **Soybeans**

9. **Barley**

10. ****

---

**MPE 2, Task 1**

Conduct research to quantify the impact of technological and economic factors.
B. TASK 2: CONDUCT RESEARCH TO DEVELOP AND DOCUMENT ADDITIONAL OR MODIFIED EMPIRICAL CROP YIELD MODELS.

WBS#: 03-U2-02-01-U0-32-(46)-C4-(46)-C1-(16)-37-(30)-12-(94)-01-(40)-37-(40)-U4-(54)-04-(54)

1. Objective

The development and documentation of additional or modified empirical crop yield models with improved forecasting and estimation capabilities.

2. Scope

Empirically based crop yield models for various "crop-country" or "crop-state" combinations as specified by users.

3. Duration

April 1, 1983, to be included in DCAR.

4. Anticipated Results and Products

Modified models and additional models developed and documented which have potential for providing improved yield forecasts and estimates.

5. Subtasks


   (1) Objective

   To provide a review of methods utilized in forecasting and estimating yields.

   (2) Technical Approach

   Acquire new literature on current operational and research methods used in the U.S.S.R., U.S.A. and other selected countries. Review literature, identify most promising methods and seek additional information required to fully describe the methods.

   (3) Anticipated Results and Products

   Description of promising operational and research methods referenced to the literature reviewed.

   (4) Test Sites - NA

   VI-7
(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: Felix Kogan, USDA SRS/RD-Columbia
               Clarence Sakamoto, USDC NOAA/EDIS-Columbia


(1) Objective

Determination of supporting research needs and development of proposed research to be conducted within the YMD project.

(2) Technical Approach

For each research area that is identified based on model tests and evaluation, identify subjects which can be successfully researched within YMD and those which require more intensive supporting research efforts. Propose specific research projects to be performed within the YMD project.

(3) Anticipated Results and Products

Supporting research needs identified. YMD research projects identified and proposals developed.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Managers: Wendell Wilson, USDA SRS/SRD-Columbia
                  Clarence Sakamoto, USDC NOAA/EDIS-Columbia

(c. Subtask 3: Conduct YMD Research Projects to Develop and Document Improved Empirical Crop Yield Models.

(1) Objective

Development and documentation of improved empirical yield models.
(2) Technical Approach

Based on project proposals, developed in Subtask 2, domestic and foreign model needs: obtain necessary data sets, conduct analyses and develop improved empirical crop yield models. Technology factors will be indirectly quantified and integrated into empirical models. Document models for their use in future research and development efforts, and to facilitate their test and evaluation.

(3) Anticipated Results and Products

Development and documentation of improved empirical crop yield models.

(4) Test Sites - User specified foreign and domestic areas.

(5) Organization and Responsibilities

Lead Organization: USDC, NOAA/EDIS
Subtask Manager: Clarence Sakamoto, USDC NOAA/EDIS-Columbia
Felix Kogan, USDA SRS/SRD-Columbia


(1) Objective

Develop semi-empirical process models for wheat, corn, and soybeans.

(2) Technical Approach

Using current research methods, adapt and integrate key processes derived from published literature, integrate models of submodels to simulate wheat, corn, and soybean plant processes.

Daily meteorological data will be used to accumulate growing degree days and/or photo thermal units over planting to harvest periods. These data will be apportioned to the key plant processes as appropriate.

(3) Anticipated Results and Products

Documented models and computer programs.
(4) Test Sites
(a) Wheat--North Dakota and Argentina
(b) Corn and soybeans--Iowa, Argentina, Brazil

(5) Organization and Responsibilities
Lead Organization: USDC NOAA/EDIS
Subtask Manager: Sharon LeDuc, USDC NOAA/EDIS-Columbia

6. Task Organization and Responsibilities
Lead Organization: USDA SRS/SRD
Task Coordinators: Wendell Wilson, USDA SRS/SRD-Columbia
Clarence Sakamoto, USDC NOAA/EDIS-Columbia

7. Resource Requirements
a. Agency Funding FY83($K)

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Washington</td>
<td>40</td>
</tr>
<tr>
<td>USDA SRS-Columbia</td>
<td>54</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>46</td>
</tr>
<tr>
<td>TOTAL</td>
<td>140</td>
</tr>
</tbody>
</table>

b. Manyear Equivalents
(1) Civil Servants FY83(MYE)

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>1.1</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>0.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1.7</td>
</tr>
</tbody>
</table>

(2) University and Others

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS, Univ. of Missouri</td>
<td>1.0</td>
</tr>
<tr>
<td>USDC NOAA, Univ. of Missouri</td>
<td>0.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1.1</td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones
TBD
9. **Interfaces**

Other AgRISTARS Projects - SR, EW, SM and ITD.

Other Major Project Elements - Element #1 and Element #4.

Within Project Element #2 - Related to all research and development.

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements**

Data acquired in MPE 2, Task 1 and MPE 3, Task 4, will be required for quantification of technology factors.
C. TASK 3: INVESTIGATE STRATIFICATION ALTERNATIVES FOR EMPIRICAL CROP YIELD MODELS

WBS#: 03-02-03-01-00-12-(25)-04-(25)-01-(25)

1. Objective

To investigate various stratification alternatives for crop yield models, evaluate procedures for forming strata and assess the impact on yield model reliability for large areas.

2. Scope

Selected domestic and foreign crop growing regions.

3. Duration

To be included in DCAR plan for future years.

4. Anticipated Results and Products

Evaluation of yield forecast and estimate reliability for various stratification procedures. Determination of stratification designs for foreign areas and future domestic applications.

5. Subtasks

a. Subtask 1: Investigate the Impact on Crop Yield Model Performance of Stratification by Mutually Determined Domestic Agrophysical Units (APU's).

(1) Objective

Investigate the impact on model performance of stratification by mutually determined APU's as compared to stratification by crop reporting districts (CRDs) and no stratification (state level models).

(2) Technical Approach

Execute empirical crop yield models by APU's, CRDs and at the state level for corn and soybeans in Indiana and Illinois and wheat and barley in North Dakota. Possibly extend wheat and barley coverage to Minnesota and Montana. Evaluate yield forecast and estimate performance for no stratification and with the two types of stratification. Performance will be evaluated primarily at the state and region level.
(3) Anticipated Results and Products
Determination of the impact on model performance of three alternative methods of stratifying crop areas.

(4) Test Sites - Iowa, North Dakota, Illinois, Indiana, Minnesota, and Montana.

(5) Organization and Responsibilities
Lead Organization: USDC NOAA/EDIS
Subtask Manager: Clarence Sakamoto, USDC NOAA/EDIS-Columbia


(1) Objective
Identify methods of stratification which produce more reliable yield estimates.

(2) Technical Approach
Investigate methods of stratification which may produce internally more homogeneous strata for model input variables, relationships modeled and/or yield. Evaluate the reliability of large area yield forecasts and estimates when various stratification procedures are used.

(3) Anticipated Results and Products
Reports describing methods of stratification used and their impact on reliability of large area yield estimates and forecasts.

(4) Test Sites - Iowa, North Dakota, Illinois, Indiana, and possibly an area with less adequate meteorological data.

(5) Organization and Responsibilities
Lead Organization: USDA SRS/SRD
Subtask Managers: Wendell Wilson, USDA SRS/SRD-Columbia

c. Subtask 3: Participate in the determination of stratification designs for foreign areas and future domestic applications.

VI-13
(1) Objective

Determine stratification designs for foreign areas and in future domestic applications which include full consideration for both yield model reliability and crop area estimation, and are thus targeted for maximum reliability in forecasting and estimating production.

(2) Technical Approach

Confer with ITD and others designing application tests and participate in determining stratification designs.

(3) Anticipated Results and Products

Mutual determination of stratification designs for foreign areas and future domestic applications.

(4) Test Sites - TBD

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Managers: Wendell Wilson, USDA SRS/RD-Columbia

Clarence Sakamoto, USDC NOAA/EDIS-Columbia

e. Subtask 4: Develop Algorithms for Determining Similarity Areas for Crop Yield Model Application

(1) Objective

To provide information on potential success of model application to areas other than where model was developed.

(2) Technical Approach

Using clustering techniques, various types of attributes including agroclimatic, pedological, crop moisture, and historical production indices will be analyzed with the aid of the computer.

(3) Anticipated Results and Products

Report of methodology and factors considered for testing algorithms to establish similarity areas.
(4) Test Site: Selected areas in U.S., Brazil, and Argentina

(5) Organization and Responsibilities

Lead Organization: USDC NOAA/EDIS
Subtask Manager: Clarence Sakamoto, USDC NOAA/EDIS-Columbia

6. Task Organization and Responsibilities

Lead Organization: USDA SRS/SRU
Task Coordinator: Wendell Wilson, USDA SRS/SRD-Columbia

7. Resource Requirements

a. Agency - Funding
USDA SRS-Columbia 25

b. Manyear Equivalents
(1) Civil Servants
USDA SRS-Columbia .5

8. Task Schedule and Milestones

TBD

9. Interfaces

Other AgRISTARS Projects - ITU and SR, mutual determination of stratification designs.
Other Major Project Elements - Element #3, Task 2, 4, 5, & 6; Element #1, Task 4.
Within Project Element #2 - Related to all research and development

10. Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements

Acquisition in suitable format of historic meteorological and agricultural data. Acquisition of ancillary data needed to conduct stratification.
D. TASK 4: WHEAT YIELD MODEL DEVELOPMENT

WBS#: U3-02-04-01-00-13-(990)-06-(990)-01-(990)
-12-(25)-01-(25)-01-(25)

1. Objective

To develop physiological and phenological yield models for wheat.

2. Scope

For major wheat growing areas of the United States with probable extension to foreign areas.

3. Duration

Three to five years.

4. Anticipated Results and Products

Physiological and phenological wheat yield models to provide wheat yield estimates for the United States and potentially for foreign areas.

5. Subtasks

a. Subtask 1: Research coordination and integration for the development of physiological and phenological yield models for wheat.

   (1) Objective

   o Research on the development of physiological and phenological wheat yield models.

   o Coordinate ARS research and field data collection efforts to support wheat yield model development and testing.

   o Coordinate ARS with SRS so that models developed can be utilized and integrated for improved crop forecasting and estimation.

   (2) Technical Approach

   o Aid in collecting field data for use in testing and validating yield model development.

   o Data compilation from field sites.
o Develop algorithms for a model from existing data and new data to simulate wheat growth and yield.

o Test and validate yield models.

o Coordinate with ARS, SRS and NASA the sites to integrate research findings into model development.

(3) Anticipated Results and Products

o Field base on representative wheat growth from 20 sites in the southern, central, and northern Great Plains and Pacific Northwest.

o Research results from ARS sites to support wheat model development.

o Development of algorithms to support a wheat growth and development model.

o Operative phenological-based wheat yield model.

(4) Test Sites: Fort Collins, Colorado

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: Wayne Willis, ARS-Ft. Collins, Colorado

D. Heermann (data compilation), ARS Ft. Collins, Colorado

b. Subtask 2: Determine basic relationships of remotely sensed crop reflectance data as related to the wheat growth cycle.

(1) Objective

o To determine basic relationships between remotely sensed canopy temperatures and reflectances as related to growth stage, biomass, leaf area index and other plant parameters under several water stress and environmental conditions, and to make these relationships independent of time of day, time of year, and latitude.

o To cooperate and assist in developing a wheat yield model.
(2) Technical Approach

- Analysis of extensive data sets from an experiment which included:
  
  a) Field plots were planted to wheat at intervals of 4 to 6 weeks under the same soil and atmospheric environmental conditions.
  
  b) Meteorological and reflectance measurements, which were collected on a scheduled basis, on the field plots.
  
  c) Plant samples were taken from each plot twice each week. Biomass, leaf area index, plant height, growth stage, and other plant parameters were measured. Soil water content was monitored three times per week in each plot at 20 cm. intervals to a depth of 160 cm.

(3) Anticipated Results and Products

Analysis of the experiment should provide basic data on the relationships between environmental, soil, and plant conditions and the spectral reflectance and radiometric temperatures of wheat. Planting wheat at different times of year caused similar environmental stresses (heat, water, etc.) to occur simultaneously to crops at different growth stages. This information should be useful in meteorological yield models. The time sequence of radiometric measurements for wheat under these various conditions should provide information that will aid in the detection and identification of crop stresses utilizing satellite data.

(4) Test Sites: The U.S. Water Conservation Laboratory, Phoenix, Arizona

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: Ray Jackson, ARS-Phoenix, AZ

c. Subtask 3: Determine winter wheat morphological development

(1) Objective

- To determine wheat morphological development from field sites for use in development and/or testing
of algorithms for winter wheat yield prediction models.

- To collect field data to assist in developing relationships between crop status and remotely sensed data, and in providing validation of wheat yield models.

- To assist in the development of wheat yield models.

(2) Technical Approach

Hard red winter wheat will be grown where soil water will be limiting during one or more growth stages or where water will never be limiting. Hot winds will be artificially applied via a wind tunnel during jointing, boot, heading, flowering, and grain filling growth stages for periods 1, 2, 4 and 12 hours (time permitting for 12) at velocities of 32 and 64 km/h with temperature at ambient and increases of 5°C above ambient. Plant water potential, dew point temperature, saturation deficit, and relative humidity will be monitored during each test. Leaf and tiller abortion will be recorded following each test and head number per unit area, kernel number per head, and kernel weight will be determined at maturity.

Collect data for wheat yield model at field locations.

(3) Anticipated Results and Products

- Determine the effect of duration and different wind velocities at various growth stages and different temperatures on crop condition and yield.

- Effect of humidity on crop condition and yield at various growth stages.

- Collect field data for model validation.

(4) Test Sites: U.S. Central Great Plains Research Station, Akron, Colorado

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: Darryl Smika, ARS

Akron, Colorado
d. Subtask 4: Develop and assess parameters for input to a physiological wheat yield model.
   (1) Objective

   Conduct basic research on the physiological aspects of wheat to complete the development of a physiological process oriented wheat yield model.

   (2) Technical Approach

   Collect field data and conduct research using SPAR units to obtain physiological wheat data for analysis, development, and testing of a yield model.

   (3) Anticipated Results and Products

   An operational physiological process wheat model.

   (4) Test Sites: Mississippi State, Mississippi

   (5) Organization and Responsibilities

   Lead Organization: USDA ARS

   Subtask Manager: D. N. Baker, ARS, Mississippi

e. Subtask 5: Research to support the development of a phenological-based winter wheat model.

   (1) Objective

   Establish field and laboratory experiments for the collection of wheat growth data to support the development and validation of a phenological-based winter wheat model.

   (2) Technical Approach

   o Collect data for phenological-based winter wheat model at two locations, with particular emphasis on factors contributing to winterkill.

   o Determine growth and morphological development of wheat for use in developing and testing algorithms for a wheat yield prediction model.

   o Evaluate the use of a three-band radiometer to predict dry matter accumulation in wheat as influenced by micro-climatic parameters associated with crop residue and soil management variables.
(3) Anticipated Results and Products

A validation data set for use in testing and evaluating a phenological winter wheat model, and expected limits governing winterkill.

(4) Test Sites: Sidney, Montana

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: J. K. Aase, ARS, Sidney, Montana

f. Subtask 6: Develop and/or test various spring wheat development and yield models.

(1) Objective

- Develop and/or test various models describing spring wheat development and yield.
- Evaluate the efficiency of a three-band radiometer to predict dry matter accumulation in spring wheat cultivars.
- Evaluate the effects of air temperature and soil fertility on inflorescence development in spring wheat.
- Evaluate the effects of water stress and nitrogen fertility on development of spring wheat.

(2) Technical Approach

Collect and evaluate data on spring wheat morphological development in relation to soil and atmospheric environmental factors.

(3) Anticipated Results and Products

- Models for spring wheat development and yield.
- Data base for model testing.
- Information to aid mitigation of stress effects on wheat growth and yield.

(4) Test Sites: Mandan, North Dakota

(5) Organization and Responsibilities

Lead Organization. USDA ARS

VI-21
Subtask Manager: A. Black, A. Bauer, ARS, Mandan
North Dakota

Subtask 7: Research to support winter wheat yield model development from physiological measurements and satellite imagery.

(1) Objective
Test developed models for predicting crop yield from physiological measurements and satellite imagery.

(2) Technical Approach
- Determine phenological development of wheat at three precipitation zone sites for the testing and development of a winter wheat yield model to describe dry matter and grain yields.
- Evaluate the efficiency of a three-band radiometer for estimating green biomass accumulation in winter wheat, and other management or microclimatic factors that affect radiation balance.

(3) Anticipated Results and Products
A winter wheat yield model for the Northwest U.S. wheat area

(4) Test Sites: Three sites in different precipitation zones within the dry-farmed agriculture region of eastern Oregon and Washington.

(5) Organization and Responsibilities
Lead Organization: USDA ARS
Subtask Manager: R. E. Ramig, ARS, Pendleton, Oregon

h. Subtask 8: Crop Water Stress Assessment

(1) Objective
- To evaluate water deficits on grain yield.
- To provide data to assess model prediction of soil water balance under deficit conditions.
- To evaluate thermal IR and spectral reflectance to assess plant water stress.
To assess yield components for various cultivars with water and nutrients both limiting and non-limiting.

(2) Technical Approach

- Collect data on CR5 instrumented sites in the southern part of the winter wheat growing region.

- Assess how water deficits reduce actual yields below potential by influencing developing yield components during successive development stages. Yield components will include plants per m², tiller and head number per plant and per m², spikelets per head, grain number per spikelet, per head and per m², and grain weight.

(3) Anticipated Results and Products

Improved information on the relationship between water and nutrient deficits and wheat yield for incorporation into a winter wheat yield model.

(4) Test Sites: Bushland, Texas

(5) Organization and Responsibilities

Lead Organization: USDA ARS
Subtask Manager: J. T. Musick, ARS, Bushland, TX

i. Subtask 9: Development of ecological based wheat yield models and improved wheat crop calendar.

(1) Objective

- Develop, test and document ecological based wheat yield models that include genetic, management and soils details.

- Improve the accuracy of the wheat crop calendar.

(2) Technical Approach

- Field and phytotron studies to determine climate, genetic interactions as related to crop calendars for use in accurately defining the time of events in crop yield models.

- Determine critical relationships between climate, management, and genetic characteristics as related to crop yield components used in crop yield models.
(3) Anticipated Results and Products

 o Improved wheat crop calendar.

 o Ecological-based wheat yield models.

(4) Test Sites: Temple, Texas

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: J. T. Ritchie, ARS, Temple, TX

j. Subtask 10: Relationships Among Spectral Data, Plant Components and Agronomic Variables

(1) Objective

 o Assist in analyzing Landsat 2 and 3 digital data for seven test wheat fields and to use them to further develop and test wheat models.

 o Assemble and analyze data from experiments dealing with response of spring and winter wheat to irrigation, vernalization, photoperiod, and temperature.

 o Establish soil background lines for handheld radiometer data; calibrate green biomass vegetative cover, and LAI to spectral indices derived from crop canopy measurements.

(2) Technical Approach

 o Utilize Landsat data correspondent to ARS wheat field sites, SRS data sets, and other sources to test confidence with which leaf area index (LAI) and green biomass, describe growth and yield, and compare these yields with yields determined by ground sampling.

 o Utilize Landsat data correspondent to ARS wheat field sites, SRS data sets, and other sources to determine relationships with plant components and agronomic variables. Where possible, agromet and spectromet models will be developed. Initially, research will be conducted utilizing present data bases for selecting vegetative indices and establishing their mean and range as that helps determine year-to-year patterns. Analyses will include
regression of selected vegetation indices, and agronomic and environmental factors against yields and yield components.

(3) Anticipated Results and Products

- Expressions to relate vegetation indices to plant components and agronomic variables which show year-to-year changes in crop condition. Relationships to be used for crop condition assessment and yield component response estimations.

- Calibrations of LAI and biomass in terms of satellite observations, so that yield models can be extended to many fields.

- Procedures for expressing handheld field spectrometer data in terms of Landsat (top of atmosphere) digital counts and vice-versa. This capability enables ground measurements to fill in between satellite overpass dates for additional detail, and to provide missing data when clouds obscure satellite observations.

- Expressions relating Landsat spectra to parameters like biomass, leaf area index, ground cover, and soil water that may be useful for inferring crop condition.

(4) Test Sites: Weslaco, Texas

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: C. Wiegand, ARS, Weslaco, Texas


(1) Objective

To determine the success of plant growth and development simulation models for making reliable large area yield estimates.

(2) Technical Approach

Five plant growth models using different approaches and levels of complexity have been identified for consideration, and areas of work include:
Examination of input requirements of models to see if parameters are estimable and if data are economically obtainable with the required degree of accuracy.

Sensitivity analysis of primary variables, parameters and functions to determine which factors are of the greatest relative importance. This analysis will also indicate whether model response is consistent with current scientific knowledge.

Evaluation of functional relationships, subprograms and entire models using available plant and climate data. Methods which perform well will be retained while those which don't will be modified or replaced.

Large scale testing will follow the development of an operative plant model.

Anticipated Results and Products

A wheat simulation model that can be used to supplement current objective methods which use sampling techniques, or can be used in foreign areas where objective data are limited or unavailable.

Test Sites: Fort Collins, Colorado

Organizational and Responsibilities

Lead Organization: USDA SRS

Subtask Manager: Greg Larsen, USDA SRS, Ft. Collins, CO


Objective

(a) To evaluate the components of winter wheat yield potential in relation to plant development, photosynthetic rate, temperature and water.

(b) To develop a model to estimate LAI from spectral information and including evaluation of the components of yield.
(2) Technical Approach

Research will be conducted to define the influence of environmental stress on yield components such as number of spikes, spikelets per spike, kernels per spikelet and mean kernel weight. Canopy photosynthesis, temperature, soil moisture and development stages will be monitored; resultant data will be included in developing a LAI estimation model using spectral information.

(3) Anticipated Results and Products

A model to estimate LAI.

(4) Test Sites

Houston, Texas; the Evaporation Field Research Site near Manhattan, Kansas; and various locations across Kansas.

(5) Organization and Responsibilities

Lead Organization: USDA ARS

Subtask Manager: G. O. Boatwright, ARS, Houston, Texas


(1) Objective

Evaluate the sensitivity of selected wheat plant process models to satellite met data as compared to met data measured at the plant growth site.

(2) Technical Approach

The plant science research personnel at each location will record phenology, planting date, rate, yield, and agronomic characteristics of each cultivar grown. These data will be sent to the wheat yield coordinator. An SRS math statistician will operate the five plant process wheat models using agronomic inputs from the coordinator with satellite derived and ground measured meteorological parameters delivered by the project liaison leader.

A sensitivity analysis will be done on each model to determine the variability in response between ground measured and satellite estimated meteorological parameters.
(3) Anticipated Results and Products

The analysis will give some insight into the applicability of satellite enhanced data to drive plant process models. Publication of results will be the perogative of the model builders and the individual researchers growing the various cultivars.

(4) Test Sites

Bushland, Texas; Ft. Collins, Colorado; Sidney, Montana; Akron, Colorado; Pendleton, Oregon; and Mandan, North Dakota

(5) Task Organization and Reesponsibilities

Lead Organization: USDA
Subtask Manager: G. Larson, USDA/SRS-Ft. Collins
Subtask Coordinators: W. Willis, USDA/SRS-Ft. Collins
J. Rogers, USDA-Houston

6. Task Organization and Responsibilities

Lead Organization: USDA ARS
Task Coordinators: Jerry Ritchie, USDA ARS, Beltsville
Galen Hart, USDA SRS/SRD, Washington, DC
Wayne Willis, USDA ARS, Ft. Collins

7. Resource Requirements

a. Agency FY83($K)

<table>
<thead>
<tr>
<th>Location</th>
<th>FY83</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA ARS - Locations</td>
<td>990</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>25</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1015</strong></td>
</tr>
</tbody>
</table>

b. Manyear Equivalents

(1) Civil Servants FY83(MYE)

<table>
<thead>
<tr>
<th>Location</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA ARS- Locations</td>
<td>13</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>13.5</strong></td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

TBD
9. Interfaces

With other AgRISTARS projects: EW/CCA, SR, SM

With all other project elements: Element #4, Task 5

With other tasks within element: None

10. Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements

TBD
E. TASK 5: SOYBEAN YIELD MODEL DEVELOPMENT

WBS#: 03-02-05-01-00-13-(640)-21-(640)-01-(640)
-12-(35)-01-(35)-64-(30)
-01-(05)

1. **Objective**

   To develop a physiological/phenological soybean growth/yield model(s) to accurately simulate the growth, development, and yield of soybeans.

2. **Scope**

   To develop a physiological/phenological soybean growth/yield model for the U.S.

3. **Duration**

   Three to five years.

4. **Anticipated Results and Products**

   This research should result in the development and testing of soybean growth and development models that can be used to follow plant growth and development under varying climatic and stress conditions and to predict yield.

   Products:
   a. Soybean growth and development models.
   b. Better understanding of soybean physiology and phenology.
   c. Documentation of results.

5. **Technical Approach**

   a. To develop the conceptional framework and necessary algorithms for developing a model that will simulate soybean growth and yield.

   b. To set up experiments and collect data necessary to define the physiological and phenological concepts necessary for the development of a soybean model.

   c. To test soybean models with available field data to determine accuracy (i.e., SRS-Missouri data set).

   d. Test Sites: Urbana, Illinois; Mississippi St., Mississippi; Gainesville, Florida.
6. **Task Organization and Responsibilities**

   **Lead Organization:** USDA ARS
   **Task Manager:** Doyle Peters, USDA ARS, Urbana, Illinois
   **Task Coordinators:** Jerry Ritchie, USDA ARS, Beltsville, MD
   Galen Hart, USDA SRS/SRD, Washington, DC.

7. **Resource Requirements**

   a. **Agency - Funding**
      
      | Agency/Location               | FY83($K) |
      |--------------------------------|----------|
      | USDA ARS-Locations             | 640      |
      | USDA SRS/SRD-Washington        | 35       |
      | **TOTAL**                     | **675**  |

   b. **Manyear Equivalents**
      
      (1) **Civil Servants**
      
      | Agency/Location               | FY83(MYE) |
      |--------------------------------|-----------|
      | USDA ARS-Locations             | 8.0       |
      | USDA SRS-Washington            | 0.1       |
      | **TOTAL**                     | **8.1**   |

      (2) **University and Others**
      
      | Agency/Location               |            |
      |--------------------------------|-----------|
      | USDA SRS/SRD (Univ. of Florida)| 0.7       |

8. **Task Schedule and Milestones**

   FY82 - Develop algorithms and computer model(s).
   FY82 and FY83 - Test model(s)
   FY82 to FY83 - Physiological and phenological research
   FY84 - Summary Report

9. **Interfaces**

   None

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements**

    All data will be collected by investigators. There are no processing, distribution, nor retention requirements on other program elements.
F. TASK 6: COTTON GROWTH AND YIELD MODEL DEVELOPMENT

WBS#: 03-02-06-01-00-13-(100)-24-(100)-01-(100)

1. Objective
   To test and improve GOSSYM as a process level model for simulating growth, development, and yield of cotton.

2. Scope
   To test GOSSYM under different climatic conditions.

3. Duration
   Two to four years.

4. Anticipated Results and Products
   Evaluation of the forecasting and estimating capabilities of the GOSSYM cotton yield model.

5. Subtasks
   a. Subtask 1: Simulation Testing of GOSSYM
      (1) Objective
         Simulation testing of the GOSSYM cotton yield model.
      (2) Technical Approach
         (a) GOSSYM will be tested using available data sets to determine how well it simulates different processes.
         (b) Experiments will be designed to better define the physiological processes in GOSSYM.
      (3) Anticipated Results and Products
         This research should result in wider testing of GOSSYM and improvement of the model.
      (4) Test Sites
         Mississippi State, Mississippi, Arizona, Israel
      (5) Organization and Responsibilities
         Lead Organization: USDA ARS
         Subtask Manager: Don N. Baker, USDA ARS
         Mississippi State, MS
         VI-32
6. Task Organization and Responsibilities
   Lead Organization: USDA ARS
   Tech. Coordinators: Jerry C. Ritchie, USDA ARS, Beltsville, MD
   Galen Hart, USDA SRS/SRD, Washington, DC

7. Resource Requirements
   a. Agency Funding FY83($K)
      USDA ARS-Mississippi 100
   b. Manyear Equivalents
      (1) Civil Servants FY83(MYE)
         USDA ARS-Mississippi 1

8. Task Schedule and Milestones
   FY82 and 83 - Summary Report

9. Interfaces
   No specific interface with other program element is required.

10. Data Acquisition, Preprocessing/Processing, Distribution, and Retention Requirements
    All necessary data will be collected or compiled by investigators. There are no processing, distribution, nor retention requirements on other program elements.
G. TASK 7: CORN AND SORGHUM GROWTH AND YIELD MODEL DEVELOPMENT

WBS#: 03-02-07-01-00-13-(300)-15-(300)-01-(300)
12-(99)-01-(99)-01-(49)-10-(50)

1. Objective
To develop and test ecological models to simulate growth, development, and yield of corn and sorghum in the United States, with potential application to foreign areas.

2. Scope
Major corn growing areas of the United States

3. Duration
Three to five years

4. Anticipated Results and Products
This research should result in the establishment and testing of corn growth and development models that can be used to follow plant growth and development under climatic and stress conditions and to predict yield. Updated sorghum model.

5. Subtasks
a. Subtask 1: Develop corn models

(1) Objective
To develop ecological models to accurately simulate growth, development and yield corn.

(2) Technical approach
(a) Test the corn model with variety of data available from literature sources and interested cooperators.

(b) Add nitrogen balance in the soil and plants to the existing model.

(c) Select experimental data from field studies in Temple for designing critical relationships needed in the model, but not available from literature.

(d) Select experimental data from growth cabinets regarding the influence of temperature and photoperiod on ontogeny and development of various corn genotypes.
(e) Develop model for estimating soil-water and nutrient parameters for the corn model using available soil classification information.

(3) Anticipated Results

This research should result in the development of corn growth and development models that are useful for large area estimation of yield, for farm management decisions, and for policy analysis.

(4) Test Sites

Temple, Texas

(5) Organization and Responsibilities

Lead Organization: USDA ARS
Subtask Manager: Joe Ritchie, USDA ARS, Temple, TX

b. Subtask 2: Investigation of Corn Simulation Models for Large-Area Yield Estimation

(1) Objective

To determine the applicability of plant growth simulation models to making reliable large-area yield forecasts and estimates for corn.

(2) Technical Approach--the areas of work will include:

(a) Feedback

Develop and incorporate "feedback" variables into existing corn models. Feedback needs to be included in the current state-of-the-art plant process models for these models to be of use to the SRS operating program. Feedback contains both growth and development information at the time of measurement and this information must be built upon so that model yield converges to the observed final yield.

(b) Validation Data

Make available existing data sets, establish specifications for data to be collected by SRS for model validation.
(c) **Sensitivity Testing**

After the incorporation of "check", conduct sensitivity analysis on input variables, model parameters, and pertinent interactions. The purpose of sensitivity testing is to provide information to the model developer on sensitivity of his model to the actual corn growth and development process and how well his model mimics this biological process.

(3) Anticipated Results and Products

(a) A number of validation data sets would be prepared and available on the SRS Network Processing System for corn model evaluation. Also, statistics would be generated to evaluate at least two presently existing input variable simulation alternatives for internal and comparative analysis.

(b) Complete model documentation including the implementation of software on the SRS Network Processing System would be accomplished.

(4) Test Site

Temple, Texas.

(5) Organization and Responsibilities

Lead Organization: USDA SRS

Subtask Manager: William Iwig, USDA/SRS

c. **Subtask 3: Improve and enhance the SORGF simulation model for sorghum**

(1) Objective

Improve and enhance the SORGF simulation model for sorghum

(2) Technical Approach

(a) Perform the following enhancements or modifications to SORGF:

- Improve light interception algorithms
- Improve dry matter accumulation algorithms
- Improve soil water subroutine
o improve phenology algorithms
o improve leaf area development algorithms
o evaluate the benefit of including yield components
o implement water stress effects on leaf area development, phenology and yield components (if needed)
o incorporate nitrogen uptake and affects on growth and development

(b) Validate model with above modifications using field data sets available from cooperating scientists and/or USDA/SRS

(c) Document modified model

(3) Anticipated Results and Products
Document describing the enhancements and improvements to SORGF.

(4) Organization and Responsibilities
Lead Organization: USDA/SRS
Subtask Manager: Jerry Arkin, Texas A&M University

6. Task Organization and Responsibilities
Lead Organization: USDA, ARS
Task Coordinator: Jerry C. Ritchie, USDA ARS, Beltsville, Maryland
Galen Hart, USDA SRS/SRD-Washington

7. Resource Requirements
a. Agency - Funding FY83($K)
USDA ARS, Temple, TX 300
USDA SRS-Washington 99
TOTAL 399
b. Manyear Equivalents

(1) Civil Servants

<table>
<thead>
<tr>
<th>Location</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA ARS-Temple, TX</td>
<td>3.0</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4.0</strong></td>
</tr>
</tbody>
</table>

(2) University and Others

<table>
<thead>
<tr>
<th>Location</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS, Texas A&amp;M</td>
<td>1.8</td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

FY82 - Test and documentation of nutrient input version of corn model

FY82 - Conduct necessary experiments for collecting missing data

FY82-83 - Research and updating of critical relationship used in corn model

FY84-85 - Summary report

Subtask 2: TBD

9. Interfaces

Other AgRISTARS Projects - EW/CCA

Other major project elements -

Within Project Element # -

10. Data Acquisition, Preprocessing, Distribution and Retention Requirements

All data will be collected by investigators. There are no processing, distribution nor retention requirements on other program elements.
VII. MAJOR PROJECT ELEMENT #3 - DATA ACQUISITION, PROCESSING AND STORAGE - 3 TASKS

Agricultural and meteorological data sets will be acquired, processed and stored in computer files for use in model development, testing, and operating of selected models as required by YMD and other projects. Procedures to store, acquire and use these data sets will be developed and documented for use.

A. TASK 1: ACQUIRE AND PROCESS DAILY HISTORICAL SYNOPTIC METEOROLOGICAL STATION DATA FOR FOREIGN COUNTRIES

1. Objective

Acquire quality controlled historic daily maximum, minimum temperatures and total precipitation and other elements as designated for all regularly reporting stations.

2. Scope

Daily maximum and minimum temperatures and total precipitation will be assembled for all regularly reporting WMO stations in AgRISTARS areas of interest. Additional data elements (daily incoming solar radiation, average wind speed, relative humidity, cloud amount and type, etc.) will be gathered where feasible.

3. Duration

Four to six years, will continue as part of FCAR plan.

4. Anticipated Results and Products

Quality controlled climatic elements including daily maximum and minimum temperatures and total precipitation stored in specified format, delivered by the contractor.

5. Technical Approach

The ETAC DATSAV files at NCG, Asheville will be unpacked into two files. File 1 will contain max-min temperatures and 24 hour precipitation and snow depth. File 2 will contain cloud cover, wind direction and velocity, dew point and sea level pressure. Data will be unpacked in three phases. Phase 1 will include 1974-1980 station data. Phase 2 will include 1966-73. Countries will be per user requirements.
6. Task Organization and Responsibilities

Lead Organization: USDC NOAA/EDIS

Task Manager: R. Ambroziak, NOAA/EDIS-DC

Task Coordinators: Sharon LeDuc, USDA NOAA/EDIS-Columbia
R. Ambroziak, USDC, NOAA/EDIS-DC

7. Resource Requirements

a. Agency - Funding Requirements FY83($K)
   
   USDC NOAA/EDIS-Washington 322

b. Manyear Equivalents FY83(MYE)
   
   (1) Civil Servants
       USDC NOAA/EDIS-Washington 3.8
   (2) University and Others
       USDC NOAA/NCC Asheville 4.0

8. Task Schedule and Milestones

Not available

9. Interfaces

With other AgRISTARS projects: EW, SR, ITD, and SM

With other organizations: FAS FCCAD

10. Data Acquisition, Quality Control, Processing, Distribution and Retention Requirements

Involves acquisition of historical data sets from national and international data centers and current data from WMO-GTS system.

Quality control includes assembling data by station, checking for homogeneity of record and consistency with surrounding station observation.

Distribution to AgRISTARS project will require ICD for coordination and to document time period constraints for users.

Retention requirements are long term (duration of project).
B. TASK 2: MAINTAIN, UPDATE, ACQUIRE AND BUILD HISTORIC AGRICULTURAL DATA BASES.

WBS#: 03-03-02-01-00-12-(34)-04-(29)-01-(29)
       -01-(05)-01-(05)

1. Objective

   Provide accurate historic agricultural data bases for use in model testing and evaluation and in research and development efforts.

2. Scope

   AgRISTARS crop and country combinations. Historical data for an appropriate time period and at a level of detail consistent with project objectives.

3. Duration

   To be included in DCAR plan for future years.

4. Anticipated Results and Products

   Accurate historic agricultural data bases, containing the latest revisions and completely documented, are available for use.

5. Subtasks

   a. Subtask 1: Maintain and Update Domestic Agricultural Data Bases.

      (1) Objective

         Maintain up-to-date and accurate historical agricultural data bases.

      (2) Technical Approach

         On a regular basis, obtain agricultural publications which contain the latest revisions and update existing agricultural data bases. Reflect status of updating activity in data base documentation.

      (3) Anticipated Results and Products

         Up-to-date and accurate existing historic agricultural data bases are maintained.
b. Subtask 2: Acquire, Develop and Build Technological and Economic Factor Data Bases.

(1) Objective

Provide accurate and useful technological and economic factor data bases to support research in Task 1 of Project Element #2.

(2) Technical Approach

Obtain information on technological and economic factors from various sources and build data sets which are as accurate and complete as possible. Participate in efforts to assure accuracy of these data bases and provide documentation to facilitate their use.

(3) Anticipated Results and Products

Technological and economic factor data bases that are as accurate and complete as possible are documented and available for use.

(4) Test Sites

N/A

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: TBD, USDA SRS/SRD-Columbia

c. Subtask 3: Acquire, Analyze and Build Suitably Accurate foreign Historic Agricultural Data Bases.

(1) Objective
To provide accurate foreign historic agricultural data bases needed for yield model development and testing.

(2) Technical Approach

Identify potential sources of agricultural information for selected foreign areas, obtain publications and/or existing data sets for these areas, and document such sources within the YMD project. Identify data sets that are actually needed, build initial data set computer files and analyze them for completeness and reliability. As necessary, seek additional information and clarification about suspect data. Review data for reliability and, if necessary, submit the data to subject matter specialist for review. Document all resulting data sets, including any reservations as to their accuracy and completeness.

(3) Anticipated Results and Products

Suitably accurate and complete foreign historic agricultural data bases are documented and available for use.

(4) Test Sites

N/A

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: James Cotter, USDA SRS/SRD Columbia

d. Subtask 4: Maintain and Update Computerized Catalog Reference System for Available Data Bases

(1) Objective

To maintain and update a computerized reference catalog of available data bases and research related to evaluation of plant process models which will be available to all AgRISTARS scientists.
(2) Technical Approach

The AgRISTARS Catalog Reference System (ACRS) has been developed for interactive access on the Martin-Marietta data system. Information about some data sets, including those currently used by the Yield Research Branch, SRD/USDA, has been entered. Information about additional data sets and evaluation related research is being abstracted from the literature and entered. Also, documentation regarding the use of ACRS needs to be formalized.

(3) Anticipated Results and Products

(a) A YMD report which documents the nature and use of ACRS.

(b) A more complete inventory of available data sets.

(4) Test Sites - NA

(5) Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Subtask Manager: Fred Baker, USDA SRS/SRD-Washington, DC

6. Task Organization and Responsibilities

Lead Organization: USDA SRS/SRD

Task Coordinator: James Cotter, USDA SRS/SRD-Columbia

7. Resources Requirements

a. Agency - Funding

<table>
<thead>
<tr>
<th></th>
<th>FY83($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA SRS-Columbia</td>
<td>29</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
</tr>
</tbody>
</table>

b. Manyear Equivalents

<table>
<thead>
<tr>
<th></th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Servants</td>
<td></td>
</tr>
<tr>
<td>USDA SRS-Columbia</td>
<td>.6</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>.1</td>
</tr>
<tr>
<td>Total</td>
<td>.7</td>
</tr>
</tbody>
</table>
8. **Task Schedule and Milestones**

TBD

9. **Interfaces**

Other AgRISTARS Projects - Various other AgRISTARS projects, depending upon where data sets are available and can be obtained.

Other Major Project Elements - Support major project elements #1, #2 and #4.

Within Project Element #3 - Relates to meteorological data sets obtained in various tasks in the level of aggregation/disaggregation.

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements**

Data sets developed will be maintained within the YMD project. Data acquisition will depend upon availability of data sets and with specific details to be determined over the life of this task.
C. TASK 3: METEOROLOGICAL DATA BASE PREPARATION

WBS#: 03-03-03-04-00-33-(450)-04-(450)-01-(450)

1. Objective
   To develop an automated system of current global daily, weekly and monthly summaries of U.S. and foreign meteorological station data.

2. Scope
   Meteorological station data for U.S. and foreign countries of interest to AgRISTARS from selected station data.

3. Duration
   Length of project.

4. Anticipated Results and Products
   An automated, accessible data base of current daily meteorological data elements (max/min temp, precip, snow depth, dewpoint depression for max/min, average wind speed, max wind gusts) for use by AgRISTARS projects.

5. Technical Approach
   Current U.S. and foreign data (three and six hourly WMO Reports) will be processed on a current basis to provide real time meteorological data for AgRISTARS use. This data will be processed by the Climatic Analysis Center, NWS, and made available through the JAWF. Missing and questionable data will be reviewed, entered or corrected, and quality controlled by a NWS meteorologist.

6. Task Organization and Responsibilities
   Lead Organization: USDC NOAA/EDIS
   Task Manager: Fred Finger, NWS/CAC-Washington

7. Resource Requirements
   a. Agency - Funding Requirements
      FY83(SK)
      USDC NOAA/NWS-Washington 450
   b. Manyear Equivalents
      FY83(MYE)
      University/Other (TBD)
      USDC NOAA/CAC, Washington VII-8 4.0
8. **Task Schedule and Milestones**

   TBD

9. **Interfaces**

   With other AgRISTARS projects: All

   With other organizations: FAS FCCAD, SRS, and JAWF

10. **Data Acquisition, Preprocessing, Processing, Distribution, and Retention Requirements**

    Data will be retained by JAWF. On-line and off-line data will be disseminated by JAWF.
VIII. MAJOR PROJECT ELEMENT #4: RELATED YIELD RESEARCH - 3 TASKS

This program element will address the potential use of satellite data or products as input to crop yield models. USDA ARS will define spectral and/or remote sensing inputs into crop growth models; NOAA/NESS will use meteorological satellite data to estimate solar radiation and maximum and minimum temperatures. Precipitation estimates from satellite are under the Early Warning Project. YMD will conduct experiments in the application of satellite spectral products and monitor other research results for potential use in crop yield models.

A. TASK 1: DEFINE SPECTRAL AND/OR REMOTE SENSING DATA REQUIREMENTS AND DEVELOP INPUT THAT CAN BE USED TO DRIVE OR TEST CROP GROWTH/YIELD MODELS

WBS#: 03-04-01-00-13-(470)-07-(470)-01-(470)

1. Objective

To determine the basic relationships between remotely sensed canopy data and crop growth, biomass, leaf area index and other crop growth and condition variables that can be used in crop growth/yield models.

2. Scope

To test satellite and other spectral data for input for crop growth/yield models, implication for early warning and crop condition alarms and assessment and responses to crop management variables.

3. Duration

Will be continued under FCAR project plan.

4. Anticipated Results and Products

These experiments should provide the basic data needed for incorporating spectral and other remotely sensed data into the crop growth/yield models being developed, and for better understanding plant canopy bidirectional reflectance and emittance at incomplete plant cover.

Products will be:

a. Comparison of seasonal spectra of different crops along with agronomic and physiological interpretations.

b. Remotely sensed data inputs to crop growth/yield models.

c. Documentation of the effects of specific stress canopy on temperatures, biomass and yield.

VIII-1
d. Test of model performance for LAI, biomass, and yield using direct observation and spectral surrogates.

5. Technical Approach

a. Small plots and fields at ARS and other model test sites will be monitored with hand-held radiometers and ground based radiometers to document reflective and thermal responses of plants to environmental conditions and specific stresses.

b. Hand-held radiometer, aircraft, and satellite data will be obtained for well documented crop and test sites to determine model parameters such as LAI, biomass, green number. These data will be provided to modelers for comparison of crop yield/growth model performance, using direct observation and spectral surrogates.

c. Small plot and field experiments will be conducted to develop spectral indicators of stress and for development of spectral inputs for models.

d. Test sites will be Weslaco, Texas; Phoenix, Arizona; Beltsville, Maryland; and other ARS locations as needed.

6. Organization and Responsibilities

Lead Organization: USDA ARS

Task Manager: Craig Wiegand, USDA ARS, Weslaco

7. Resource Requirements

a. Agency-Funding Requirements FY83($K)

USDA ARS - Weslaco, 470
Phoenix, Beltsville

b. Manyear Equivalent FY83(MYE)

(1) Civil Servants

USDA ARS, Weslaco, 6.0
Phoenix, Beltsville

(2) University and others - not determined at this time.

8. Task Schedule and Milestones

FY81 to 82 - Determination of spectral response of crops and effects of management variables
FY82 to 85 - Input of spectral and remotely sensed data to crop growth/yield models, early warning alarms and crop condition assessments.

FY82 to 85 - Models or descriptions of plant canopy bidirectional reflectance and temperature at incomplete plant canopy.

9. Interfaces

Close interface with modeling efforts is necessary to determine input needs of model. Close coordination is needed with many early warning tasks.

10. Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements

TBD
B. TASK 2: EVALUATION OF SPECTRAL INFORMATION FOR CROP YIELD ESTIMATION

WBS#: 03-04-02-01-01-32-(250)-04-(200)-01-(30)
     -37-(170)
     -02-(50)-01-(50)

1. Objective

   Develop crop yield estimation techniques using digital spectral data.

   Compare spectral reflectance of Landsat to NOAA series satellites.

   Correlate spectral response from both satellites to specific crop yields.

2. Scope

   Four sample segments in Missouri and sixteen in North Dakota.

3. Duration

   Data collection and model form development in FY82 and 83.
   Follow-on with Landsat D and NOAA 7 in FY84 and 85. Will continue under FCAR project.

4. Anticipated Results and Products

   This experiment should provide information on the relationship of seasonal variation of spectral response as it relates to yield of barley, corn, soybeans, and wheat. A relationship will be established between spectral response (vegetative indices) of Landsat and NOAA 6. A subjective model form relating periodic spectral response to corn, soybean, barley and wheat yields.

5. Technical Approach

   Landsat and NOAA 6 digital data for crop years 1980 and 1981 will be acquired for North Dakota and Missouri areas surrounding the 20 sample segments. Vegetative indices (band 7-band 5 for Landsat and band 2-band 1 for NOAA 6) will be computed for each 25x25 mm I, J grid in which each segment falls.

   Ground truth data collected by ITD for crop years 1980 and 1981 will be acquired along with county, CRD and state yield data for corn and soybeans in Missouri and wheat and barley yield data for corn and soybeans in Missouri and wheat and barley.
in North Dakota from USDA SRS. Statistical analysis of the
spectral value/crop stage/yield relationship will be done.
This statistical analysis and subjective judgments will be the
basis for a model form to be developed.

Landsat and NOAA series digital data will be collected in crop
years 1982 and 1983 for further development and testing of the
model form on a real-time (every 9 or 18 days) basis. Year
end evaluations will be done each year to verify in year
tracking results.

This technique will be evaluated for possible use on USSR

6. Organization and Responsibilities

Lead Organizations: NASA and NOAA

Task Managers: Tom Barnett, NASA-Columbia
Mike Helfert, NOAA EDIS-Houston

7. Resource Requirements

a. Agency Funding FY83($K)

<table>
<thead>
<tr>
<th>Organization</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Columbia</td>
<td>200</td>
</tr>
<tr>
<td>NASA-Columbia</td>
<td>-</td>
</tr>
<tr>
<td>USDC NOAA-Houston</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>250</strong></td>
</tr>
</tbody>
</table>

b. Manyear Equivalents FY83(MYE)

(1) Civil Servants

<table>
<thead>
<tr>
<th>Organization</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA-Columbia</td>
<td>0.4</td>
</tr>
<tr>
<td>USDC NOAA-Houston</td>
<td>1.0</td>
</tr>
<tr>
<td>USDC NOAA-Columbia</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.4</strong></td>
</tr>
</tbody>
</table>

(2) University or Others

<table>
<thead>
<tr>
<th>Organization</th>
<th>MYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Univ. of Columbia</td>
<td>1.0</td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

See schedule, page VIII-6

9. Interfaces

SR for Landsat data.
ITD for segment ground truth.
EW and FAS for NOAA 6 and 7 data.
SRS for county, CRD, and stage yield data.

VIII-5
### MPE MILESTONES AND SCHEDULES

**CY1982**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>CY1982</th>
<th>CY1983</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Request Landsat Data</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>2. Request Met Sat Data</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>3. Acquire Ground Truth, 80 and 81</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>4. Compute Landsat VI's</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>5. Compute Met Sat VI's</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>6. Develop Model Form</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>7. Subjective Review of Model</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>8.</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>9.</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>10.</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

**MPE4, TASK 2**

**EVALUATION OF SPECTRAL INFORMATION FOR CROP YIELD ESTIMATION**

*ORIGINAL PAGE IS OF POOR QUALITY*
10. Data Acquisition, Preprocessing, Distribution, and Retention

Landsat digital data will be required for all acquisitions for Missouri and N. Dakota, and no segments for 1980 and 1981 crop years. This requirement will continue through 1982 and 1983. NOAA 6 digital data will be required over the same area for 1980 and 1981. NOAA series digital data will be required through 1982 and 1983. All of the digital data will require processing to compute vegetative indices for each image for each acquisition. Software exists in the Early Warning project to accomplish this task.
C. TASK 3: REAL TIME TEST AND EVALUATION OF WHEAT PLANT PROCESS MODELS

WBS#: 03-04-03-01-01-32-(355)-04-(315)-01-(65)
-37-(250)
-02-(40)-01-(40)

1. Objective

Evaluate the utility of wheat plant process model(s) in a real time environment.

2. Scope

Seventy winter wheat and eighty spring wheat grid cells in eastern Europe and USSR.

3. Duration

One crop year for actual model operation plus an additional year for evaluation and model adjustment.

4. Anticipated Results and Products

A comparison of the utility of two to four wheat plant process models for real time prediction of phenology and yield potential in relation to a base year. Products will be a biweekly output of predictions from up to four different wheat process models.

5. Technical Approach

A base year (crop year 1982) will be run using gridded meteorological data from GWC, USAF as meteorological data input. Crop year 1983 will be run every two weeks using real time data from GWC, USAF, up to the data of model operation. The same met data used for the base year will be input from the current date through the end of season.

The base year model output for each model will be used to compare to known results for that year and minor correcting may be made to model parameters. A final iteration of each model will be done for use as the base years output and model baseline. Periodic iteration results of the models for the current crop year will be compared to the base year output for use as a crop condition comparison. This current year output will also be compared against vegetative indices for the same grid cell, crop stress model outputs, crop condition reports, etc., to determine the utility of the model output.

6. Task Organization and Responsibilities

Lead Organizations
Crop Modeling Center
USDA/SRS and NOAA/EDIS
7. Resource Requirements

a. Agency Funding

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83 ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Columbia</td>
<td>315</td>
</tr>
<tr>
<td>USDC NOAA-Houston</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>355</td>
</tr>
</tbody>
</table>

b. Manyear Equivalents

(1) Civil Servants

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Columbia</td>
<td>2.9</td>
</tr>
<tr>
<td>USDC NOAA-Houston</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>3.9</td>
</tr>
</tbody>
</table>

(2) University

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY83(MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Univ. of Missouri</td>
<td>2.5</td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

See schedule next page.

9. Interfaces

Models will be operated by the Crop Modeling Center in Columbia, Missouri, using NOAA computer facilities in the World Weather Building, Suitland, Maryland. Gridded daily meteorological data and initial soils, soil moisture data, and planting dates will be furnished by FCCAD/FAS.

Biweekly outputs will be furnished FCCAD as they are produced.

10. Data Acquisition and Processing

Input data acquisition and processing for transmission to NOAA/EDIS is funded by FCCAD/FAS
# MPE Milestones and Schedules

<table>
<thead>
<tr>
<th>CY1982</th>
<th>CY1983</th>
</tr>
</thead>
<tbody>
<tr>
<td>JFMAMJJASOND</td>
<td>JFMAMJJASOND</td>
</tr>
<tr>
<td>Spring</td>
<td>Winter</td>
</tr>
</tbody>
</table>

1. Extract 1982 Crop Year Data
2. Prepare Soils Data Input
3. Determine Agronomic Variables
4. Prepare Base Year Output
5. Review Model Performance for Base Year
6. Operate Winter Wheat Models Real Time
7. Operate Spring Wheat Models Real Time
8. 
9. 
10. 

---

**MPE 4, Task 3**

REAL TIME TEST AND EVALUATION OF WHEAT PLANT PROCESS MODELS
IV. MAJOR PROJECT ELEMENT #5: PROJECT MANAGEMENT AND SUPPORT - 3 Tasks

The YMD project management will be accomplished through coordination with assigned task managers reporting to the project leader. Task managers will participate in the major project reviews as necessary. The senior USDA and/or NOAA task leaders at Columbia will participate in all planning efforts with designated representation from ARS and SRS-Washington.

A. TASK 1: SUPPORT PERSONNEL AND PROJECT MANAGEMENT

WBS#: 03-05-01-04-00-32-(13)-04-(13)-01-(13)
  12-(13)-01-(24)-01-(13)
    -04-(20)-01-(20)

1. Objective
   a. To provide statistical, clerical and other support to Yield Project personnel.
   b. To provide overall project management, planning, budget and other management support to project personnel.

2. Scope - NA

3. Duration
   Continuous for length of project.

4. Anticipated Results and Products - NA

5. Technical Approach - NA

6. Organization and Responsibilities
   Lead Organization: NOAA, USDA
   Task Managers, USDA: Galen Hart, USDA SRS/SDR, Washington
   Jerry Ritchie, USDA ARS, Washington
   Russ Ambroziak, USDC/NOAA, CEAS/EDIS, Washington

7. Resource Requirements
   a. Agency - Requirements FY83($K)
      USDC NOAA-Washington 13
      USDA SRS-Washington  24
      USDA SRS-Columbia     20
      TOTAL               57
   b. Manyear Equivalents

IX-1
<table>
<thead>
<tr>
<th>Civil Servants</th>
<th>FY83 (MYE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDC NOAA-Columbia</td>
<td>0.5</td>
</tr>
<tr>
<td>USDA SRS-Washington</td>
<td>0.5</td>
</tr>
<tr>
<td>USDA SRS-Columbia</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.4</strong></td>
</tr>
</tbody>
</table>

8. **Task Schedule and Milestones** - NA

9. **Interfaces**
   
   With other AgrISTARS projects: EW/CCA, ITD, SR, SM, PMG
   
   With other project elements: All
   
   With other organizations: FAS/FCCAD, SRS, ARS, NOAA-EDIS, NOAA-NESS

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements** - NA
B. TASK 2: LIAISON WITH AND MONITORING OF RESEARCH ACTIVITIES IN OTHER AgRISTARS PROJECTS

WBS#: 03-05-02-04-00-32-(13)-04-(13)-01-(13)
     12-(49)-02-(49)-01-(49)

1. Objective
   a. Provide required support to other AgRISTARS projects through liaison and maintenance of Interface Control Documents (ICD).
   b. Monitor research conducted in all AgRISTARS projects to assure early technology transfer for improving yield model performance.

2. Scope
   Interface Control Documents will be prepared and maintained with all other AgRISTARS projects where required. Continuing liaison at the project management level will be maintained to monitor research activities within YMD and with the other projects. This monitoring will include technical assistance in evaluating techniques developed that can be used to improve yield model performance.

3. Duration
   Liaison and monitoring activities will continue through FY85.

4. Anticipated Results and Products
   It is expected that several yield model components or improvements will be developed as a result of research efforts of the eight AgRISTARS projects. These should include adjustable crop calendar models for several crops, techniques for estimating solar radiation, temperature extremes, precipitation amounts, available soil moisture, plant evapotranspiration and quantification of technological inputs and their effect on crop yield. ICD's developed in FY80 will be updated as required.

5. Technical Approach
   A representative of project management will be designated to maintain liaison with other AgRISTARS projects. This activity will include preparation and maintenance of ICD's with each project where an ICD is required. Needs identified for improvement of yield model capabilities will be submitted to the project management team to task the proper project with technique development.

   Qualified technical personnel (agronomists, ag. meteorologists, statisticians, etc.) will be assigned as required to monitor research in phenological/physiological yield relationships,
soil moisture estimation/simulation; satellite derivation of spatial estimate of solar radiation, temperature extremes, and precipitation amounts; spectral estimates of LAI, biomass, phenology, reflectance and their relationship to biological yield.

Liaison with JAWF, FAS/FCCAD, and GWC/USAF will be maintained to assure quality controlled current meteorological data for yield model evaluation and operation.

6. Organization and Responsibilities

Lead Organization: USDA

Task Manager: J. Rogers, USDA YMD, Houston

7. Resource Requirements

a. Funding Requirements FY83($K)

<table>
<thead>
<tr>
<th>Organization</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA, Columbia</td>
<td>0</td>
</tr>
<tr>
<td>USDC NOAA, Columbia</td>
<td>13</td>
</tr>
<tr>
<td>USDA SRS, Houston</td>
<td>49</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>62</strong></td>
</tr>
</tbody>
</table>

b. Manyear Equivalents FY83(MYE)

<table>
<thead>
<tr>
<th>Organization</th>
<th>Manyeats</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA, Columbia</td>
<td>0.1</td>
</tr>
<tr>
<td>USDC NOAA, Columbia</td>
<td>0.5</td>
</tr>
<tr>
<td>USDA SRS, Houston</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.6</strong></td>
</tr>
</tbody>
</table>

8. Task Schedule and Milestones

NA

9. Interfaces

a. ITD for joint description of yield strata for crops and areas. Furnish recommendations on yield models for pilot test. Deliver yield estimates to support production forecasts.

b. Supporting Research to review and monitor technology for crop growth models, soils, and crop stress effects.

c. EW to review and monitor techniques for relating leaf area, biomass, crop species, plant pests and disease, winterkill and moisture stress to biological yield. Furnish EW techniques for spatial estimation of solar radiation and temperature extremes. Monitor techniques for estimating precipitation amounts.
d. SM to review techniques to model and predict soil moisture in plant root zone areas. Deliver techniques for spatial estimation of solar radiation and temperature extremes.

e. JAWF to keep updated definition of requirements for current meteorological data.

f. Data management team for data requirements.

g. FCCAD to access meteorological data received in Houston from JAWF and GWC, USAF.

h. GWC, USAF, to maintain up-to-date descriptive and definition of USDA derived gridded agromet data.

10. **Data Acquisition, Preprocessing, Processing, Distribution and Retention Requirements** - NA
C. TASK 3: NEW TASKS FOR FY83-85

WBS #: 03-05-03-01-00-12-(13)-01-(13)-01-(13)  
32-(11)-04-(11)-01-(11)

1. **Objective.**

   To initiate research, development and test tasks in an orderly progression and expansion of yield model development.

   To support yield estimation requirements of other AgRISTARS projects and USDA operational requirements.

2. **Scope**

   The exact nature of these tasks will be specified as required to accomplish YMD objective of this task.

3. **Duration**

   Through FY85.

4. **Anticipated Results and Products**

   An orderly, efficient progression and expansion of the Yield Model Development project effort. The FY83 plan and changes in FY82 plan will reflect this effort.

5. **Test Sites - As specified.**

6. **Organization and Responsibilities**

   Lead Organization: USDA ARS

   Task Coordinators: Russ Ambroziak, NOAA EDIS, Washington  
   Fred Warren, USDA SRS/SRD, Washington  
   Jerry Ritchie, USDA ARS, Beltsville

7. **Resource Requirements**

   a. **Agency - Funding**  
      FY83($K)

      NOAA EDIS, Washington  
      USDA SRS, Washington  
      TOTAL

      11  
      13  
      24

   b. **Manyear Equivalents**  
      FY83(MYE)

      NOAA EDIS, Washington  
      USDA SRS, Washington  
      TOTAL

      0.4  
      0.2  
      0.6
8. Task Schedule and Milestones

TBD

9. Interfaces

Interfaces will result from the composition of the proposed tasks.

10. Data Acquisition, Preprocessing/Processing, Distribution and Retention Requirements

Will be defined in each individual task as it is developed.