The Third Asian Conference for Information Technology in Agriculture
AFITA2002

A Web Application for Soil Nitrogen Balance Estimation

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Abstract : To support rational fertilization management on vegetable farms, we developed a Web application, *Soil Nitrogen Balance Estimation System* to estimate the soil mineral nitrogen balance in response to fertilizer applications, cropping, soil conditions, and climate conditions. The system comprises of soil nitrogen dynamic models, a database of N-mineralization parameters in soils and organic fertilizers, a database of crop N-absorption parameters, an AMeDAS climate database, and Web interface programs. The soil nitrogen dynamic models comprises of N-mineralization models, a crop N-absorption model, and a soil N-leaching model. Two versions of Web interface programs were developed. In the simple version, users can run the models easily by entering an AMeDAS point, a crop, cropping period, amount of fertilizers, and a soil group. In the detail version, users can enter optional parameter values for the soil nitrogen dynamic models. The system is open to the public on WWW. Now, in cooperation with prefectural researchers, system improvement and data collection are being continued.
Keywords : Web application, fertilization, nitrogen, mineralization, dynamic model, database

Introduction

In agriculture, with increase of concerns on environment conservation and food safety, it becomes more important to apply an appropriate amount of chemical fertilizers to each farm. Particularly, tendency of soil nitrogen overload in vegetable farms is one of the most serious environmental problems, because excessive soil mineral nitrogen not absorbed by crops frequently leaches into groundwater and causes river pollution. To decrease amounts of soil-applied nitrogen, it is required that farmers can accurately evaluate soil nitrogen balance on their own farms.

Some computer programs for soil nutrient estimation or diagnosis had been developed, but most of them were standalone programs and distributed among only researchers. With the wide popularity of WWW (the World Wide Web), various kinds of Web application systems have been developed and utilized in business. In agriculture, if more Web systems to support effective crop production are open to the public, they will be available for more farmers, extension officers, and researchers.

To support more rational nitrogen fertilization on vegetable farm management, we developed a Web application named *Soil Nitrogen Balance Estimation System*, which can estimate the soil mineral nitrogen balance in response to fertilizer applications, cropping, soil conditions, and climate conditions.

System Architecture

The *Soil Nitrogen Balance Estimation System* comprises of soil nitrogen dynamic models as main programs, a database of N-mineralization parameters in soils and organic fertilizers,

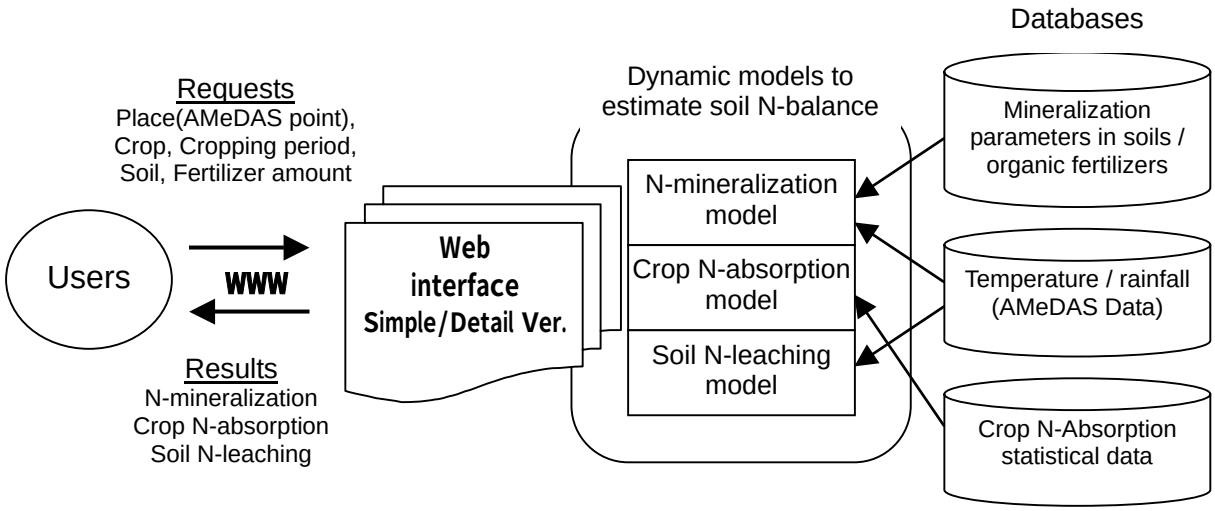

Fig.1 Architecture of the *Soil Nitrogen Balance Estimation System*.

a database of crop N-absorption parameters, an AMeDAS climate database, and Web interface programs (Fig.1). Now, it is open to the public on WWW.

1. Web Server

The Web application was implemented on a common AT-compatible personal computer and software products of Microsoft Corporation (MS). Its data processing except user interface on Web pages is operated on server side, so users can run it on popular Web browsers. The development and operational environment of it is as follows.

Server PC : Gateway2000 G6-233 (Pentium II 233MHz)
Operating System: MS Windows 2000 Server
WWW Server : Internet Information Server 5.0
DBMS : MS Access 2000 & ODBC
Server-side Script: Active Server Pages 3.0
Client-side Script : JavaScript 1.2

2. Soil nitrogen dynamic models

To calculate soil mineral nitrogen balance, the system comprises of N-mineralization models, a crop N-absorption model, and a soil N-leaching model. Two types of N-mineralization models which were reported by Konno and Sugihara (1986) and Saito (1988) are selectable. These models calculate an amount of mineralized nitrogen from soils and organic fertilizers by daily soil temperature in cropping period, using DTS (the number of days transformed to standard temperature) method based on chemical kinetics. Daily soil temperature is estimated using a linear function of daily air temperature. The crop N-absorption model calculates an amount of crop-absorbed nitrogen by crop nitrogen content and yield of transferred products. The soil N-leaching model calculates an amount of leaching mineral nitrogen from the soil by an amount of soil permeant water in cropping period. The amount of soil permeant water is estimated in proportion to accumulated rainfall level. As a result, sum of calculated values by these models is an amount of soil remaining mineral nitrogen after cropping.

3. Databases

In the National Agricultural Research Center, N-mineralization parameters of soils and organic fertilizers based on the N-mineralization models were collected by a nationwide survey (Furue and Uwasawa, 2001), and a database was built using MS Excel. For the *Soil Nitrogen Balance Estimation System*, DBMS of the database was transferred to MS Access 2000. On the other hand, in the National Institute of Agro-Environmental Sciences, crop nutrient absorption data had been collected by a nationwide survey, and a statistical report was compiled (Owa, 1996). We extracted nitrogen-related data on major vegetable crops from the original data and built a database of crop N-absorption parameters using MS Access 2000.

Daily average temperature and rainfall data of AMeDAS points in East Kanto region were downloaded from the MAFFIN agricultural database server and saved as CSV files in the Web server for the system. These were registered to ODBC (open database connectivity) as a database, so that the models can easily utilize the climate data in the Web server.

4. Web Interface

Two versions of Web interface programs were developed using MS server products. In the simple version (Fig.2A), users can run the models easily by entering an AMeDAS point, a vegetable crop, cropping period, amount of mineral or organic fertilizers, and a soil group. When the Web server receives requests, it calculates soil nitrogen balance combining the models and the databases, and returns results to the users. In the detail version mainly for researchers (Fig2B), users can enter optional parameter values to run the soil nitrogen dynamic models, other than selecting sample data regarding crops, soils, or fertilizers. The nitrogen mineralization parameters of each soil or organic fertilizer in the database can be browsed in the both versions.

The *Soil Nitrogen Balance Estimation System* is open to the public on WWW. Now, the language on the Web pages is Japanese only.

URL: http://riss.narc.affrc.go.jp/kssys/soil/nitro.asp

Discussion

The system is available for anyone on WWW and users can easily try to calculate soil nitrogen balance in various farm conditions. We expect that the system will contribute wider popularity of individual appropriate fertilization to each farm.

We have to collect more parameters of the nitrogen dynamic models in soils, fertilizers, and crops from a wider range of sites. In order to estimate the soil nitrogen balance more accurately, it is necessary to calibrate and validate the soil dynamic models in various farm conditions from now on. In cooperation with prefectural researchers mainly, system improvement and data collection are being continued.

Now, the *Soil Nitrogen Balance Estimation System* is being improved to access the meteorological data mediation system “MetBroker” (Laurenson et.al., 2002) using SOAP (Simple Object Access Protocol) technology, so that it can utilize temperature and rainfall data from not only AMeDAS but several databases in the world.

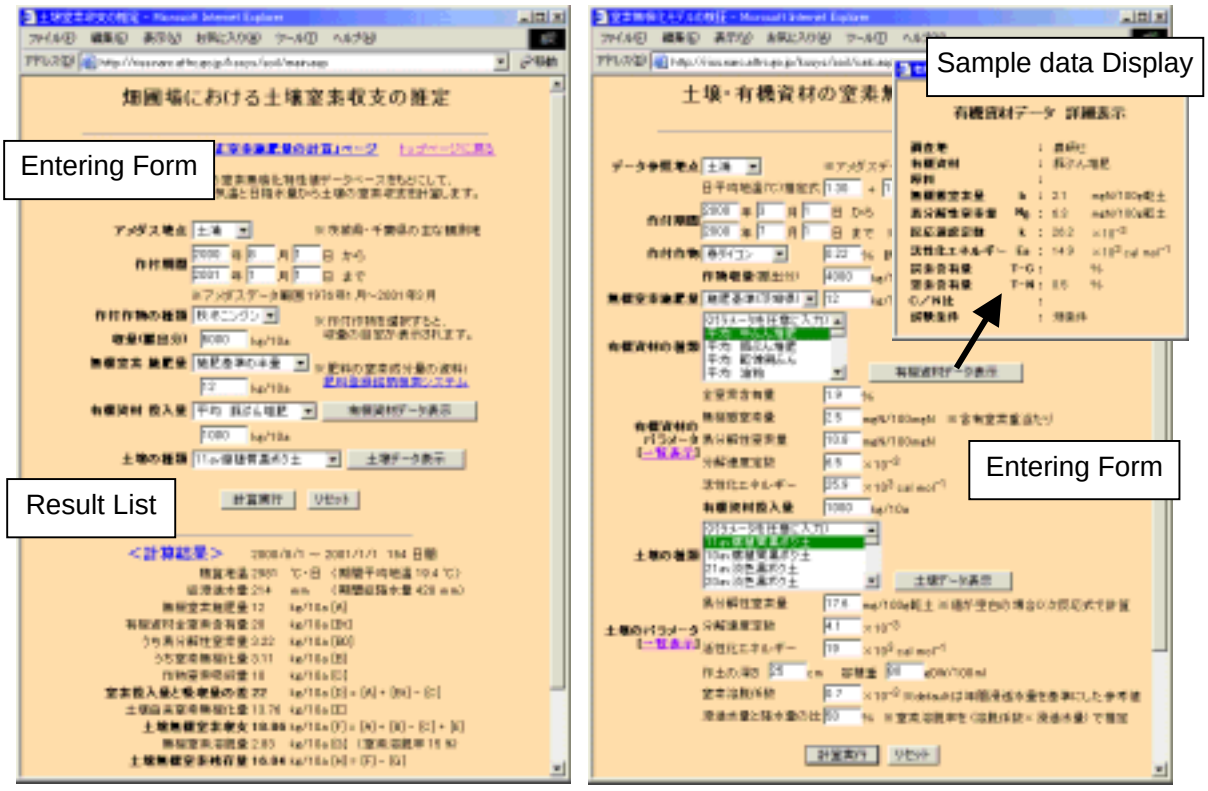

Fig.2 Displays of the *Soil Nitrogen Balance Estimation System* on a Web browser.
A(left) : Simple version - Calculation result
B(right): Detail version - Parameters-entering form

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