

### 2.1.1 Laboratory : Crop Science

Member:	Professor	Shiraiwa, Tatsuhiko, Dr. Agric. Sci.
	Associate Professor	Katsube-Tanaka, Tomoyuki, Dr. Agric. Sci.
	Assistant Professor	Homma, Koki, Dr. Agric. Sci.
	Doctor's program	5
	Master's Program	6
	Undergraduate	3
	Other	2
	Post-Doctoral fellow	1
	Researcher	1

#### **A. Research Activities (2009.4-2010.3)**

##### **A-1. Main Subjects**

a) Mechanisms for high productivity of soybean and its adaptability to changing environments

The yield of soybean remains low and unstable as compared to the major cereal crops. This study aims at identification of major factors that limit yield potential of current genotypes and environmental factors that cause a large variation of soybean yield. Field experiments demonstrated that a close and consistent correlation exists between seed yield and CGR during the initial seed filling stage across diverse genotypes. A remarkable difference in leaf photosynthetic ability was observed between Japanese and US cultivars and the underlying mechanisms and genetic factors are being investigated. The phenomenon of “delayed stem senescence (DSS)” has broadly been observed in the soybean farms and reduces seed quality and even yield. Based on field experiments and field surveys, we found that the occurrence of DSS is promoted by unstable soil moisture condition especially during reproductive growth periods and we are analyzing crop physiological mechanism for DSS and genetic factors. In the soybean production area, a large field-to-field variability exists in the yield. We have investigated variations of soil moisture and fertility conditions and proposed major sources of yield variation, further we are developing methodology for evaluating field condition employing the remote sensing technique and the water budget model.

b) Identification, genotypic evaluation and simulation-modelling of major traits determining yield potential of rice under field conditions

Stagnation of yield potential of rice cultivars has been recognized since the Green Revolution. The objectives of this study are to identify the processes that limit rice yield potential under field conditions and to evaluate genotypes in the processes. So far, we have conducted field experiment using Rice Diversity Research Set of germplasm (RDRS) selected by NIAS and have reported several traits associated with yield potential. Analysis of genetic variability in leaf photosynthetic ability ( $P_n$ ) and associated factors revealed that some local varieties were promising for breeding, and that stomatal conductance and leaf nitrogen concentration was significantly different among genotypic groups which were classified by DNA markers. We also develop a rice crop simulator to interface gene functions to field performances based on the results in a multi-site experiment conducted under diverse environments in Asia. The processes of dry matter and spikelet production, and leaf area development have been modeled.

c) Quality improvement of rice seeds and analysis of mechanisms for high-temperature injury  
Rice grain is one of the most important cereals since around half of the world's population consumes rice as a staple food. Rice seed is, however, deficient in the essential amino acid, lysine. Therefore, nutritional improvement in the amino acid composition of rice protein is needed especially for developing countries. We have focused on compositional change of the most major seed protein, glutelin by genotype- and/or environment/management- oriented improvement techniques. So far we demonstrated the possibility that the lysine content is increased by ~10% using glutelin mutants which are deficient in a subunit with less amount of lysine and that the composition is altered by adjustment of plant nitrogen and/or sulfur nutrition. Screening and analysis of wild rice species is also carried out to isolate novel superior glutelin gene. On the other hand, analysis on the quality loss of rice seeds caused by global warming, etc. has shown that some plant hormones and transcription factors are involved in the high-temperature injury, by using unique experimental system of detached ear culture.

d) Improving productivity and sustainability of rain-fed rice culture in the world

More than half of rice cropping lands in the world is still under rain-fed condition. We have conducted the field surveys on constraints of rice production in rain-fed paddy culture and upland culture in North-east Thailand, North Laos and Madagascar. The surveys in Thailand and Laos demonstrated that inappropriate land and soil managements have caused serious degradation of soil fertility and decline of productivity. In order to improve the productivity, introduction of legume manure crops during fallow seasons and return of clay-accumulated soil to the clay-eloded soil were the two major putative technologies. In North Laos, soil respiration and biomass production of plant community of cropped and fallow plots have been monitored at a shifting agriculture area to estimate CO<sub>2</sub> balance of the ecosystem. The survey

in Madagascar on the System of Rice Intensification (SRI) revealed importance of soil fertility amendment to achieve high yield under insufficient resource input. We further investigated status of land use and rice productivity in a village where the lowland rice culture and the shifting agriculture are typically mixed up with strong land use pressure. For stabilizing rice production and consequently ameliorate deforestation, effectiveness of several management options, such as utilization of un-used crop residues as organic fertilizer, were examined.

## **A-2.Publications and presentations**

### **a) Publications**

#### Books

- Inoue, Y., Qi, J., Kiyono, Y., Ochiai, Y., Saito, K., Asai, H., Horie, T., Shiraiwa, T., Dounagsavanh, L., Oliso, A. (2009) Land use and carbon stock capacity in slash-and-burn ecosystems in mountainous mainland of Laos. In A. Roder and J. Hill (Eds.) Recent Advances in Remote Sensing and Geoinformation Processing for Land Degradation Assessment. Taylor and Francis Group, London, 343-358.
- Homma, K., Horie, T. (2009) The Present Situation and the Future Improvement of Fertilizer Applications by Farmers in Rainfed Rice Culture in Northeast Thailand. In L.R. Elsworth and W.O. Paley (Eds.) Fertilizers: Properties, Applications and Effects. Nova Science Publishers, New York, 147-180.

#### Original Papers

- Asai, H., Samson, B.K., Stephan, H.M., Songyikhangsuthor, K., Homma, K., Kiyono, Y., Inoue, Y., Shiraiwa, T., Horie, T. (2009) Biochar amendment techniques for upland rice production in northern Laos. 1. Soil physical properties, leaf SPAD and grain yield. Field Crops Res. 111, 81-84.
- Asai, H., Saito, K., Samson, B.K., Homma, K., Shiraiwa, T., Kiyono, Y., Inoue, Y., Horie, T. (2009) Yield response of indica and tropical japonica genotypes to soil fertility conditions under rainfed uplands in northern Laos. Field Crops Res. 112, 141-148.
- Homma, K., Mochizuki, A., Horie, T., Shiraiwa, T., Supapoj, N. (2009) Nutrient deficiency in the rice-Stylosanthes guianensis relay-intercropping system in rainfed lowland rice ecosystem in Northeast Thailand. Plant Prod. Sci. 12, 390-393.
- Homma, K., Shiraiwa, T., (2009) Evaluation of Water Stress in Soybean Based on the Difference in Canopy Temperature between Soybean and Rice. Japanese J. Crop Sci. 78, 387-394.

- Katsura, K., Maeda, S., Horie, T., Shiraiwa, T. (2009) Estimation of respiratory parameters for rice based on long-term and intermittent measurement of canopy CO<sub>2</sub> exchange rates in the field. *Field Crops Res.* 111, 85-91.
- Mikoshiba, H., Homma, K., Sudo, K., Ushio, A., Okai, H., Ozaki, K., Shiraiwa, T. (2009) Analysis of Production Variability of Soybean 'Tanbaguro' II. Difference in yield and planting environment among 4 villages in Tanba in 2007. *J. Crop Research* 54, 9-17.
- Rahman, M.M., Amano, T., Shiraiwa, T. (2009) Nitrogen use efficiency and recovery from N fertilizer under rice-based cropping systems. *Aust. J. Crop Sci.* 3, 336-351.
- Saito, K., Linquist, B., Keobualapha, B., Shiraiwa, T., Horie, T. (2009) *Broussonetia papyrifera* (paper mulberry): its growth, yield and potential as a fallow crop in slash-and-burn upland rice system of northern Laos. *Agroforest Syst.* 76, 525-532.
- Saito, K., Linquist, B., Jongkeawwattana, S., Shiraiwa, T., Horie, T., Homma, K. (2009) Effects of intensified agricultural practices on upland rice productivity in Northern Thailand. *Trop. Agr. Develop.* 53, 118-122.
- Tanaka, Y., Shiraiwa, T. (2009) Stem growth habit affects leaf morphology and gas exchange traits in soybean. *Annals of Botany* 104, 1293-1299.
- Tsujimoto, Y., Horie, T., Randriamihary, H., Shiraiwa, T., Homma, K. (2009) Soil management: the key factors for higher productivity in the fields utilizing the System of Rice Intensification (SRI) in the central highland of Madagascar. *Agric. Sys.* 100, 61-71.

#### Reviews

- Katsura, K., Yoshihira, T., Homma, K., Purcell, L.C., Katsube-Tanaka, T., Shiraiwa, T. (2009) Field Studies on Factors Causing the Widening Gaps in Soybean Yield between Japan and USA. -Field Observation Reports in USA-. *J. Crop Research* 54, 149-154.

#### b) Conference and seminar papers presented

- The 228th Ann. Meeting of Crop Sci. Soc. of Japan : 4 presentations
- The 227th Ann. Meeting of Crop Sci. Soc. of Japan : 4 presentations
- The 167th Ann. Meeting of the Society of Crop Science and Breeding in Kinki, Japan: 1 presentation
- International Symposium on Enhancing Soybean Productivity for 21st Century : 1

presentation

- The 2009 Ann. Meeting of the Fertilizer- and Pesticides- free Cultivation Research Group : 1 presentation
- The 2009 Ann. Meeting of the Hokkaido Branch of the Japanese Society of Breeding and the Hokkaido Branch of the Crop Science Society of Japan: 1 presentation

### **A-3.Off-campus activities**

#### Membership in academic societies

- Shiraiwa, T. : Crop Science Society of Japan (Councilor, Editorial board member of Japanese journal, Chair of reviewing committee, Member of symposium committee), The Society of Crop Science and Breeding in Kinki, Japan (Councilor)
- Katsube-Tanaka, T. : Crop Science Society of Japan (Reviewing committee member, Regional editorial board member of Japanese journal)
- Homma, K. : Crop Science Society of Japan (Member of strategy committee for young members, Member of strategy committee for men and women cooperative), The Society of Crop Science and Breeding in Kinki, Japan (Chairperson of symposium organizing committee)

#### Research grants

##### 1. Grants-in-aid for Scientific Research(KAKENHI)

- Scientific Research (B) : Shiraiwa, T. : Mechanisms for delayed stem senescence in soybean: evaluation of gene by environment interaction and identification of major genetic regions
- Scientific Research (B) : Shiraiwa, T. : Contribution of environmental, genotypic and agronomic factors to increasing gap of soybean yield between Japan and USA
- Scientific Research(C) : Katsube-Tanaka, T. : Analysis of seed storage protein variation to reduce allergen in buckwheat.

##### 2.Other Research Grants

- Research Project for Utilizing Advanced Technologies for Agriculture, Forestry and Fisheries : Sudo, Kenichi : Production Technologies for Stable Production of “Black Soybean” in The Cropping System in Kinki Region.
- Research Project by Ministry of Agriculture, Forestry and Fisheries : Taniyama, Ichiro : Impact assessment of global warming on agriculture, forestry and fisheries and development of technology for amelioration and adaptation (Impact assessment of global warming on soybean production)

#### **A-4.International cooperation and overseas activities**

##### Membership in academic societies

- Shiraiwa, T.: Plant Production (Editorial board member)

##### International joint research, overseas research surveys

- Contribution of environmental, genotypic and agronomic factors to increasing gap of soybean yield between Japan and USA, Shiraiwa, T. (USA: University of Arkansas, University of Illinois)

##### Visiting Research Scholars

- Postdoctoral Fellow     1 (Pakistan)

#### **B.Educational Activities(2009.4-2010.3)**

##### **B-1.On-campus teaching**

###### a) Courses given

- Undergraduate level:    Outline of Bioresource Science I (Shiraiwa), Crop Science I (Shiraiwa), Crop Science II (Shiraiwa, Tanaka), Laboratory Course in Biological and Environmental Science I, (Tanaka, Homma), Seminar in Crop Science (Shiraiwa), Exercises in biostatistics (Homma)
- Graduate level:            Crop Science-Seminar (Shiraiwa, Tanaka), Special Laboratory Work in Crop Science (Shiraiwa, Tanaka), Crop Environmental Physiology (Tanaka)

##### **B-2.Off-campus teaching etc.**

##### Part-time lecturer

- Shiraiwa, T.: Fukui Prefectural University (Crop Science)

##### **B-3.Overseas teaching**

##### International students

- International students :    Master    1 (Mozambique)    Research Students    1 (Bangladesh)

#### **C.Other Remarks**

- Shiraiwa, T. : Agriculture, Forestry and Fisheries Research Council (Outsider's evaluation member for research grant)