Decision Support Systems for Risk Management in Agriculture: An Overview of FAPS and Noyaku-Navi Projects

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The total number of students currently amounts to 19,000 while the faculty members number 2,350. At present there are more than 1,100 international students from about 70 countries studying here. The university has 16 faculties, 16 graduate schools and 11 undergraduate schools.
Speech outline

- Background for developing DSS
  - DSS: Decision Support System

- Type of decision making
  - Long term vs. short term

- DSS for long term decision making
  - FAPS project
    - FAPS, FAPS-DB, NAPASS,
      (Optimal Farm Planning, Farm simulation)

- DSS for short term decision making
  - Noyaku-Navi project
    - Noyaku-Navi
      (Agrochemical risk management system),
      (Warning system for inappropriate chemical use)
      (GAP support system)

- Concluding remarks
- References
Background for developing DSS

- **Big social and economic changes**
  - Agriculture has been facing big and many social and economic changes recently.
  - FTA/EPA is one of the approaches used for promoting free trade among countries.
  - A structural reform of agriculture is a big policy issue in the countries that increase the import of farm products.

- **Improvement of decision making**
  - The improvement of decision making in farming is necessary for innovation of agriculture in many countries including Japan.
  - Decision support systems for farmers and agricultural extension staffs are needed for their better decision making.
Type of decision making
Long term vs short term

- **Long term decision making (monthly or yearly)**
  - FAPS-DB: Estimation of the influence by the management strategy of the farming
  - NAPASS: Analysis of market information
  - FAPS: Farm planning under risk and uncertainty

- **Short term decision making (every day)**
  - Noyaku-Navi: Warning system for inappropriate use of agrochemical & automatic recording of agrochemical
  - GAP Navi: Supporting for Good Agricultural Practice
DSS for long term decision making

- **FAPS-DB**
  - is a decision support system that is appreciable for overall estimation of the influence by the management strategy of the farming.
  - Both technological and financial data are stored in the database.
  - Economic and risk assessment

- **NAPASS**
  - The database stores daily market price and quantity of vegetable and fruits in more than 50 major markets after 1977 in Japan.

- **FAPS**
  - is a decision support system for farm planning under risk and uncertainty in agriculture.
  - The system is able to generate optimal farm plans according to risk preference under yield risk, market risk and weather risk based on stochastic programming.
Over view of the systems

Farming Plan Making System

Farming-systems Analysis and Planning System under Risk (FAPS)
Making of advanced and detailed farming plan under agricultural risk

Farming Index Data Import Tool (ToFAPS)

Farming Index data (Ms-Excel Book)

Farming Plan Trial Calculation Tool (FSDBOut)
Making of introductory farming plan that considers owned management resources

Trial Balance of Farming Plan (Ms-Excel Book)

Database System for Agro-technologies

Farming-systems Database (FSDB) PostgreSQL

Data set for Farming-systems (Ms-Excel Book)
Excel to XML
XML to DB

Farming Management Indicator Generation System (FMIGS)
Generation of farming index by a simple operation

Market Information Database for Vegetables and Fruits (NAPASS)
Displayed on the Web

PC Client systems
Web Server Systems

Arrangement and confirmation of data
for DB Administrator
Displayed on the Web
FAPS-DB has been developed since 2003. The systems consist of a database server and a web server. Both servers run on a Linux operating system. The support system for farm planning using the database is operated on the web server.
Perl & ODBC Interface and SOAP Interface
Users can select a suitable farming system.

Users can type a desired farm land size in are. 100 a = 1 ha

<table>
<thead>
<tr>
<th>作付面積(a)</th>
<th>技術体系名</th>
<th>有効</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>レタス（スティディ, 6月がり, 全面マルチ, 1ha規模, 3500kg/10a, 岩手: 北部, 高冷地）</td>
<td>✔</td>
</tr>
<tr>
<td>75</td>
<td>レタス（サマーランド, 7月がり, 全面マルチ, 1ha規模, 3500kg/10a, 岩手: 北部, 高冷地）</td>
<td>✔</td>
</tr>
<tr>
<td>200</td>
<td>キャベツ（YR青春, YR青春2号, 7月がり, 1ha規模, 4500kg/10a, 岩手: 下半域）</td>
<td>✔</td>
</tr>
<tr>
<td>100</td>
<td>だいこん（YR桜坂, 7月がり, 1ha規模, 4000kg/10a, 岩手: 北高冷地除く）</td>
<td>✔</td>
</tr>
</tbody>
</table>

Selected farming system and area.
Simulation results of the selected farming systems. Throughout the column 1 to 4, users can find planted area, yield, average price, and revenue respectively. From column 5 to 7, it can be found management cost, profit, and labor force demand per year in hours, respectively.

<table>
<thead>
<tr>
<th>日付</th>
<th>技術体系名</th>
<th>作付面積 (a)</th>
<th>収量 (kg/10a)</th>
<th>平均単価 (円)</th>
<th>粗収益 (1) (千円)</th>
<th>経営費 (2) (千円)</th>
<th>所得 (1)-(2) (千円)</th>
<th>年間労働時間 (時間)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>レタス（ステディ，6月より，全面マルチ，1ha規模，3500kg/10a，岩手県北・高冷地）</td>
<td>150</td>
<td>3,501</td>
<td>112</td>
<td>5,882</td>
<td>11,788</td>
<td>3,830</td>
<td>7,958</td>
</tr>
<tr>
<td>75</td>
<td>レタス（サマーランド，7月より，全面マルチ，1ha規模，3500kg/10a，岩手県北・高冷地）</td>
<td>75</td>
<td>3,500</td>
<td>107</td>
<td>2,809</td>
<td>3,410</td>
<td>1,916</td>
<td>1,494</td>
</tr>
<tr>
<td>200</td>
<td>キャベツ（YR青春，YR青春2号，7月より，1ha規模，4500kg/10a，岩手県下全域）</td>
<td>200</td>
<td>4,500</td>
<td>72</td>
<td>6,480</td>
<td>7,104</td>
<td>4,706</td>
<td>2,398</td>
</tr>
<tr>
<td>100</td>
<td>だいこん（YR桜坂，7月より，1ha規模，4000kg/10a，岩手県北（冷地を除く））</td>
<td>100</td>
<td>4,000</td>
<td>76</td>
<td>3,040</td>
<td>2,607</td>
<td>1,704</td>
<td>903</td>
</tr>
<tr>
<td>525</td>
<td>経営全体</td>
<td>525</td>
<td>-</td>
<td>-</td>
<td>18,210</td>
<td>24,910</td>
<td>12,156</td>
<td>12,753</td>
</tr>
</tbody>
</table>

予想より所得が低いと思った場合はこちら（試算結果利用上の留意点）

- 固定費計算条件（農機・施設の利用年数）の確認・変更
  棄機・施設を法定耐用年数より長く使う等の経営努力を行うことにより，固定費（減価償却費）を減少させた場合の収支を計算します。
Revenue and management cost per farming system
Cumulative working time in times series at 10 days interval

Legend
16 kinds of tables with graphs are generated

- Semimonthly financial balance and cash flow
- List of materials invested
- List of required machinery and facilities
- Farm work timetable

16 tables with graphs are displayed.
The database covers both production and finance data, such as yield and price of crops, the efficiency and price of a machine, working hours, and quantity and price of input materials. These data are indispensable to farm planning.

125 kinds of standardized farming system data of Iwate prefecture are stored in the database. These data covers the main agricultural products and cultivation types within the prefecture. Other prefectures also consider making their database.
The access situation of the FAPS-DB

The present system has been released since April 2007

[ ´10000 page hits]

- **Accesses this month**
- **Total accesses until last month**
- **Daily Avg**

![Graph showing page hits over time from April 2007 to April 2008.](image-url)
Framework of the assessment

Farm Planning (decision variable)
- Cultivation acreage by each crop / variety
- Kind and quantity of agricultural material (pesticide, fertilizer, machinery and etc.)

Economic risk (unexpected outcome)
Unexpected Income fluctuation (a probability distribution)

Environmental risk (unexpected outcome)
Negative effects on health of human being and natural environment

NAPASS DB (market info. DB)
FAPS-DB (Input output data of Farming systems, price, yield, cost, materials, labor and etc.)
Noyaku-Navi (agro-chemical DB)

<table>
<thead>
<tr>
<th>Unexpected fluctuation of income (source of risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>price fluctuation</td>
</tr>
<tr>
<td>yield fluctuation</td>
</tr>
<tr>
<td>weather condition (rain fall etc.)</td>
</tr>
</tbody>
</table>

Greenhouse gas (source of risk)
RST: Risk score (toxicity) of agricultural technology with chemical, source of risk

Economic risk (unexpected outcome)

Environmental risk (unexpected outcome)
Example of estimated economic risk
(Income fluctuation of tomato farming)

![Graph showing tomato price fluctuation and income fluctuation of the farm over years.]

- a) Tomato price fluctuation (Yen/kg)
- b) Income fluctuation of the farm (Million Yen)
Example of environmental risk (Greenhouse gas (GHG) emissions risk and chemical risk of rice and tomato farming)
DSS for short term decision making

- **Agricultural Chemicals Law**
  - Japanese consumers feel insecure in the safety of farm products including imported products.
  - Japan has very strict Agricultural Chemicals Law.
  - The farmer who violates the law confines three years or less, and receives the amercement of one million Japanese yen (10000 US$).
  - The standards for agricultural chemical use have been revised several times, thus becoming more detailed and complicated.

- **Noyaku-Navi**
  - The first goal of the system is to enable farmers to prevent carelessness in agricultural chemical misapplication.
  - The second goal of the system is to register easily and correctly the application records.
  - This is done by using bar-codes attached to the agricultural chemical containers.
  - This latest system is used by more than 11,000 farmers in Japan.
1. Prepare a pesticide spraying plan

2. Request a judgment for the plan

3. You get results of judgment

*Illegal*

*Note*

*Memo*

● Total frequency of use of the active ingredient will exceed the total frequency prescribed in the law.
System Overview

The Noyaku-Navi system is integrated to food traceability system. Multi-stage judgment is one of the major characteristics of the system.
# Pesticide Spraying and Cultivation Planning

![Image of a spreadsheet with columns for date, name of agrochemical, and dilution and other spraying practice.]

- **Date**
  - [Insert date information]
- **Name of the agrochemical**
  - [Insert name of agrochemical]
- **Dilution and other spraying practice**
  - [Insert details of dilution and spraying practice]

**Working schedule**

Cultivation planning table:

<table>
<thead>
<tr>
<th>No.</th>
<th>予定日</th>
<th>予定作業</th>
<th>投下資材</th>
<th>区分</th>
<th>用途</th>
<th>数量・投下量（内空基）</th>
<th>希釈倍数使用量</th>
<th>計画の希釈倍数使用量</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4月上旬</td>
<td>植剤散布</td>
<td>スプレーオイル</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>50倍（2ppm）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4月上旬</td>
<td>植剤散布</td>
<td>水溶性</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>50倍（2ppm）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4月上旬</td>
<td>植剤散布</td>
<td>石灰硫黄粉剤</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>10倍（10ppm）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5月中旬</td>
<td>植剤散布</td>
<td>サンリット水和剤</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>4,000倍（25g）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5月後半</td>
<td>植剤散布</td>
<td>アクタラショウ水溶剤</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>20,000倍</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6月上旬</td>
<td>植剤散布</td>
<td>カプラィド水和剤</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>150倍（6.7g）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>6月上旬</td>
<td>植剤散布</td>
<td>ダイホルトフロアプル</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>500倍（200g）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6月上旬</td>
<td>植剤散布</td>
<td>タンプター水和剤</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>1,000倍（100g）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>6月上旬</td>
<td>植剤散布</td>
<td>ベルクート水和剤</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>1,000倍（100g）</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>6月上旬</td>
<td>植剤散布</td>
<td>アミーチェロフロアプル</td>
<td>指定なし</td>
<td>殺虫剤</td>
<td>1,000倍（100m）</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Judgment based on the legal and individual standards

When the results of the judgment do not conform to the standard, the result is indicated as "×". Each user can set the conditions of the marks. The indication of the judgment can be controlled by the judgment level.
The ago-chemicals registration number can be obtained by the bar code on the container with camera equipped mobile phone.
The 5W1H historical information on agrochemical application automatically recorded.

- **When**: time of access to the server
- **Where**: name of farm fields or latitude and longitude obtained by the GPS
- **Who**: name of producer, login ID, or identification information of the mobile phone
- **What**: registration number or name of the agrochemical,
- **Why**: images of target agricultural pest and weeds
- **How**: dilution rate, amount, or images of spray may be also available
Optical character recognition (OCR) vs. mobile phone

620 farmers used OCR-based system

30 farmers used mobile phone-based system

OCR: Optical Character Recognition
**Evaluation of mobile phone-based approach**

<table>
<thead>
<tr>
<th>Age</th>
<th>Farmers want to use the mobile phone system continuously</th>
<th>Dose not want to use the mobile phone system continuously</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 51</td>
<td>27%</td>
<td>73%</td>
</tr>
<tr>
<td>Under 50</td>
<td>69%</td>
<td>31%</td>
</tr>
<tr>
<td>Total</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Note: n=24
Mobile Phone vs. OCR

OCR-based system (User: over 12000 farmers)

- Advantage
  - easy installation

- Disadvantage:
  - difficult to actually collect and judge the documents often,
  - prejudgment just before spraying cannot be performed,
  - reading and correction of OCR documents at the JA branch offices are inevitable.

Mobile phone-based system (User: few farmers)

- Advantage
  - solve the disadvantage of the OCR-based system
  - improve the reliability of the 5W1H information.

- Disadvantage
  - Not familiar to old farmers, Need for mobile phone literacy?
Traceability System of Vegetables and Fruits with mobile phone

Shipment and arrival processing

Display of marketing channel information
Concluding remarks

- An overview of the decision support systems is introduced with their applications in Japan.
  - The technical parts of the decision support systems are also discussed with inside of the systems.

- An integration of both systems for long and short term decision making is one of the big issues in developing an innovative DSS.
  - We are going to develop a GAP navigation system based on Noyaku-navi.
  - Then we will integrate GAP navigation system and FAPS systems.
  - The research project under MAFF budget has been just started.
  - The budget will be 1.4 million USD for 3 years from 2008 to 2010.

- The basic ideas and technologies of the systems are applicable to any countries in the world including APAN member.
  - The user interface and the database should be adjusted to the domestic conditions in each country.
Recent references for long term DSS

Recent references for short term DSS

Agenda of AG-WG

- Chair: Masayuki Hirafuji (NARO / Univ. of Tsukuba)
  Teruaki NANSEKI (Kyushu University)

- Objectives:
  - Many kinds of IT applications are required in agriculture, and advanced information technologies, cutting edge devices and low-cost infrastructure such as sensor networks are indispensable to realize applications, especially for rural areas and developing countries. In this session, application developers and hardware/infrastructure developers will present their past/current activities and future plans to encourage their developments with collaborations.

- Target Audience:
  Agricultural / Biological software developers / researchers / engineers,
  Sensors Network Community

- Remark: VTC (Skype), Projector, wireless Internet access
Agenda of AG-WG

Chair T. Nanseki (Kyushu University)

- 09:00-09:30
  - Decision Support Systems for Risk Management in Agriculture: An Overview of FAPS and Noyaku-Navi Projects,
  - Teruaki NANSEKI (Kyushu University)

- 09:30-10:00
  - Decision Support System for Oil Palm Plantation Management,
  - Wan Nor Zanariah (Universiti Putra Malaysia)

- 10:00-10:30 (VTC)
  - Malaysian National Paddy Precision Farming Project,
  - Abdul Rashid Bin Mohamed Shariff (Universiti Putra Malaysia)
  - (with Mr. Ebrahim and Miss Nik Norasama)

Coffee break
Agenda of AG-WG

- Chair M. Hirafuji

- 11:00-11:30
  Monitoring Glacial Lake in Himalayas through Sensor and Wireless Technology,
  Bhushan Shrestha (NREN)

- 11:30-11:50
  Found problems and solutions of Field Server,
  Masayuki Hirafuji (NARO / Univ. of Tsukuba)

- 11:50-12:10
  Projects and Organization for ICT agriculture,
  Seishi Ninomiya (NARO / Univ. of Tsukuba)

- 12:10-12:30 AG-WG discussions