Information design for agricultural Plant Planning and Satellite based Remote Sensing Data Visualization

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Abstract

This paper shows design and cooperative design process for agricultural plant planning system based on information Design point of view. The system allows farmers planning kinds and yields of vegetables for the coming year. Developing functionalities for plant planning, visualization of Satellite based Remote Sensing (SRS) data, interactions for operating the system and graphical user interface are concerned in the design. The design project consists of farmers and multidisciplinary researchers those are agricultural biologist, remote sensing researcher and information designers. The objective of the design project has been vegetable farming in Tokachi area of Hokkaido, Japan.

1. Introduction

The vegetable farmers deal with thirty hectare field on average and fifteen to twenty crops in Tokachi. For the planning at this moment of our survey, hand drawing maps of the field and hand writing names and quantities of crops that he planted in each year have been used as figure 1. And notes of manures and fertilizers are existed.

The design we proposed is an assistance for the planning as interactive system for the farmers. Basic functions of the system are browsing, planning and recording concerning to vegetable crops, several values of harvests, and records of insects and disease.

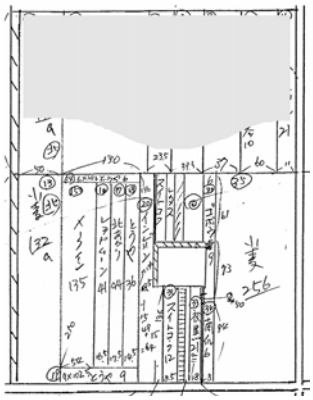

Fig. 1. A hand drawing map of fields, names and quantities of crops planned by farmer for 2005 (YM, 2005)

2. Planning Support System for Cropping and Fertilizing

2.1. Basic functions of the system

Following functions are designed in the Planning Support System. Those are (1) cropping for the next year, (2) fertilizing for the next year, (3) recording agricultural information concerning to this year that is listed in table 1, and (4) browsing past information about planning and recording in preceding years.

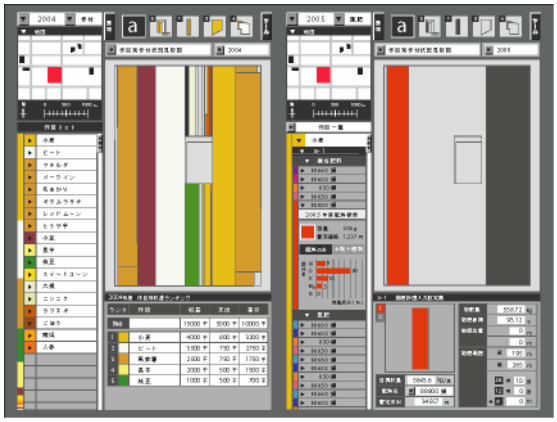

Fig. 2. A Screenshot of the Planning Support System for Cropping and Fertilizing

A main screen of the system is shown in figure 2. Left side of the screen is an area for planning crops on a plan of field where the farmer considers and right side is an area for browsing past information on same plans. Horizontal lists of the left area shows potential kinds of crops for the planning. The right area shows harvested kinds of crops with which the farmer deals.

Table. 1. Variables of agricultural information for the planning

a. Plan of Field for Cropping
b. Plan of Field for Fertilizing
c. Yields and productions
d. Starch-concentration (potato)
e. Sugar-concentration (beet)
f. Protein (wheat)
g. Nitrogen-content (soil)
h. Insects and diseases
i. Profit and loss

2.2. SRS data for the system

Variables of estimation for the system are followings. Those are calculated from SRS data.

j. Estimated yield of each crop
k. Estimated starch-concentration of potato on each field
l. Estimated sugar-concentration of beet on each field
m. Estimated protein of wheat on each field
n. Estimated nitrogen-content of soil on each field

2.3 Social system configuration for the planning support system

The planning support system is used by a number of farmhouses under management by a certain organization of the region. The organization contracts with SRS data provider. Figure 3 shows the providing system.

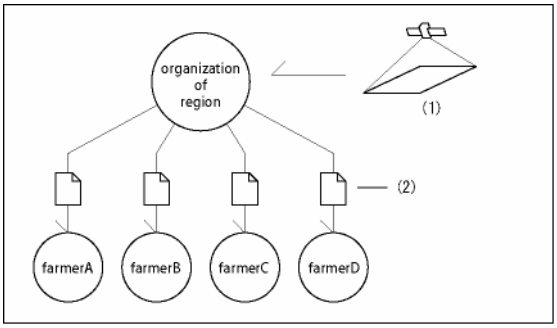

Fig. 3. Providing system for the planning support system
(1) SRS data of the region
(2) Providing values of the calculated data of each farmhouse field for the system on farmer's PC

3. Information Design Study on Visualizations for variables from SRS data

3.1. Visualizations

Values of the Variables are calculated from SRS data by functions constructed by SRS researcher (HONGO. 2004). Information designers visualize the variables. Purpose of the visualization is making legibility of the values for the farmers who deals with the values of crops, fertilizers, and his/her tasks on the fields.

Our study of the visualization has been based on SRS research for a couple of fields of potato that is grown by farmer YM in Tokachi as a case. Following visualizations are derived from the potato data.

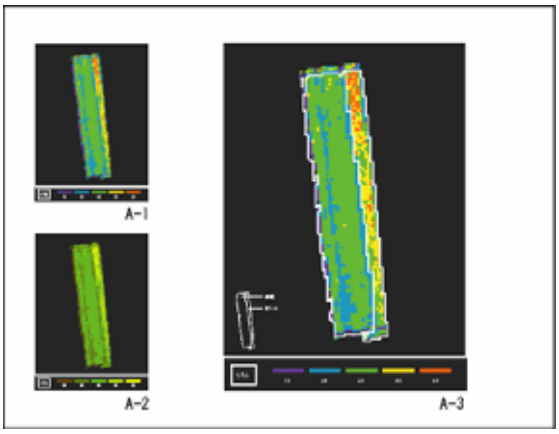

Fig. 4. Legible scatter-gram of Estimated yields of potato by SRS data
A-1. Scatter-gram of Estimated yields from SRS values
A-2. Scatter-gram of Estimated yields from SRS values (different color scale from A-1)
A-3. Overlapped visual expression depicting Preceding Crops

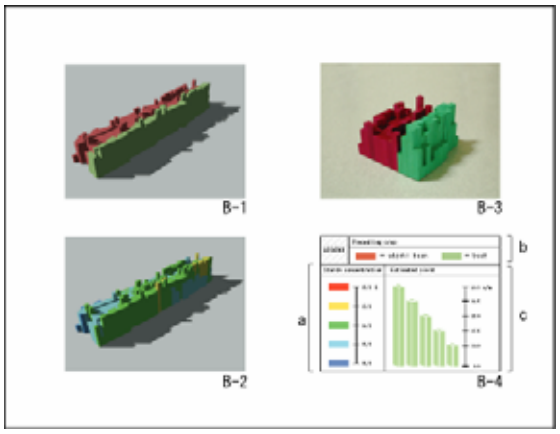

Fig.5. 3D Visual Expression depicting Yields, Starch-concentration and Preceding Crops
B-1. Visual Expression depicting Preceding Crops and Estimated yields (Height represents Estimated yield, Color is a kind of the crop)
B-2. Visual Expression depicting Estimated starch concentration and Estimated yields (Height represents Estimated yield, Color is Estimated starch concentration)
B-3. 3D Physical model of B-1
B-4. Legend;
a : Estimated starch concentration
b : Preceding Crops
c : Estimated yields

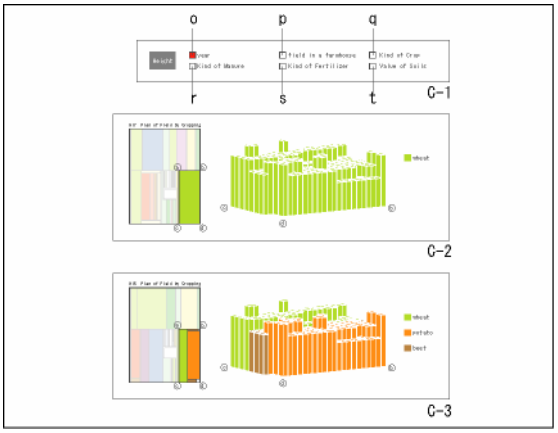

Fig. 6. 3D Visual Expression depicting Preceding Crops and Crops of this Year on specific Area of the fields
C-1. Check boxes of variables to visualize;
o : Year
p : Field in a farmhouse
q : Kind of crop, Yield, Sales of the crop, Value of harvest on the crop
r : Kind of manure, Quantity of the manure
s : Kind of fertilizer, Quantity of the fertilizer
t : Value of soil
C-2. Visualization of this year (Left), 3D Visual Expression (right)
C-3. Visualization of preceding year (Left), 3D Visual Expression (right)

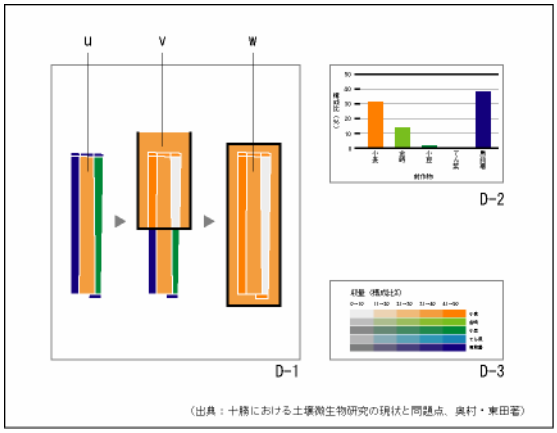

Fig. 7. Simulative Expression for the Influenced-by-the-preceding-crop Model
D-1.Simulative Expression for wheat with Influenced-by-the-preceding-crop
u : Preceding crop
v : Filter of “wheat” for preceding crop
w : Estimated yield of wheat
D-2. Graph of differentiations of Influenced-by-the-preceding-crop to crop of this year
D-3. Influenced-by-the-preceding-crop Model (OUMURA et al, 1991)

3.2. Evaluation for the visualizations

Evaluation for the visualizations has been received from farmer YK and other in a few times of meeting. Opinions from the hearing and discussion for some visualizations are presented as figure 8.

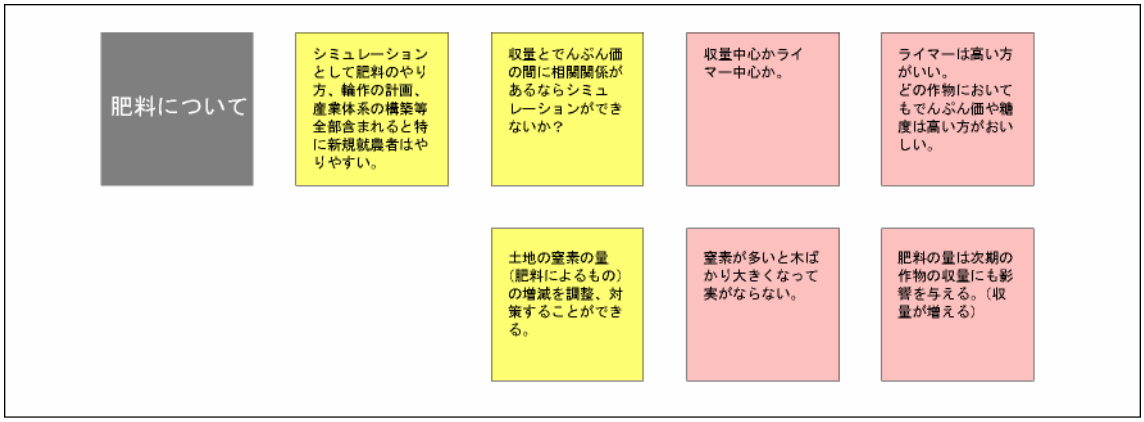

Fig. 8. Presentation of one discussion

Opinions of Farmers for the visualizations are followings.

(1) “The visualization is similar with farmer’s image. And it demonstrates state of his field much more clear than usual image through his working. ” This opinion is for the legible scatter-gram of estimated yields of potato by SRS data (Fig. 4.).
(2) “It may possible to simulate relationship between Estimated starch-concentration and Yield of potato on the field. ” This opinion is for the 3D visual expression depicting yields, starch-concentration and preceding crops (Fig.5.).
(3) “It is useful that system represents estimations and facts of each field.” This opinion is for the 3D visual expression depicting preceding crops and crops of this year on specific area of the fields (Fig. 6.).
(4) “The system allows new comers to learn their work and business on agriculture concerning to crops, fertilizers, distributions and so on.” This opinion is for the simulative expression for the influenced-by-the-preceding-crop model (Fig. 7.).

4. Future work and Acknowledgements

Through the design development of the plant planning support system, it is figured out that SRS data allows a various understanding of relations between estimated values and harvested facts on their farming. Future work of our design studies is developing cyclic model of crops and soil. The cyclic model is able to describe as follows.

(i) Crops and fertilizers in preceding year have been comprised in values of soils.
↓
(ii) The values of soils constraint plant planning of cropping and fertilizing in the next year.
↓
(iii) Crops and fertilizers makes the yields of this year. And those are comprised in values of soils.

Finally, we thank partner farmers for their contribution to the design development.

Reference

(1) (Okumura et al, 1991) Masatoshi OKUMURA, Syuji HIGASHIDA, “Current Status and Problems of Research on Soil-Microorganisms in Tokachi district”, Hokunou, vol.58, No.1, PP 6-15
(2) (Hongo, 2004) Chiharu HONGO, “The 10th CEReS International Symposium on Remote Sensing”