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COSPAR: THE CONTRIBUTION OF SPACE OBSERVATIONS
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A EUROPEAN YIELD FORECASTING AGROMET SYSTEM: A PROPOSAL TO USE METEOSAT AND LANDSAT-3 DATA IN CORRELATION WITH A METEOROLOGICAL D.C.P. NETWORK

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1. INTRODUCTION

Crop Yield forecasting is an essential element of any agricultural policy; subjective or more objective forecasting systems are currently operated in many countries. Important economic and commercial consequences depend from their accuracy.
In the most advanced objective systems currently operated, the following elements are combined in order to give a continuous prediction of crop production: a census (generally based on farmer's declarations with a statistical sampling control) provides the acreage for each main crop (and possible varieties), meteorological stations provide the factors which influence the yield and test fields under permanent control by specialized well-trained farmers farmers provide the standardization factors from previous years results.

2. EUROPEAN SYSTEMS

2.1. E.E.C. Agricultural Meteorology

In the E.E.C. countries, networks of meteorological stations exist and their observation can be used for agricultural purposés; 70 particular stations are used by the Statistical Office of the European Communities. Their observations are monthly published in "Crop Production" Series. They include : mean maximum air temperature, mean minimum air temperature, mean variation in the temperature, the absolute maximum air temperature, the absolute minimum air temperature, total precipitations, number of days during which precipitation was 1 mm or less, total potential evapotranspiration from a compact group of plants in full growth, and balance of total precipitation and total potential evapotranspiration, over a ten-day period. Ten-day averages over 20 years, in absolute figures are also available for all comparisons or regression studies.

2.2. Yield Models

Several E.E.C. countries are already using climatological models for cereals.
These models are either regression global models (F.R.G. or

E.E.C.) or dynamic regional models (France, Netherlands).
In the first case, their good accuracy is due to the averaging effects on large areas; in the second case, their accuracy is variable and depends strongly on the experimentation conditions (choice of the test-parcels, good observations, introduction of new varieties and cultural practises).
In both cases, the main difficulty consists to extract mathematically or experimentally the yield - climate correlations, i.e. to determine what climatologic parameter is influent (with its weighting factor) at each phenological stage of the plant.

2.3. Needs

Regression models are self-improving with time and they are also self-adapting to changes (new varieties, new cultural practices). But they are strongly dependent from the choice and the density of the meteorological stations.
Experimental models require also a dense agromet network, since the estimation presents a local or regional character. Standardization of the results for national or E.E.C. forecasts require a strong effort, since the accuracy is determined by variable experimentation conditions.
Both require unified data and a unified system.

3. CONTRIBUTION OF SPACE OBSERVATIONS TO CROP YIELD FORECASTING

3.1. Meteorological Data

Meteorological data obtained through an agricultural weather network can be used in real time to give informations and recommendations to farmers on production - related matters.
The use of meteorological satellites could bring supplementary advantages :

- Improvement of the method to determine the amount of solar energy available to crops (measurement of cloud cover and correlation with ground - truth pyranometers). Such improvement is studied by NOAA and USDA in the U.S. Great Plains (satellite GOES-1)
- The high repetitivity of the surface temperature measurement introduces a supplementary information. This information could be used for the daily determination of evapotranspiration or soil moisture or differential leaf-air temperature.

3.2. Data Collecting Systems (D.C.S.)

Data collecting systems (D.C.S.) operating with satellites provide a fast, accurate, unified and synoptic modern way to record climatic data measurement by a data collecting platform (D.C.P.) network.
In addition, the possibility to install the D.C.P.s. in remote areas allows a good choice for their location.

4. A PROPOSAL FOR A EUROPEAN SYSTEM

4.1. Basis of the Proposal

a) Availability of D.C.S. covering E.E.C. with a high repetitivity :
ARGOS System in 1978, METEOSAT in the second half of 1977;

b) availability of accurate thermal infra-red sensors covering E.E.C. with a high repetitivity:

METEOSAT (radiometric resolution 0,4 K), spatial resolution about 7 Km, TIROS-N, 1978; (radiometric resolution 0,2°K), spatial resolution 1 Km;

c) availability of low repetitivity thermal infra-red sensors, but providing a good spatial resolution; LANDSAT-C (radiometric resolution 1,5°K, ground resolution 240 m).

4.2. A.D.C.P. Network

A.D.C.P. network will integrate, complete and/or substitute the agromet network. 100 D.C.P. will be installed in the center of isoclimatic zones. Their location will also take into account the density of the main crops (wheat, rye, barley, grain-maize, potatoes, sugar-beets, etc...). Conductivity soil moisture probes will be included in addition to the existing sensors, in well reproducible conditions (grass or bare soil).
D.C.P.s. will be programmed in order to deliver their data to the satellite once a day. Temporary memories will accumulate and perform the necessary calculations on the recorded data.

4.3. Integration of Data from Several Satellites

The poor ground resolution of METEOSAT justifies the integration of data from TIROS-N and LANDSAT-C.
The poor repetitivity of LANDSAT-C (18 days) will only allow the use of the thermal I.R. good spatial resolution (240 m) as a control and check element for soil moisture when temperature measurements yield ambiguous data (combined approach of reflectance to estimate low moisture levels and thermal inertia to estimate higher levels).

4.4. Models

The global yield model will be the sum (or combination) of partial models :

a) Regression model giving the history of the crop (genetic improvements, varieties evolution, cultural practices evolution, etc...)

b) Experimental model (ground truth) giving the various calibrations of the phenological stages in each zone, so that forecasts will be put in phase at global level

c) Surface temperature model; interpolation model for the low density D.C.P.-network or principal model supported by D.C.P.-ground-truth.

5. CONCLUSION

5.1. Constraints

- A conventional system exists
- A new system must be faster and more accurate
- Large climatic variability
- Many crops, many varieties

5.2. Proposed System

The proposed system is :

- Evolutive (from purely ground system to widely space - Based)
- Faster (space communications)
- More accurate (X 300 AGROMET Network)
- Maintains Continuity (with the conventional system)
- Can be continuously improved.

PROPOSED SYSTEM