Journal of Integrated Field Science

Vol. 1

March. 2004

Field Science Center
Graduate School of Agricultural Science
Tohoku University

Journal of Integrated Field Science (JIFS)

Office : Integrated Field Science Center,
Graduate School of Agricultural Science,
Tohoku University,
232−3, Yomogida, Ooguchi, Naruko,
Tamatsukuri, Miyagi, 989−6711, Japan

Contents

Integrated Field Science

Food production systems have been studied in order to improve production capacity and quality in individual bio−production fields, and these advances have contributed to establishing a sufficient food supply to meet the needs of the increasing world population since the industrial revolution. However, it has also been clarified in the last two decades that agricultural activity has also contributed to increases in environmental loading such as increase of global warming gases, stream and subterranean water pollution, soil degradation etc. The development of environmentally friendly food production systems that integrate high production efficiency with the ecosystems, including human society, is expected to be of great interest.

The Investigation Research Group on ideal ways of the attached farm and forest facilities in National University discussed a current analysis and a preferable future image of these facilities, and announced, "What should be of the farm and forest facilities in National University (middle summary) " (October, 1999). According to this report, to strengthen the educational research function of these facilities, the following things were proposed : to promote an education and research on integrated science of new biosphere "Field Science" using these facilities as the mother's body, to establish an integrated body of the these attached facilities in each university if necessary (The example of the name : Field Science Center), and to examine organic cooperation of those organization. The National Councils for University moreover submitted a report requesting "Irradiative Individuality at each University "(October, 1998). In addition, the examination−working group of nationwide Dean of Agricultural Department Conference concerning what should be of attached field facilities issued "Examination report concerning what should be of attached facilities". According to this, the role of field facilities of university in research side, bio−production farm and economic forest, center of field science for constructing sustainable bio−production, center of the environment relative researches. center of the creation of a new research by the cooperation of agriculture and another field (July, 2002)

In these reports, the research and education of the field science that was originally the base of agricultural science was shifted from the main body of department of agriculture to field facilities. And, attached field facilities such as university farm, university forest and university fishery experimental station, etc. were reorganized, and the establishment of the Field Science Center was promoted in nationwide. Moreover, the role as the research and education center of the field science with organic cooperation is expected in these combined facilities. That is, the roles of newly established Field Science Center are not only deepening the research and education concerning the bio−production in individual ecosystem, but also constructing sustainable bio−production systems in integrated ecosystem considering the interaction with the adjoining ecosystem. Therefore, the birth of " Integrated Field Science" is indispensable to construct sustainable bio−production system that considers the environment in the integrated ecosystem in higher−order.

In Tohoku university, to facilitate the development of environmentally friendly food production systems that consider the ecosystem, the new Field Science Center was also established in 2003 through the merger and reorganization of two former educational and research facilities for field science : the University Farm and the Education and Research Center of Marine Bio−Resources. The new center has three educational and research stations : the Field Control Station (Sendai), the Terrestrial Field Station (Naruko), and the Marine Field Station (Onagawa), and the following 5 research groups : the Forest−Andisols Group, the Ruminant Production Group, the Rice Production Group, the Marine Bio−production Group, and the Integrated Field Control Group.

We hope this "Journal of Integrated Field Science" issued annually by Field Science Center of Tohoku University will contribute to the progress of research on "Integrated Field Science" and to establish sustainable bio−production system in integrated ecosystems.

March 12, 2004

Director of Field Science Center of Tohoku University

Dr. Prof. Masahiko Saigusa

1st International Workshop on Integrated Field Science in Terrestrial−Marine Ecosystem

Program

Date : 19−22 November 2003.

Place : No.1 Lecture Room, Graduate School of Agricultural Science,
Tohoku University, Sendai, Japan

19th November 2003

Opening Ceremony

13:00～ Welcome remarks Dr. Yukio Akiba,
Dean of Graduate School of Agricultural Science, Tohoku University

13:05～ Welcome remarks Dr. Hitoshi Onishi
Vice President of Tohoku University

13:10～ Workshop Purpose Dr. Masahiko Saigusa
Director of Field Science Center, Graduate School of Agricultural Science, Tohoku University

1st session : Field Studies in International Interuniversity Network

13:15～13:35 Research core on biological−production ecosystems in the area of forests, grasslands and volcanic ash soils
Dr. Masami Nanzyo (Tohoku University)

13:35～13:55 Research, facilities and education at SLU and Uppsala University, Sweden
Dr. Laura Parducci (Uppsala University)

13:55～14:15 Recent topics of rice studies in Graduate School of Agricultural Science, Tohoku University
Dr. Tadahiko Mae and Dr. Amane Makino (Tohoku University)

14:15～14:35 Field studies in Kasetsart University, Thailand
Dr. Mingkwan Mingmuang, Prof. Dean. (Kasetsart University)

14:35～14:55 Field facilities and fields researches at the Szent Istvan University Hungary
Dr. Ombodi Attila (Szent Istvan University)

14:55～15:15 **Coffee Break**

15:15～15:35 Studies on ruminant production research core in Graduate School of Agricultural Science, Tohoku University
Dr. Yutaka Nakai (Tohoku University)

15:35～15:55 Field studies on Animal Science in Cheju National University, Korea
Dr. Moon−chul Kim, Prof. Dean & Dr. Min−soo Kang (Cheju National University)

15:55～16:15 Current Studies on Research Core in Marine Bio−production in Graduate School of Agricultural Science, Tohoku University
Dr. Makoto Osada (Tohoku University)

16:15～16:35 General information, fields of biological research and international relations in Siberian Branch of Russian Academy of Science, Russia
Dr. Anna A. Barinova (Siberian Branch of Russian Academy of Science)

16:35～16:55 Field studies on Aquaculture in Ocean University of China, China
Dr. Qi Li (Ocean University of China)

16:55～17:15 Marine science studies in Vigo University, Spain
Dr. Maria del Mar Ortega−Villaizan Romo (Vigo University)

17:15～18:00 **General discussion** : Chairman : Dr. Yutaka Nakai

18:00～ **Welcome Party** : Large Meeting Room

20th November 2003

2nd session : Field Studies in Miyagi Prefecture Network

09:00～09:20 Introduction of Miyagi Prefectural Forestry Research Institute
09:20～09:40 Introduction of Miyagi Prefectural Livestock Experiment Station
09:40～10:00 Introduction of Miyagi Prefectural Furukawa Agricultural Experiment Station
10:00～10:20 **Coffee Break**
10:20～11:00 Introduction of Research Institutes for Aquatic and Marine Science in Miyagi Prefecture
Dr. Akihiro Kijima (Oyster Research Institute/Tohoku University)
11:00～11:20 Current situation on research core of Integrated Field Control
Dr. Masahiko Saigusa (Tohoku University)
11:20～12:00 **General discussion** : Chairman : Dr. Yutaka Nakai

Field Survey :

20th November 2003

13:30 Departure to Naruko
14:30 Furukawa Agricultural Experiment Station
Stay in Naruko (Naruko Kaikan)

21st November 2003

09:00 Field Survey in Integrated Terrestrial Station of Tohoku University
13:30 Departure to Onagawa
15:30 Miyagi Prefecture Fisheries Research and Development Center
Stay in Onagawa (Field Station)

22nd November 2003

09:00 Field Survey in Integrated Marine Station of Tohoku University
14:00 Matsushima Bay
17:00 Arrival at Sendai

Opening Remarks by Dean of the Graduate School

Professor Hitoshi Onishi, Vice President of Tohoku University, distinguished participants overseas, ladies and gentlemen, it is my great pleasure this afternoon to make the opening address for 1st International Workshop on Integrated Field Science in Terrestrial−Marine Ecosystem.

Human health and welfare are dependent on bioindustrial products. A safe, readily accessible food and necessaries of life are the fundamentals of existence and security for individuals, communities and nation. Keeping step with the rapid pace of scientific development, the Graduate School of Agricultural Science performs 21st century−oriented agricultural science by acknowledging agricultural science's relation to the bio−industry and the need to deal with problems of food production, health and environment that form the basis of human existence.

Another aim of our agricultural science is to establish scientific basis for the sound promotion of the bioscience related to agriculture, animal husbandry and marine industry by integrating molecular biology, cell biology, physiology, bioorganic chemistry, ecology and social economics. For future development of Bioindustries, we are also conducting frontier researches directed to bioindustrial application on the basis of microbiology, food science, bioorganic chemistry, genomics and bioinformatics. In view of facilitating the development of environmentally friendly food production systems that consider the ecosystem, the new Field Science Center was established in 2003.

The new center has three educational and research stations : the Field Control Station (Sendai), the Terrestrial Field Station (Kawatabi), and the Marine Field Station (Onagawa), and the following research groups which we refer as Cores: the Forest−Andisols Core, the Ruminant Production Core, the Rice Production Core, the Marine Bio−production Core, and the Integrated Field Control Core.

This workshop on the Integrated Field Science will, I am sure, provide you, the participants with a valuable opportunity to meet each other and to share views and concepts on field science. I would like to express special appreciation to the organizers, and to all the others who have worked to convene this workshop.

Finally, I look forward to the discussions and exchanges that will take place here being an important step towards sustained and even closer cooperation among the participants and to create a new partnership for the future research collaboration.

Thank you very much.

November 19, 2003

Dean Professor Dr. Yukio Akiba,
Graduate School of Agricultural Science, Tohoku University

Welcome Remarks

It is an honour and our great pleasure to have such distinguished guest participants in this First International Workshop on Integrated Field Science in Terrestrial−Marine Ecosystems. This project for integrating terrestrial field science and marine one from the perspective of ecology seems to be a very ambitious and pioneering scientific attempt. And, such a pioneer spirit in science is one of the main principles our University has adopted since its establishment.

Tohoku University was founded in 1907 as third imperial university, and from the start the University has maintained uniqueness within Japan. The University has always conceived strong loyalty to science while other former imperial universities have tried to meet the governmental needs. So, pioneering scientific research has been always our principal mission.

Our University has also placed great emphasis on an "open−door" policy. Actually, we have had constant influx of large numbers of international students and scholars from every corner of the world. Therefore, I believe, this workshop shall not merely make a great contribution to the progress in science but also have a clear mark in the history of our University. So, I really thanks guest participants for joining this new and traditional scientific adventure.

I wish the Workshop with a great success.

Hitoshi OHNISHI,
Vice President
Professor of International Relations
Tohoku University

Research core of biological−production ecosystems in the fields of forests, grasslands and volcanic ash soils.

Masami Nanzyo

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Key words : forest ecology, volcanic ash soil, biological production

Introduction

There are many volcanoes in Japan, especially in Hokkaido, Tohoku, Kanto, Chuubu and Kyuushuu districts. Volcanic ash soils showing distinctive properties are widely distributed around and eastern side of the volcanoes. The volcanic ash soils cover 16% of Japanese lands. Natural and agricultural ecosystems with high biological activities and productivities are formed on these volcanic ash soils. These soils and ecosystems serve as a water reservoir due to their highly porous properties and gradually provide abundant water and inorganic nutrients such as silicon and basic cations to the downstream ecosystems. Comprehensive research and education works are carrying on regarding the biological−production and ecosystems in the area of forests, grasslands and volcanic ash soils.

Forest ecology

A variety of seed−size and phenology among and within species contribute to maintain succession and diversity of species in the deciduous broad−leaved forests in the temperate regions (Seiwa, 1998; 1999a,b; 2000; Kanno et al., 2001; Saitoh et al., 2002; Nagamatsu et al., 2002; Tomita et al., 2002). Figure 1 shows acorn dispersal by *Apodemus argentius*. Although many acorns germinate near their parent trees, most of them die due to species−specific diseases. Seedlings established far from their parent trees can grow, leading to species diversity in the forest (Seiwa et al., 2002a; 2002b). It was also found out that the riverside tree species, *Salix sachalinensis* and *Juglans ilanthifolia*, have a special reproduction strategy (Ueno and Seiwa, 2003; Kimura et al., 2004). Further, using DNA sequencing, AFLP and SSR analysis, ecological studies on the molecular basis are in progress covering phylogenetic relationships among species of forest plants, and gene flow and clonal structures at the community level (Suyama et al., 2000a, b; Obayashi et al., 2002; Iwamoto et al., 2002; Tsumura et al., 2000). Figure 2 shows an example of the parent and children relationship found using the DNA analysis. The white dots show the position of mature trees in the natural beech forest in the square of 150m by 150m. The seedlings locate within 20 m from their parents whereas pollens come from farther places.

Figure 1. Acorn dispersal by *Apodemus argentius*. Many acorns germinate near their parent trees, but most of them die due to species−specific diseases. Seedlings established far from their parent trees can grow, leading to species−diversity in the forest.

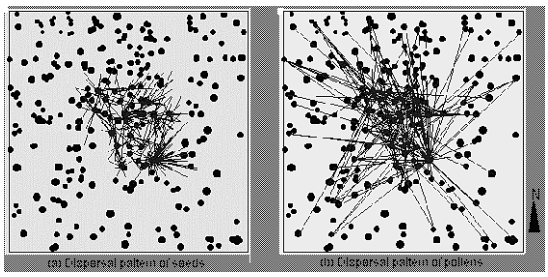

Figure 2. Seed and pollen dispersal patterns revealed by DNA analysis. Positions of mature trees in the natural beech forest of 150mx150m(●), and their seed and pollen dispersal patterns. DNA analysis was done using 253 mature trees and 1258 seedlings.

Genesis, properties and classification of volcanic ash soils

Major parent material of the volcanic ash soils are tephras (Figure 3), including some other aolian additives to various extents. Tephras are provided to the ecosystems by huge eruption of volcanoes with different dormant periods or intermittent small−scale eruptions of active volcanoes. Strong westery and river water play an important role to disperse tephras in the wide areas. Rock types of volcanic ash, which affect the properties and productivities of volcanic ash soils, are defined with SiO_2 content of the fresh ash (Shoji et al., 1975a; Kobayashi et al., 1976). Rock type of the matured volcanic ash soils can also be estimated using V/Zn content of ferromagnetic minerals that are resistant to weathering (Shoji et al., 1975b). A major component of fresh volcanic ash is volcanic glass and it rapidly weathers under humid climate and good drainage releasing large amount of Si, Ca, Na and so on. Aluminum is residually concentrated as allophane, imogolite, Al−humus complex and halloysite, and iron, ferrihydrite and other iron minerals in the volcanic ash soils. Most of these are poorly crystalline and they give distinctive chemical (high humus accumulation, variable charge, high P sorption, and so on) and physical (low bulk density, high water retention and high water permeability, high aggregate stability, high liquid and plastic limits, irreversible changes with drying, and so on) properties to the volcanic ash soils.

High P sorption is one of the chemical indices characterizing high active Al and Fe content in the volcanic ash soils. The P sorption reaction shows various intermediate properties between adsorption and precipiation depending on the forms of the active Al and Fe. A similarity of P sorption by noncrystalline Al hydroxide to precipitation is obtained from solid−state nuclear magnetic resonance (NMR) spectrometry (Bleam, 1991; Rothwell et al., 1980; Tropp et al., 1983; Williams, 1981; Lookman et al., 1994). Sidebands enhancement with cross−polarization supports a phosphate has P−O−H group (Figure 4a, b). No sideband enhancement (Figure 4f) suggests that the P sorption product is a material close to noncrystalline Al phosphate (Figure 4d). However, the sorption product is not exactly the same with noncrystalline Al phosphate because there is a very small difference between the chemical shift values in Figure 4c and e.

Opaline silica, or a pedogenic opal, was found out as one of the newly formed minerals in young volcanic ash soils (Shoji and Masui, 1971; Shoji and Saigusa, 1978). This mineral is formed from Si released from volcanic ash when solutes in the soil solution are concentrated with drying or freezing.

During the volcanic ash soil formation, some alkaline and alkline−earth elements are eluviated and many heavy metals are concentrated in the soils due to highly sorptive nature of the poorly crystalline components (Masui et al., 1972; Yamasaki et al., 2001; Nanzyo et al., 2002a). Consequently, content of many trace elements in the volcanic ash soils is not lower than those in other soils.

Properties of the volcanic ash soils are dependent on climatic conditions. Under temperate−humid conditions, Andosols in the WRB soil classification system or Andisols in the USDA soil taxonomy is dominantly formed whereas Podzols or Spodosols are formed under cold−humid climatic conditions (Ugolini et al., 1988; Shoji et al., 1988a, b; Takahashi et al., 1989). In the eluvial horizons under podzolization, concentration of Al complexed with soluble humus is high. This feature is reflected in the Al−humus complex accumulated in the illuvial horizon and the Al−humus accumulated under podzolization is highly extractable than those under Andosolization (Shoji and Ito, 1990; Ping et al., 1990; Ito et al., 1991; Shoji and Yamada, 1991). Properties of humus in volcanic ash soils are also affected by biological activities. Black and highly humified humus is accumulated under grass vegetation and dark brown humus with high content of fulvic acid is accumulated under forest vegetation (Takahashi and Shoji, 1988; Shoji et al., 1990a,b; Dahlgren et al., 1991). Human activities contributed to keep grass vegetation under humid climate.

Clay formation is also affected by climatic conditions and soil water movement in soil. Under semi−dry or water−saturated conditions, halloysite is formed rather than allophane and imogolite due to relatively high Si concentration in the soil solution. Some halloysites show high selectivity for K^+ and NH_4^+ compared with Ca^{2+} (Saigusa et al., 1978; Takahashi et al., 1993; Takahashi et al., 2001a).

The volcanic ash soil at Kawatabi Field Center contains large amount of Al−humus complex and 2:1 to 2:1:1 intermediate minerals with scarce amount of allophane and imogolite and shows high acidity.

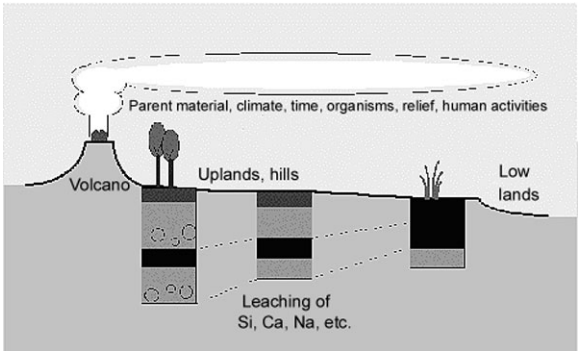

Figure 3. Schematic representation of soil formation processes from volcanic ash deposits.

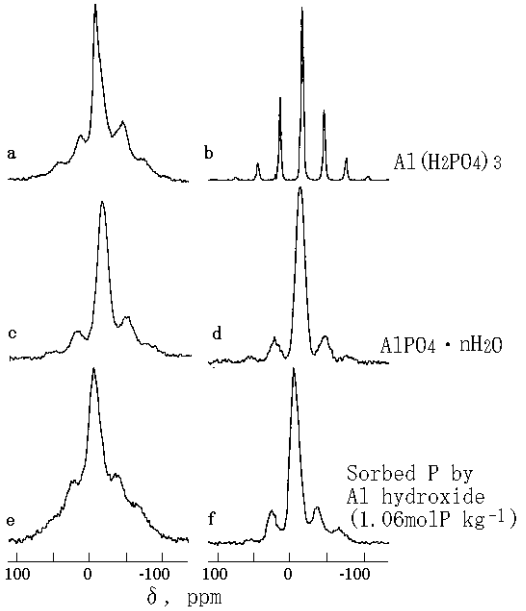

Figure 4. ^{31}P solid-state NMR spectra of P in the reference materials (a, b, c and d) and sorbed P by Al hydroxide (e and f).
a,c,e : Without cross polarization (CP).
b,d,f : CP with H, contact time=1ms.
(Courtesy of K. Deguchi, 1986)

After recognition of nonallophanic volcanic ash soil (Shoji and Ono, 1978; Shoji et al., 1984) originated from the volcanic ash soil at the Kawatabi Field Center, the central concept of Andisols in USDA soil taxonomy was revised from amorphous clay minerals to active Al and Fe (Shoji and Fujiwara, 1984; Shoji et al., 1985; Shoji, 1985). The international type locality of the nonallophanic Andisol was set at the Mukaiyama area of the Kawatabi Field Center. Further, nonallophanic Andosol was newly incorporated in the soil classification system of Japanese cultivated soils in 1995. The nonallophanic Andisols occupy one-third of Japanese Andosols and loess from China is also contained in this soil (Saigusa et al., 1992, Matsuyama et al., 1992; Saigusa et al., 1993a; Matsuyama and Saigusa, 1994a,b; Saigusa and Matsuyama, 1998; Matsuyama et al., 1999a, b). "Volcanic ash soils-genesis, properties and utilization" (Shoji et al., 1993) was published after establishing a database on the properties of volcanic ash soils in the northern part of circum-pacific volcanic zone (Nanzyo and Shoji, 1992; 1993; Shoji et al., 1996).

Biological production

Volcanic ash soils had chemical problems such P deficiency, Al toxicity in the nonallophanic Andosols (Saigusa et al., 1980), rapid nitrogen-fertilizer loss with rain, slow mineralization of organic nitrogen, and so on. However, P deficiency was amended with heavy application of P fertilizers, the Al was detoxified with liming, amelioration of toxic Al in the subsurface horizon was studied using gypsum (Saigusa et al., 1991; Saigusa et al., 1995; Saigusa et al., 1994a,b; Saigusa and Toma, 1997; Saigusa et al., 1997; Toma and Saigusa, 1997a,b; Toma et al., 1999; Takahashi et al., 1999; 2000; Morikawa and Saigusa, 2000a,b; 2002; Takahashi et al., 2001b), and low efficiency of N fertilizer was improved using controlled availability fertilizers. The controlled availability fertilizers are also effective in reducing labor for fertilizer application because the fertilizer can be applied with crop seeds such as rice and dent corn (Saigusa et al., 1993b; Saigusa et al., 1994; Ito et al., 1988, 1997; Ito et al., 2000; Inoue et al., 2000a,b,c,d; Saigusa et al., 2001a,b; Inoue et al., 2001a,b; Taki et al., 2002), and the duration of N-release period can be synchronized with N absorption by crops (Gandeza et al., 1991; Shoji et al., 1991; Shoji and Kanno, 1994). Apatite is included in the fresh volcanic ash and it is utilized by some crops that can exudate chelating organic acids or a large amount of proton from their roots (Nanzyo et al., 1997a; Nanzyo and Yamasaki, 1998; Nanzyo et al., 1999; Nakamaru et al., 2000).

Future prospects

Education and researches on chemical, physical and biological functions of volcanic ash soils in the areas of forests and grasslands will go on further to improve biological production in these areas. High quality, high yield, low cost, saving labors, fertizers and energy, and environmental protection

in biological production are the goals of the future researches (Ombodi et al., 1988a, b; 2000a, b; Ombodi and Saigusa, 2000a, b, c, d; Saigusa, 1999; Kosuge et al., 2000; Kosuge et al., 2001a, b, c; Saigusa et al., 2001). Studies on the genetical structure and the gene flow in the forests established on volcanic ash soils lead to elucidation of mechanisms how genetical diversity is maintained in these ecosystems. The effect of different soil colloids on P availability and reactivity with acid deposition will be elucidated using different volcanic ash soils. Moderate Al release from nonallophanic Andosols is effective to controll some soil−born plant diseases (Mizuno et al., 1998; Furuya et al., 1999). P foraging root growth of *Brassica* plants appears effective in improving P efficiency in the Andosols (Nanzyo et al., 1997b; Nanzyo et al., 2002b).

Acknowledgement

The author thanks Professors K. Seiwa, Y. Suyama, T. Takahashi, M. Saigusa and T. Ito for their valuable comments and assistance.

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Research, facilities and education at SLU and Uppsala University, Sweden

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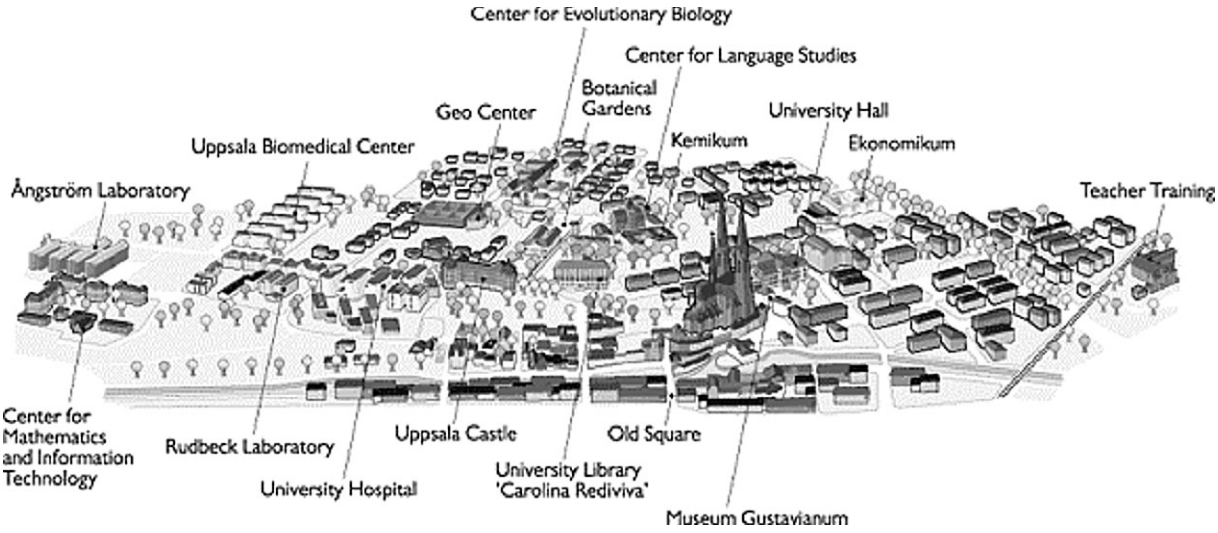
In this paper I will present the main fields of research and education carried out at SLU (Sveriges lantbruksuniversitet−Swedish University of Agricultural Sciences) and at Uppsala University, in Sweden. In the first part of the talk I give an overview picture of the Swedish landscape and countryside, while in the second part I present the research activities and the education carried out at the two Universities with special attention given to SLU. The Swedish University of Agricultural Sciences was established in 1977 but root stretch back more than 200 years. The University activities are spread between several departments in three faculties : Faculty of Agriculture, Landscape Planning and Horticulture, Faculty of Forestry and Faculty of Veterinary Medicine and the main campuses are located at Alnarp, Skara, Ultuna and Umeå. The University research and teaching activities are carried out throughout the country in University campus as well as in different research centres and field stations.

SLU i Sverige **Lokalisering**
SLU har sin huvudverksamhet förlagd till : Alnarp, Skara, Uppsala och Umeå. Försöksverksamhet, forskning och utbildning bedrivs över hela landet.

SLU finns representerat på flera platser i Uppsala. Ultuna är ett stort campusområde som ligger i en naturskön miljö utmed Fyrisån, ca sju km söder om Uppsalas stadskärna. Här finns ca 2 000 anställda och ungefär lika må nga studenter. På Ultuna finns också huvuddelen av universitetets centrala administration och ledning.



An interdisciplinary, holistic approach is a hallmark of Uppsala University. The University is investing to create optimal environments for cross‑disciplinary research and education, settings conducive to innovation and creativity. In the major campus areas researchers and students are gathered from different subject areas.

Recent topics of rice studies in Graduate School of Agricultural Science, Tohoku University

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Produced in more than 110 countries, rice is a staple food grain for more than half the world's population. It accounts for about 30% of total cereal production, almost equal to the level of wheat production. Unlike wheat, 92% of world's rice production is in Asia, home to 60% of world's population. It is estimated that the world population will be about 50% larger by 2025 (IRRI 1995). This projected increase will be mostly in Asia. It is therefore crucial to increase rice production within a relatively short period, and that the increases in rice production are achieved by increases in yield from the land presently used. Thus, a better understanding of the growth and functional performance of rice plants from molecular to whole plant levels is required for further development of rice varieties and improvement of cultivation practices (Mae 1997). Here, we will briefly review the recent topics of rice research held in the Graduate School of Agricultural Science, Tohoku University.

1. Improvement of leaf photosynthesis : Decrease in Rubisco by antisense rbcS leads to a higher N−use efficiency of photosynthesis under conditions of high CO_2

Rice (*Oryza sativa L.*) plants with decreased Rubisco were obtained by transformation with the rice *rbc*S antisense gene under the control of the rice *rbc*S promoter. The transformants were screened for their Rubisco to leaf N ratio. Plants transformed with 65% wild−type Rubisco were selected as having the optimal Rubisco content at saturating CO_2 partial pressures for photosynthesis under conditions of high irradiance. Although the plants with decreased Rubisco content showed 20% lower rates of light−saturated photosynthesis in normal air (36 Pa CO_2), they had 5−15% higher rates of photosynthesis in elevated partial pressures of CO_2 (100−115 Pa CO_2) than the wild−type plants for a given leaf N content. It is concluded that rice plants with 65% wild−type Rubisco show higher N−use efficiency of photosynthesis under conditions of saturating CO_2 and high irradiance (Makino et al., 1997, 2000).

2. Improvement of sink capacity : Increase in grain size of japonica−type rice leads to a higher grain yield

A new large−grain cultivar of japonica−type rice (*Oryza sativa* L), Akita 63, recorded a high yield (brown rice) of 936−1057 g m^{-2} (Av. = 982 g m^{-2}, n = 3), that was comparable to the past highest yield record of japonica−type rice in Japan. Although total biomass and total plant nitrogen of Akita 63 at harvest did not differ from those of a local high−yielding cultivar, Yukigesyou, grown under the same conditions, the harvest index of Akita 63 was higher than that of Yukigesyou (0.59 versus 0.47). The high yield of Akita 63 could be attributed to its large yield capacity, mainly due to its large grain size (31 mg versus 23 mg for Yukigesyou) with an efficient translocation of dry matter into spikelets throughout the ripening period (Inaba et al., unpublished data).

3. Molecular basis for nitrogen recycling : Analysis of mutants inserted retrotransposon Tos−17 and QTL mapping

When 20 seeds, in which *Tos17* is possibly inserted into *GS1* gene, were germinated and grown in a green house, 4 lines of mutants were successively isolated. In these lines, *Tos17* was homozygously inserted into the exon−8 of *GS1* gene. GS1 protein and its activity in leaves were hardly detectable in these lines. The GS1 mutants also exhibited an extreme delay of plant growth and a dwarf phenotype. They were needed for a long period from heading to flowering and most spikelets were not filled. A few seeds were obtained,

although these were sterile. Amongst the remaining 16 seeds, 11 lines were heterozygously inserted and 5 lines had no insertion. These lines showed no difference in phenotype or GS1 protein contents when compared to the wild type. These phenotypes suggest that GS1 is essential for normal growth and development of rice.

A QTL on chromosome 2 determines the GS1 content (positive allele : Nipponbare), panicle weight (positive allele : Kasalath) and spikelet number (positive allele : Kasalath) of rice. To isolate near isogenic lines (NILs), backcrossed isogenic lines (BILs) originated from Koshihikari's genetic background (C lines) were used. Linkage analysis showed that the QTL was mapped to be close to a CAPS marker, R1843 on chromosome 2. One line (C−22) was selected from self−pollinated progeny derived from C lines. This line was nearly isogenic with the target QTL consisting of the chromosomal segment from Kasalath. This line (C−22) showed less content of GS1 protein in leaf blades than wild type Koshihikari, indicating that the replacement of this region with the Kasalath chromosome has a negative effect on GS1 content. C−22 also had a higher tiller number at early stages of growth, higher panicle number, and greater total panicle weight than Koshihikari in both green−house and field conditions, particularly grown with low−nitrogen supply. These results suggest that the target QTL is important in the development of tiller and panicle in rice (Obara et al., 2001, Yamaya et al., 2002).

4. Improvement of chilling resistance : An increase in unsaturation of fatty acids by introduction of genes for glycerol−3−phosphate acyltransferase enhanced low−temperature tolerance in rice seedlings

Chilling−sensitive plants, such as rice, contain a high proportion of saturated fatty acids in phosphatidylglycerol (PG) of chloroplast membranes, while chilling−tolerant plants, such as spinach and *Arabidopsis thaliana* tend to contain lower levels. Glycerol−3−phosphate acyltransferase (GPAT; EC 2. 3. 1. 15) in chloroplasts plays an important role in determining the saturation levels of fatty acids in PG. A cDNA for GPAT of spinach and *Arabidopsis* under the control of a maize ubiquitin promoter was introduced into rice. The percentage of the sum of the minimum proportions of high−melting point molecular species of PG (Sat (%)) in leaves of transgenic rice were found to be 58% that of wild−type plants when they were transformed with spinach GPAT and 67% when transformed with *Arabidopsis* GPAT. The rates of photosynthesis of leaves at 17°C and 14°C and the fresh weight of seedlings after exposure to 17/14°C (day/night) for 6 weeks were examined in transgenic lines with spinach GPAT, *Arabidospsis* GPAT, a segregated non−transgenic line and wild−type plants. There was a significant correlation between the Sat (%) value and the chilling tolerance with respect to the rate of photosynthesis and the fresh weight of seedlings. These results indicate that the introduction of cDNA for spinach GPAT causes greater unsaturation of fatty acids in PG and confers more chilling tolerance upon rice seedlings (Ariizumi et al., 2002).

5. Improvements of field practices : Single basal application of total fertilizer−N into nursery box saves labor's cost and improves the nitrogen−use efficiency

A unique technology of single basal application of the total amount of fertilizer nitrogen into rice nursery box was first developed in the Experimental Farm of Tohoku University. It saved labor costs of fertilization and improved the nitrogen−use efficiency of fertilizer by rice plants. All fertilizer nitrogen needed by rice plants for entire growing season was applied in nursery box by co−situs placement using a sigmoid, 100 day−type of polyolefin coated fertilizer (POCUs−100), which is a class of slow−release fertilizer. Rice seedlings grown by these methods showed no significant difference in morphological properties compared to those grown by conventional methods, rather, the dry weight and nitrogen content of the plants were often somewhat greater. Innovative no−tillage transplanting cultivation of rice with a combination of single basal application of total fertilizer nitrogen in nursery box greatly improved the nitrogen use efficiency of fertilizer. This cultivation method was first demonstrated in very poorly drained soils, later applied to almost all soil types, and proved to be effective. The nitrogen recoveries from the single basal application of POCUs−100−N by rice plants (73−83%) were

much higher than those from basal application of ammonium sulfate−N in the conventional cultivation (20−39%). Brown rice yields of this cultivation were the same to those of conventional ones or even greater. The method was also proved to be effective in decreasing methane emissions, water pollution, and lodging of rice plants (Sato and Shibuya 1991, Saigusa et al., 1996).

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Field Studies in Kasetsart University, Thailand

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Organization

Kasetsart University is one of the oldest public universities in Thailand. It was the first specialized university emphasizing on agricultural science. The name "Kasetsart" means Agriculture. February 2, 1943 has been officially designated as the foundation day. Besides the main campus in Bangkok, many new campuses have been established to serve and meet the increasing demand for higher education in the country. Up to present, Kasetsart University has expanded to the total of 7 campuses, 16 research stations and 5 field stations distributed to cover all regions of the country.

Bangkhen Campus is the original and main campus of the University. It is located 6 kilometers to the south of Don Muang International Airport. The faculties in this campus are Agriculture, Agro−Industry, Architecture,Business Administration, Economics, Education, Engineering, Fisheries, Forestry, Humanities, Science, Social Sciences and Veterinary Medicine.

Si Racha Campus is in Si Racha District of Chon Buri Province at the distance of approximately 107 kilometers to the east of Bangkok. It was originally an agricultural research station of the University. Its establishment as a campus took place in 1989 and was dictated by the pressing of high quality manpower shortage of the country as a consequence of the Eastern Sea Board Development Project. At present, the campus provides the bachelor's degree programs in three faculties, which are Engineering, Management Science, and Resource and Environment.

Faculty of Resource and Environment aims to produce the high quality graduates, research and development of technology, enhance the cooperation with worldwide partners. Bachelor's degree programs offering are Computer Science and Environmental Science. Research on biodiversity, plant ecology, coastal resource management, water quality control, air pollution, waste management, as well as the research on digital image processing, artificial intelligence, software engineering database management are conducted.

Activities

Kasetsart University was established to be the university that introduces the maximum value of all natural resources to mankind. The university has focused the goals on the production of high quality graduates, supporting the society and providing equitable opportunities for higher education nationwide, cooperation with private sectors both domestic and abroad.

Technological research and development, modern information technology, networks, communications knowledge, success in production of high quality graduate are our achievement which are used to master the Thai's economic and entitle the standard living to Thai people.

As the first agricultural university of Thailand, Kasesart university has launched research stations in all regions of the country so that it could facilitate wide range of field trails appropriate to different local conditions and provide training for farm practices. Experiment stations in the North work on temperature fruits and flowers, watershed management and reforestation. In the Central, there are stations for swine research, field crops, and tropical fruits. Research on fisheries and mangrove forest is conducted at stations in the East and the South. For animal hygiene, there are University veterinary hospitals on Bangkhen and Kampaeng Saen Campuses. Cut−flowers and ornamental crop research are undertaken in almost all stations.

Technology transfer has been one of the most

important functions of Kasetsart University. The university has been introducing new agricultural technologies, new economic animals and new crop varieties for the last 60 years.

International Collaboration

Kasetsart University has started to expand its role in greater cooperation with other countries. Kasetsart University has entered into formal agreement for faculty and student exchange, joint research, collaborative implementation of academic programs and conferences with 57 regional and international organizations and 167 universities and institutes in 31 countries worldwide. Tohoku University has been one of our collaborators since 1993, and we hope we will actively continue to work together for the next decade to come.

Field facilities and field researches at the Szent István University, Hungary

Attila Ombódi

Szent István University, Hungary

Szent István University was formed from previously independent universities and colleges in 1st January 2000. based on a new political concept in Hungarian higher education, and was named after the first Hungarian king. This university is mainly devoted to agricultural education and research. At the moment the former University of Veterinary Science, University of Agricultural Sciences at Gödö llő, Ybl Miklós College of Architecture and Teacher's Training College of Jászberény form the Szent István University.

Presently Szent István University has six schools operating in three different cities, three of them in Gödöllő (School of Economics and Social Sciences−**www.gtk.szie.hu**, School of Engineering −www.mgk.szie.hu, School of Agricultural and Environmental Sciences−**www.fa.gau.hu**), two of them in Budapest (School of Veterinary Science− www.univet.hu, Ybl Miklós School of Architecture −www.ymmf.hu) and one of them in Jászberény (School of Jászberény−www.jtkf.hu). More than eleven thousand students attend this university, six thousand of them on full time training and 350 on PhD training. There are almost two thousand stuff members, 700 of them teachers and researchers. These numbers indicate that Szent István University is a large agricultural university, even by European Union standards.

Szent István University has eight experimental model farms, one of them belonging to the School of Veterinary Science. The other seven belong to the G ödöllő Campus, and are operating in the framework of the Gödöllő Agribusiness Center Public Benefit Company (www.gak.hu). These experimental model farms are serving as the place of practical education and as the place of field research activities. All of the farms are situating not further than 30 kilometres from the corresponding campuses, which enables the researchers and the students to attend them even daily if necessary.

The experimental model farms of the Szent István University are the followings :

Educational model farm of the School of Veterinary Science at Üllő. Land area is 1155 ha, from which 750 ha are occupied by crop land and 250 ha by grassland. In this unit a veterinary clinic, a sheep farm, a dairy farm and a slaughterhouse are situated. The livestocks are 70 cows, 350 breeder sheep and 15 mares.

Animal husbandry educational model farm at Gö döllő. This unit is situated next to the campus with four cowsheds and a milking house. 50 cows and 40 breeder sheep are raised here. Because of its locality, this farms serves as a main area for practical education.

Rural development educational model farm at Babatvölgy. Land area is 275 ha, from which 108 ha are crop land, 11 ha are grassland, 9 ha are reedy area. Ten fish−ponds amount to 5, 3 ha. There are also 20 horses and a riding hall in this farm. The main aim of this farm is to work out such agricultural entrepreneurial models here, which can give adequate answers for the challenges of the European Union.

Goose breeding research institute and educational model farm at Babatvölgy. Among many other facilities a building for one thousand breeder geese, numerous pens and raising houses can be found here.

Experimental and educational model farm at Jó zsefmajor. Land area is 270 ha, from which 255 ha are crop land. Two stables are situating there.

Crop production educational and exhibitional modern farm at Gödöllő. Land area is 272 ha from which 271 ha are crop land and one ha is fruit orchard. The main crops are wheat, corn and lucerne. Being located in the Gödöllő administrative area this farm plays a key role in the student's practical education.

Horticultural educational model farm at Gödöllő. Land area is 2 ha, from which 2000 m2 is plastic house, 1300 m2 is equipped for trained cultivation. As this farm is situated almost in the town centre, not just students attend it regularly but also local growers and even citizens.

Engineering experimental, exhibitional and

educational model farm at Gödöllő. This farm is located next to the Gödöllő campus and serves as the main practical educational area for the students of the School of Engineering

Using these facilities a considerable number of research projects can be carried out. Obviously field researches are mainly carried out by the departments of the School of Agricultural and Environmental Sciences. Some of the main field research topics of recent past and present days are the followings :

Animal husbandry : effects of meteorological factors on performance of dairy and beef cattles; slaughtering performance of lambs in different sheep breeds; development of new reproduction sows.

Veterinary science : environment physiological researches; development of animal−friendly technological instruments; investigation of value of indigenous domestic animals.

Wildlife biology and management: hare and red deer management; habitat use of red and roe deers; monitoring of mammalian predators.

Aquaculture : fish nutrition, with special reference to vitamins and genetically modified cereal feeds; interspecific androgenesis between common carp and goldfish.

Crop production : sustainable crop production, soil management and land use; relationship between soil tillage and carbon sequestation; examination of N−fixation by leguminous plants; production of oil crops.

Plant protection : application of endemic species as biopesticide; ecological impact assesment of transgenic crops (non−target effects); hyperparasitic microorganisms in plant protection.

Horticulture : development of intensive open field vegetable and strawberry production technologies; adaptation of globe artichoke growing to Hungarian climate.

It is perhaps not coincidental that from among the numerous Japanese universities the Tohoku University and the Hokkaido University are the ones, which have official cooperation agreement with the Szent István University. As the climate conditions of Hungary and Miyagi Prefecture are quite similar (the biggest difference being the amount of precipitation) cooperation in the agricultural field researches between the Tohoku University and the Szent István University is highly possible. For example methods developed in Japan can be tested among semiarid conditions in Hungary, and on the contrary. Also as in both countries researches related to sustainable and environment friendly agriculture have high priorities nowadays, research objectives can be matched very easily.

Studies on Ruminant Production Research Core in Graduate School of Agricultural Science, Tohoku University

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Domestic cattle have been selected and bred as milking cow and beef cattle from an ancestral species, auroch *Bos primigenius.* Cattle are ruminant animals that mainly feed grass, and their habitats are the grassland. Domestic cattle have been kept in the mountainous area in many countries. Recent production systems of cattle are being separated from the grassland to achieve the high efficiency of the production. As a result, outbreaks of BSE and environmental issues of animal waste occurred. One of these causes is imported feed. Now we should re−construct the grassland animal production system using domestic feed products in Japan.

Our research core will study ruminant animals, ruminant production systems, grassland, animal production environment and animal health mainly in the mountainous area. I will mention research topics performed and future research of our research core.

1. Nutritional and physiological studies on the ruminant

We have clarified the crucial role of volatile fatty acids (VFAs), which produced by bacterial fermentation from plant fibers in the reticulo−rumen, as an important energy source for the synthesis of dairy products as well as for essential body maintenance. In addition, we found the importance of nitrogen recycling in this species by the dilution method with ^{15}N stable isotopes. The physiological characteristics in the ruminant are inevitably related with the function of the reticulo−rumen. We found that post−prandial decreases in HCO_3^-−rich saliva secretion and feed intake are caused by the acidosis induced by an excess transport of alkaline reserve from blood to the intestinal lumen in sheep. Post−prandial decrease in plasma GH is reproduced by VFA injection into venous blood or the reticulo−rumen, or treatment of somatotrophs with VFAs, indicating that VFAs show an inhibitory action on GH secretion. Lactogenic actions of GH have been studied by the isotope dilution method with 6,6−$^2H_2$−glucose and by the euglycemic insulin−clamp method in dairy cows. Although the function of the reticulo−rumen is undeveloped in pre−weaning animals, it rapidly develops at 4 – 6 weeks of age and becomes mature at 13 weeks of age. The concentration of salivary HCO_3^- is increased, but that of Cl^- is reciprocally decreased, with the development of the reticulo−rumen, suggesting an age−dependent increase in buffering action of saliva on VFAs produced in the forestomachs in calves. Finally, we found a significant relationship between salivary HCO_3^- concentrations and carbonic anhydrase activity in the parotid gland.

2. Grassland utilization and animal production

Various aspects of land ecosystem have been studied, which especially focused on grassland being about 40% of the land area which exist in border areas between arable land and woodland and between desert and woodland, and on which many herbivores are living. Relationships within and among constituent elements such as soil and/or microorganism, plants and animals are investigated of matter dynamics, the style of living and behavior from the viewpoints of plant production, animal production and environmental remediation. Following themes are studied; 1) relationships among soil/microorganism, plant and animal in land ecosystem, 2) plant physiological and ecological studies of grassland productivity, 3) behavior and welfare of herbivores.

3. Animal Breeding and Genetics

For the genetic improvement of reproduction, growth rate, feed efficiency, disease resistance, quality and amount of products, the following subjects are studied with various approaches of statistical, molecular, physiological and

immunogenetics. 1) The methods for the genetic improvement of the production traits such as milk yield, meat productivity supported by the reproduction, growth and disease resistance traits of animals. 2) Practical breeding plan for each livestock species and its application. 3) Theoretical prediction of long−term selection response. Beef and dairy cattle, sheep and swine are mainly considered in these studies. Laboratory animals are also used for the basic studies as the pilot of the domestic animals.

We have obtained followings. 1) Crossbreds, such as Japanese black (cow) x Brahman (bull) and Japanese Shorthorn (cow) x Brahman (bull), showed higher fitness and productivity than indigenous breeds on the pasture. 2) Packed red blood cell volume was proposed as a selection criterion for higher resistance to *Thileria orientalis sergenti* infection in Japanese Shorthorn and Japanese Black. 3) For the genetic improvement of the dairy and beef cow herd in the University Farm, most adequate semen for A. I. or bulls for natural mating were selected and the performances of the cow herd are improved.

4. Animal Health and Management

We performed epidemiological survey for *Cryptosporidium*, which is the pathogen of a zoonotic protozoan parasitic disease. We identified an isolate from beef cattle as a new strain by experimental infection and DNA analysis, and referred to it as *C. andersoni* Kawatabi strain. We also have been isolating functional microbes removing malodorous materials generated from animal waste and their treatment processes, and clarified the distribution and function of microbes degrading indole or skatole and microbes assimilating ammonia in wastewater treatment processes and composting processes.

5. Future study

In the field for nutrition and physiology of the ruminant, we are to investigate 1) transport mechanisms for prion proteins in the calf intestinal epithelium, 2) changes in physiological and endocrine functions of weaning calves, 3) usage of nucleic acid−related compounds and lactoferrin as feed additives for growth promoters, and 4) usefulness of myostatin−gene−mutated calves as meat and gene resources. We are to investigate 1) genetic resistance to bovine mastitis, 2) genetic resistance to piroplasmosis of pasturing cattle, 3) genetic improvement of general performance of Holstein, Japanese Black, and Japanese Shorthorn in the field for animal breeding. In the field of animal health and management, we will perform 1) molecular epidemiology of *Cryptosporidium*, 2) development of eradiation of pathogenic *E. coli* O157 in the environment of the animal production, 3) analysis of structures of the microbial community in animal waste treatment processes and composting to develop novel treatment systems.

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Grazing behaviour of Jeju Native Horses*

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The famouse, indigenous horses of Jejudo, called "Chorangmal", can be seen grazing while walking leisurely on the expansive grassy slopes of Mt. Halla. As becomes readily evident in the old sayiong, 'Send your son to Seoul and your horse to Jeju', Jeju has been famous for its native horses for quite a long time. The Jeju horses(Eqqus caballus), a breed of native horses, are an important part of Korean heritage. It is believed that the Jeju horses are descended from "Kwahama", the native stock of horses which had been distributed on the Korean peninsula a long time ago. The native horses were cross-breed with horses brought to Jeju from China by the Mongolian army after the Mongol invasion during Koryo dynasty(1276-1376), to the Jeju horses have evelved into a truly unique breed of horse well adapted to the natural environment of Jeju.

Since the Jeju native horses are considerably smaller than their western counterparts, they are also called 'Kwahama(horse that is able to pass under a fruit tree without touching it)' or 'Tojongma'(indigenous horse)'. A full-grown Jeju horse stands about 115 to 120 high and has a chestnut colored coat. It has a heavy head, big round eyes, a thick neck, and short, thick limbs. It is characterized by very strong hooves.

As they are very docile, the Jeju horses were used as beasts of burden in farming or transportation. These day, however, their number has sharply fallen as farming

Fig. 1. Jeju native female horse

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* This study worked by the development fund of Cheju National University.

operations and transportation have become increasingly mechanized. Pure-blooded Jeju horses are also in serious danger of being bred out of extinction due to increasing cross-breds as a result of a lack of an effective breeding program. For their preservation, the Korean goverment designated the Jeju horse as National Monument No. 347 in 1986.

Table 1. Eating and resting time of Jeju mare horses

Month	No. of mare	Length of obser.+	Eating	%	Resting	%
Apr.*	11	360	247.9±66.6	68.9	85.8±45.2	23.9
May	9	420	239.4±69.6	57.0	100.6±84.5	24.1
June	10	420	234.8±67.7	47.9	125.5±61.8	35.0
July	5	420	298.8±53.5	71.1	33.6±31.4	8.0
Aug.	12	420	341.8±25.3	69.8	76.2±19.4	18.1
Oct.	6	360	219.0±62.5	60.8	81.6±18.7	22.8

* Off grazing season
Length of observation(min) : 10:00−12:00 hr and 13:00−18:00 hr in Apr. − Aug. and 13:00−17:00 hr in Oct.

The eating and resting behaviour of 10 lactating Jeju native mare horses on pasture with free access to water were recorded from 10:00 hr to 18:00 hr. Lactating mares on the pasture spent 57.0%(239 minute) of the time foraging in spring and 47.9% to 71.1%
in summer and 60.8%(219 minute) in fall. Time spent for resting by mares was 24.1% during May and 35.0% in July, 18.1% in August and 22.8% in October.

As the foals grew older, the number of feedings decreased with the highest in May at 11.8 times during the observation period, 7.3 times in June, 9.9 times in July and 5.5 times in November. A similar tendency was observed in suckling time, greatest in June(73 sec.), 79 seconds in May, 54 seconds in July and 32.1 seconds in November. Number of urinations during observation was greater in spring(3.0) and summer(3.0), but decreased in fall(1.4 times). Number of defecations gradually increased from spring(3.0 times) and was highest in July(4.6 times) and lowest in November(3.3 times). Fresh weight of feces from one defecation on the pasture were 1,177g in May, 840g in June, 1,418g in July and 1,271g in October, however the lowest values were recorded during the off grazing season(778g). Mounting interval of stallion was 33.8 minutes when the stallion was introduced to the breeding mares on the first week. However, the time was delayed to 260 minutes after one week of introduction of the stallion. The time spent for mounting, intermission and ejaculation of stallion was 26.9 seconds on the first day, and no differences were observed at the end of breedng season.

Current Situation on Research Core in Marine Bio−production

Makoto Osada and Nobuhiko Taniguchi

Graduate School of Agricultural Science, Tohoku University, Japan

Introduction

The productions of domestic animal, crop and forest have been performed in the limited and controlled area of the land during a long history of agriculture. Domestic animals are reared at the fenced area and a feed is given to them. Crops are cultured at the field where is considerably fertilized. At the same time the breed of terrestrial animals, crop and forest have been improved.

On the other hand, the productions of aquatic animal and plant have mostly depended on a capture of wild species for a long time. Since last decades, the production of artificial seed, mariculture and the development of aquaculture facility in the land have been undertaken, and the aquaculture products greatly contribute to fisheries products today. Miscellaneous wild species containing commercial species inhabit and aquaculture organisms are cultured in a various aquatic environment with other natural creatures; eg) fresh water in land, estuary, coastal area, offshore and a various depth in each area. Therefore, fisheries production has a close relation to the aquatic environment and natural bio−resources. Thus the relationship between environment and bio−production in marine is greatly different from that in the land. It seems that a development of production system based on conservation of natural habitat is required in the coming fisheries production. From this point of view our research group has focused on the biological oceanographic, ecological, physiological, genetic and toxicological projects and found a lot of interesting aspect.

Biological oceanography

The food chain relationship in the food web should be probed to considerably know an ecosystem of marine. Phytoplankton (containing nano− and pico−phytoplankton) and detritus play an important role as a primary production in energy flow. These with other microorganisms and organic particles provide most energy from the surface through the bottom of deep sea (Sasaki et al., 1988, Endo et al., 1999, Taniguchi, 1999).

Ecology

The primary production links to a higher production in the food chain. The complex of higher level of food chain is formed among many kinds of finfishes and bentic animals. It is suggested that the conservation of ecosystem in the food web that is composed of a various species is necessary to sustain fisheries production based on a capture from natural resource (Omori, 1977, Sasaki et al., 2001).

Rocky shore is covered with a lot of kelp where is a good habitat of harbivorous animals; sea urchin and abalone, which are very important commercial animals. "Coralline flat" which macroalgae disappears from rocky shore is a serious problem in coastal fisheries. The mechanism of transition of marine forest and ecological relationship between macroalgae and herbivorous animals via a chemical substance has been demonstrated, resulting in the possibility of remediation of "coralline flat" (Taniguchi et al., 1994, Sano et al., 1998).

Reproductive biology

Bivalve (mollusk) is also one of the commercially important species, especially oyster is a world wide animal in aquaculture. The technology of artificial seed collection of Pacific oyster had been developed in 1940s by our senior members and greatly contributed to bivalve and gastropod aquaculture all over the world. At the same time a local race of the oyster had been characterized by using the breeding technology. Reproductive biology and endocrinology of bivalves has been investigated to achieve artificial control of reproduction for breeding and to estimate reproductive condition, and several important biologically active substances regarding gametogenesis and spawning have been found (Osada et al., 2003, Osada et al., 2004). Bivalves are a sessile animal and exposed to the coastal water containing municipal effluent at all time.

The investigation of relationship between bivalve reproduction and polluted environment at protein and molecular levels is ongoing as a cooperative study on endocrine disruption with colleagues of oversea.

Genetics

Genetic study has been performed to analyze a structure of population and relation between wild population and released population bred within a limited number of parents, and to establish a strain with certain heredity. In several fishes the population structure has been demonstrated by using molecular markers and a necessity of molecular diversity was proposed to sustain the natural population and its production in the future (Takagi et al., 1999, Ikeda et al., 2003). In near future the establishment of strain will be required to improve a breed. Seeking genetic markers was undertaken to detect some genes linked to the DNA markers and new approach to achieve an efficient breeding was proposed (Li et al., 2002).

Toxicology

It is well know that aquatic animals are occasionally contaminated with toxic substances. In our group the structure of maitotoxin and other toxins have been determined and the poisoning mechanism of shellfish with toxins in the field was demonstrated (Satake et al., 1995, Mackenzie et al., 1996, Okumura et al., 1996). This study has greatly contributed to guarantee the safety of seafood.

Marine bio−production closely relates to the surrounding environment, biologically and chemically. Our group will carry forward our project to conserve marine bio−production and natural habitat and environment in our integrated studying field.

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General information, fields of biological research and international relations in Siberian Branch of Russian Academy of Science

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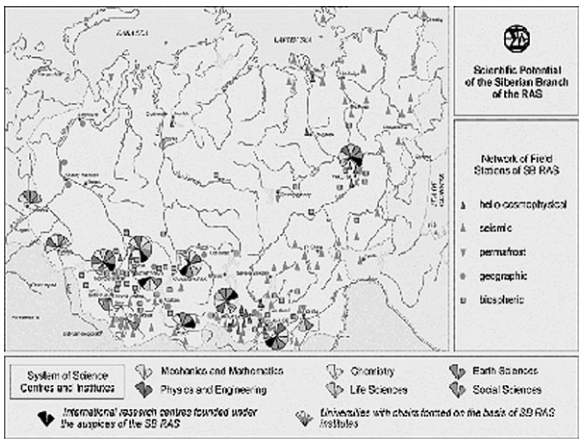
Siberian Branch of Russian Academy of Science, Russia

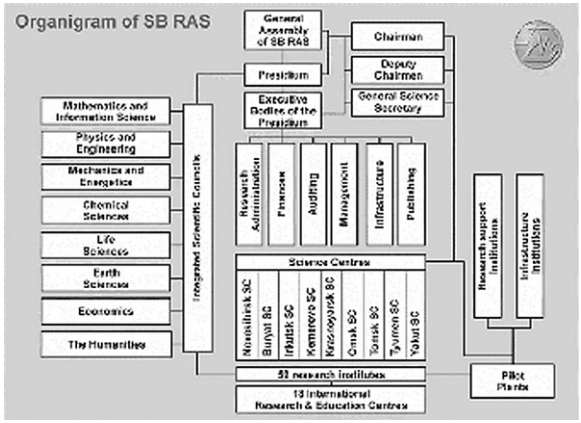
Siberia is an enormous area in north Asia, which is greater than one−half of the area of the Russian Federation. Thanks to Siberia's dimensions, it still contains large, relatively slightly impacted territories. Development of Siberia has always been associated with exploitation of its natural resources. To develop these resources, cities and industrial communities with fuel−power, mining and processing industry were built, and thousands of kilometers of petroleum and gas pipelines, railways and electric power transmission lines were laid. Since the 60−ies, the Siberian Branch of the Russian Academy of Sciences (SB RAS), aimed at promoting a more rapid growth of productive forces of Siberia, was designed. The future of Siberia largely depends on the scientific and educational potential accumulated here. Since the first days of its existence, the work of SB RAS has been based on the productive combination of fundamental and applied research and close relations of science and education.

The Siberian Branch is a network comprising science centers and institutes situated in administrative centers of the regions of Siberia : Novosibirsk, Tomsk, Krasnoyarsk, Irkutsk, Ulan−Ude, Yakutsk, Kemerovo, Tyumen and Omsk. There are also single institutes in Barnaul, Kyzyl and Chita.

There are 59 research institutions in SB RAS and design−and−technology institutes, whose areas of study cover physics and mathematics, engineering, life sciences, Earth sciences, humanities and economics. A wide network of biological and geological research stations carry out field and stationary research in biosphere and geosphere. The science centers of the SB RAS are mostly arranged as isolated science towns near to large cities or form campuses inside the cities. The campuses (Akademgorodoks) territorially unite research and design institutes, pilot plants, residential areas equipped with social, cultural and health care services, kindergartens, schools. Eighteen International research Centers have been set up and are actively operating co−founded together with Siberian Branch of RAS by research institutions and Universities of European countries, the USA and Japan. These centers function as international non−governmental organizations and carry out research on major interdisciplinary problems. Institutes of the SB RAS work closely with universities and higher schools, with business and industry in their regions. SB RAS has always been interested in the practical application of its scientific, technological and designing results and maintained close connections with industrial enterprises and ministries. Design departments and pilot plants, established to finish research developments and further introduce them into industry, served as a basis for creating new types of high−technology industrial enterprises and attracting investments.

About half of scientific potential of SB RAS is concentrated in Novosibirsk Research Center, which





was the first to be founded in 1957. In Novosibirsk Center research in life sciences is performed by the Institute of Soil Science and Agrochemistry, the Central Siberian Botanical Garden, the Institute of Animal Systematics and Ecology, the Institute of Cytology and Genetics and the Institute of Bioorganic Chemistry. These institutes have greenhouses, vivaria and experimental farms, including a unique collection of genetic pool of native animals.

Presidium and the institutes of SB RAS invite foreign scientists and international organizations to use the infrastructure for the joint research projects, practical training of young scientists, individual training for the students, and summer schools.

Home page of Siberian Branch of Russian Academy of Sciences is :

http://www-sbras.nsc.ru/eng/

The catalogue of major completed research and design developments of the institutes of the SB RAS can be found in :

http://www-sbras.nsc.ru/eng/sbras/main-work.html

Field studies on Aquaculture in Ocean University of China, China

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1. Field studies on Aquaculture

Ocean University of China (formerly : Ocean University of Qingdao) is a comprehensive university under the direct jurisdiction of the State Ministry of Education, offering coursework in the fields of Economics, Liberal Arts, Medical Sciences, Management, Law, Sciences, Engineering and Agronomy. Ocean University of China (OUC) is located in Qingdao, a renowned summer resort and an attractive historic tourist city of scenic beauty and temperate climate. OUC consists of 18 colleges and departments. There are over 15,000 registered students at OUC including 2,100 Master's and Doctoral graduate students and over 500 international students. Among the excellent facilities for teaching and research, OUC owns "Dong Fang Hong 2", a research vessel of a 3,500−ton displacement for both teaching and scientific research. One of the major activities of OUC has been its extensive participation in international academic exchanges. Since 1958, OUC has accepted international students, and now has developed close cooperative relations with over 30 universities.

Aquaculture department was founded in 1946 and was the first college aquaculture major in china. Aquaculture discipline is one of the national key disciplines in the university, and has a key Lab of Aquaculture Research of National Education Ministry, a aquaculture institute and a microalgae stock pool, with the master degree, doctoral degree, postdoctoral programs in Aquaculture, and Hydrobiology specialty. Staffs have 40 people. 13 Professors, 11 Associate Professors, 16 Lectures and Engineers. Now, We have 6 main research fields : Fish Culture, Invertebrate Aquaculture, Disease control in Aquaculture, Genetics and Breeding science, Systematic Ecology in Aquaculture, Nutrition and Feed studies of Aquatic animals.

In the recent years, remarkable progress has been made in aquaculture in the coast of China, and China is the world's leading kelp, shrimp, oyster, kelp and scallop producing nation today. The total mariculture production in China in 2002 is about twelve millions ton. However, the shortage of culture seeds, deterioration of water quality, mass mortality, and deterioration of culture seeds performance in recent China began to retard the development of mariculture. To achieve sustainable mariculture, the field studies on aquaculture in Ocean University of China are focused on : 1) Improvement in techniques of artificial seeds production, 2) development of excellent culture species and strains, 3) development of seed production of new culture species, 4) intensive culture techniques, 5) preventive techniques against diseases, 6) improvement of artificial compound feed, and 7) techniques for polyculture.

2. Microsatellites in the Pacific abalone : development, inheritance and applications

Eight polymorphic microsatellites were isolated from the Pacific abalone. The inheritance mode of seven microsatellite markers was investigated in four families. Four of the seven loci showed the presence of null alleles. Six of the 56 parental alleles were null alleles (10.7%). By microsatellite analysis, offspring from 4 full−sib families were

unambiguously discriminated in the neighbor−joining dendrogram, demonstrating that the microsatellite markers might be capable of discriminating between related and unrelated abalone larvae in a situation where no pedigree information is available. To assess the utility of microsatellite markers for detecting changes of genetic diversity in hatchery strains, we used six microsatellite markers to estimate the level of genetic diversity within three hatchery strains and two wild populations of Pacific abalone. Compared to wild populations, all the hatchery strains showed less genetic variation as revealed in lower number of alleles and lower expected heterozygosity, indicating that bottleneck effects occurred when each strain was founded. Significant differentiation was found between the hatchery strains, and between the hatchery strains and wild populations, and no obvious difference was detected between the wild populations. The results obtained in this study indicate that it is necessary to genetically characterize the abalone strains that are being released every year in order to monitor the effect on the genetic diversity of wild populations.

Marine Science studies in Vigo University (Spain)

Maria del Mar Ortega−Villaizan Romo

University of Vigo, Spain

The University of Vigo is located in Vigo city, Galicia prefecture, North−West of Spain, facing the Atlantic Ocean (Figure 1). The University of Vigo is a public university which was created in 1989. Nowadays has 30.492 students and 42 degrees. Within those degrees, Sea Sciences degree, in the Faculty of Sciences of the University of Vigo (Figure 2), started its program on 1993.

Vigo University, together with three other Universities distributed along Spain, which are Cadiz University (Andalucia Prefecture), Las Palmas de Gran Canaria University (Canary Islands) and recently Alicante University (Valencia Prefecture), are the main points dedicated to the Sea Sciences study in Spain.

Sea Sciences degree was defined as a multidisciplinary degree, which comprises studies related to biology, mathematics, chemistry, physics, geology and law. The main objective of this degree is to provide the students a global and diversified vision of the sea as a richness source, promoting the maximum use of its resources, at the same time that prepare the students how to undertake situations of contamination disaster.

Specifically, in the University of Vigo, there are three degree orientations: living resources, marine environment and pollution, and non living resources. In the faculty of sciences of the University of Vigo several departments are carrying out at the moment diverse studies related to the Sea Sciences, as for example: fauna adaptation to intertidal environments, Atlantic and Antarctic benthonic zoology and ecology, neural system in fishes, genetics of fishes and marine mollusks, evolutionary radiation of fishes, littoral and fluvial marine sedimentology, coastal engineering, environmental impact and territory planning.

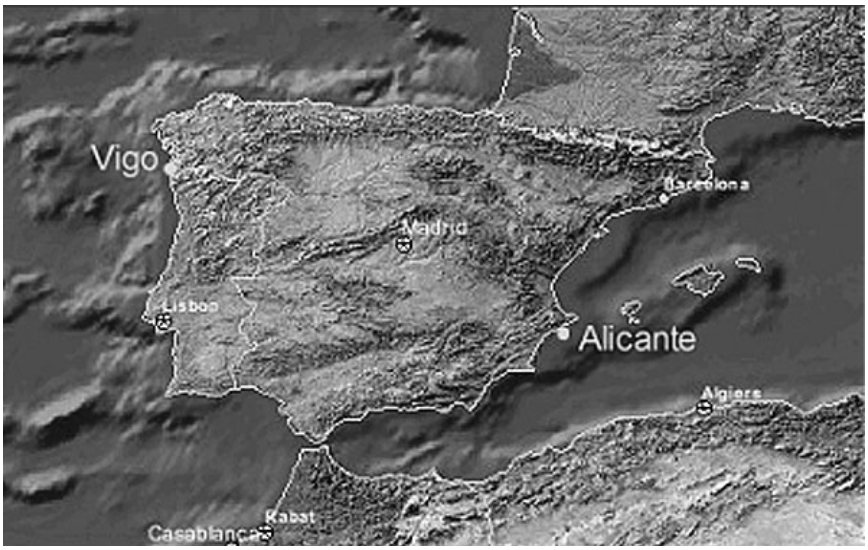


Figure 1 : Vigo location

Figure 2 : Faculty of Science, University of Vigo

Miyagi Prefectural Forestry Research Institute

OUTLINE

The role of Miyagi prefectural Forestry Research Institute (JAMFRI), Japan

Through research and technological development for forests and forestry, JAMFRI contributes to improvement of life and industry in Miyagi prefecture, following 3 key principles : " Increase ", " breeding ", and " good use ".

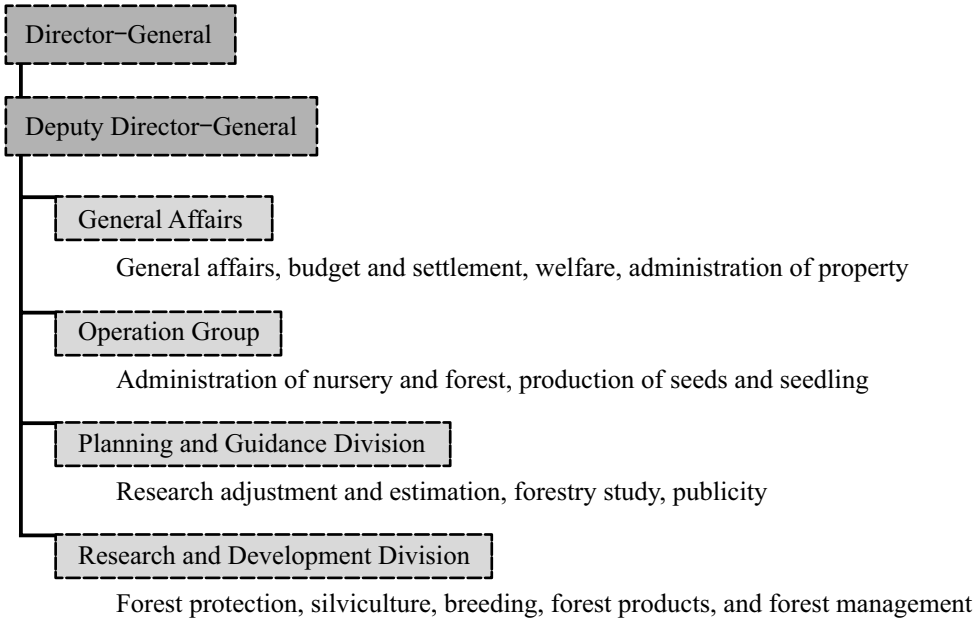
History

【1953】Established as Miyagi Prefectural Agricultural Experiment Station, Forestry Department

【1962】Established as Miyagi Prefectural Forest Tree Breeding Station

【1970】Established as Miyagi Prefectural Forestry Research Institute (Unification of Agricultural Experiment Station Forestry Department and Forest Tree Breeding Station)

Organization and Contents



Outline of research and development

−For enhancing multi−functionality of forests−

♦Breeding of cryptomeria (sugi), and hinoki cypress and other species, which improves growth increment, and tolerance to cold damage, and so on.

♦Selection of varieties resistant to pine wilt disease (Japanese red pine, Japanese black pine).

♦Development of the control method for Rooshi pitch canker, which deteriorates quality of hinoki cypress wood.

♦Investigation at 20 survey points for effects of acid rain on forests.

♦Research for the control method of countryside forests.

−For receiving favors from forest resources−

♦Development of highly functional domestic timber for wooden houses.

♦Development of new materials, utilizing wood injured by pine wilt disease, bark and other unused resources.

♦Development of the artificial cultivation method for the wild mushroom as natural, healthy food.

♦Development of mechanized operating system, especially the improvement of productivity of high performance forestry machines.

−To foster forest employees and forest supporters−

♦Training for forestry masters and high performance forestry machine operators. They the future leaders of regional forestry.

♦Forestry school revegetation course, open to the public in order to deepen understanding of forests and forestry among the people of Miyagi.

Recent results of research and development in JAMFRI

♦A supply of fine seeds and seedlings for forest owners.

♦Patent of fire−retardant material, cryptomeria(sugi) LVL (Laminated Veneer Lumber).

♦Selection and development of the field culture method for Lyophyllum decastes.

♦Development of a retaining wall for civil engineering utilizing thinning.
(Applying for a patent.)

Forestry Research Institute premises

Main establishment

■Land area (102.77ha)

■Main building and house 4,990m^2

■Location

25km north from center of Sendai City.

3km from Taiwa−matsushima Interchange of Tohoku Expressway.

14, Aza−hanuki, Oohira, Oohira−mura, Kurokawa−gun, Miyagi 981−3602 Japan

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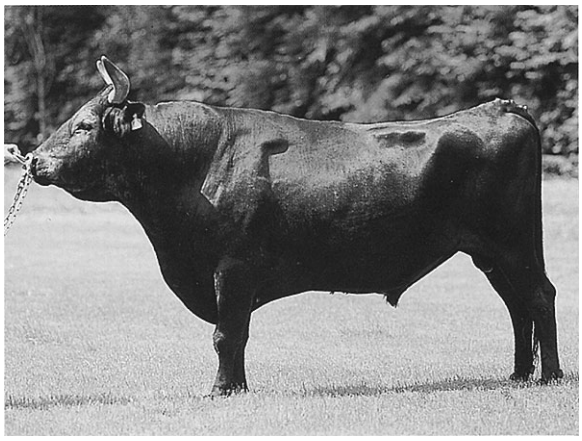
URL http://www/pref.miyagi.jp/ringyos/

Introduction of Miyagi Prefectural Livestock Experim ental Station, Japan

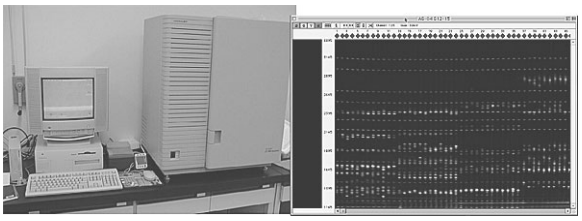
The Miyagi Prefectural Livestock Experimental Station (MLES) is a research organization established in 1975, with the amalgamation of Miyagi Prefectural Aquaculture Experimental Station Livestock Department and Miyagi Breeding Farm. The MLES aim at playing an important part in increasing the productivity of safe and high quality animal products in Miyagi. To achieve the aim, we have been pioneered innovative techniques and breeded high quality animals based on the new scientific knowledge, and disseminated them to farmers in order to contribute the further flourish of the future livestock industry in Miyagi.

The MLES has fifty full−time staffs including twenty−two researchers. Research works are carried out at three sections ; research for cattle (Dairy & Beef), swine, and forage crop and livestock industry environment. These sections research on technical improvement in the livestock production including cloning and genetic breeding, the use and the selection of forage crops that are suitable for the climate of Miyagi Prefecture, and the process and the utilization of animal wastes. We are also breeding and provided animals and semen to farmers.

Nutrient requirement of heifer on preparturient stage.
Control preparturient disease (Bovine masititis).

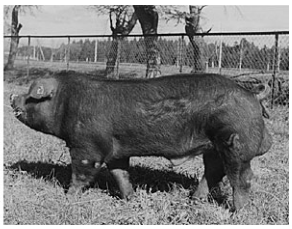


The test of meat production performance in Japanese Black Cattle.
Studies on the fattening technology for the quality beef.

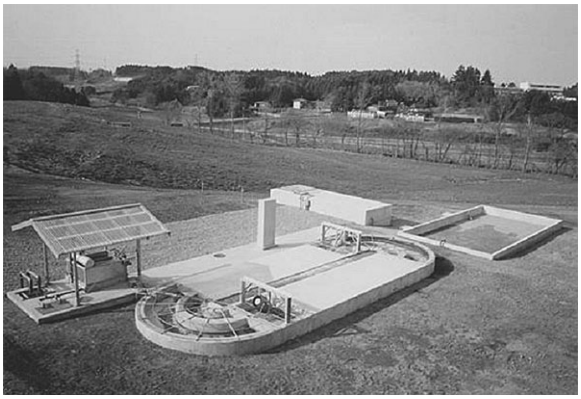


Breeding and genetic improvement of animals using molecular genetic analysis.
Detection of hereditary diseases (Swine, Bovine)

"Miyagino”
The line breed landrace pig.
High Dairy gain.
Thick Loin−eye area muscle.



"Shimofuri−Red”,
The line breed Duroc pigs.
High Dairy gain.
Intramascular fat and tender meat.
Thick Loin−eye area muscle.



Actual proof of activated sluge batch treatment system for livestock wastewater.
Test of low cost compost manufecturing method manufacturing.

Studies on rice whole crops silage.
The selection test of the forage crops suitable climate of Miyagi.

Introduction of Miyagi Prefectual Furukawa Agricultural Experiment Station, Japan

Brief History

Furukawa Branch Station of Miyagi Prefectural Agricultural Experiment Station was established in 1921 with its objectives to conduct research programs and develop new technologies related to rice cultivation improvement in northern part of the Sendai Plain, the main rice growing district of Miyagi Prefecture. The station also has the responsibility according to the national breeding program to develop new rice varieties with good quality adaptable to the middle and southern part of the Tohoku district (northeastern district of Japan), since 1926. In 1973, the branch station was up−graded and named Miyagi Prefectural Furukawa Agricultural Experiment Station with widening responsibility on the research programs for the rice production in Miyagi Prefecture. In 1999, the station was newly settled at the current place.

Location

Miyagi Prefectural Furukawa Agricultural Experiment Station is in Furukawa city 41 km north from Sendai or approximately 400 km northeast from Tokyo. It is located on 38° 36′N latitude and 140° 55′E longitude and is about 28.0 m above sea level.

Climate

Mean annual temperature : 11.1 , Mean annual rainfall : 1,200 mm, Total annual sunshine : 1,500 hr.

Soil

The land area of the station consists mostly of alluvial soil classified as "Saga series(code number1303)".

Organization

1. Director General

2. Dep. of Administration affairs : General Affairs, Accounting

3. Dep. of Breeding

research area : Rice Breeding

We are developing rice varieties as the commission research of Ministry of Agriculture, Forestry and Fisheries of Japan. Rice varieties bred. in Furukawa Agricultural Experiment Station stretch to 36 percent of cultivars in Tohoku district at the year of 2001. Rice variety Hitopmebore, which was born and bred in this institute and has both of cold tolerance and good eating quality, has been embraced by 22 prefectures in Japan from Tohoku district to Okinawa prefecture, the southernmost part of Japan.

In 2002, the planted area of Hitomebore has occupied the second place in Japan, and it has really become one of the big−name rice cultivars in Japan.

Besides, we also breed rice varieties with new characters to be used for various purposes, for instance, scented or colored rice varieties and low amylose varieties.

The green house for accelerated generation advancement, which allows us to cultivate four times in one cropping season, provides us shortened breeding cycle, as is the case with the anther culture breeding system. With the help of DNA marker method, we are eager to develop the efficient selecting technologies for rice varieties equipped with cold tolerance and blast disease resistance.

Some of the main research tasks are as described bellow;

- □ Enhancement of cold tolerance
- □ Enhancement of rice blast disease resistance
- □ Breeding of rice varieties with high quality and superior eating quality

4. Dep. of Lowland Farming

research area : Agronomy (Rice, Soybean, Wheat, Barley), Weed Control

The principal purpose of the division is to establish systemized farming technologies with low cost and high quality crop production of rice, barley, wheat and soybean in paddy fields.

The key objective of our research activities is four−fold : first, performance test for recommendable crop varieties, for instance rice varieties equipped with cold tolerance and good eating quality, second, establishment of cultivation technologies for newly developed varieties, third, development of low cost and labor saving rice direct seeding technologies, and fourth, technologies of paddy−upland rotation for high utilization of paddy fields.

At the same time, we implement the regular survey on the growth of rice, barley, wheat and soybean, including nitrogen nutrition diagnosis of rice plants in several districts. Based on these survey data and diagnosis results, we offer timely and accurate information to farmers and extension agents as periodic pamphlets.

Some of the main research tasks are as described bellow;

- □ Development of direct seeding technologies aimed for high quality and good taste rice production
- □ Weed control experiments in both of the upland and flooded conditions
- □ Establishment of wheat−soybean inter−cropping technology aiming for highly and stable productivity of these crops in paddy−upland rotation system

5. Dep. of Soil and Fertilizer

research area : Soil Management and Plant Nutrition

We are engaged in investigations on plant nutrition, soil conservation, soil pollution prevention and farmland consolidation to improve crop production in paddy fields. Main facilities we have are soil precise analysis room, crop plant nutrition laboratory, water quality laboratory and atomic absorbance analysis room, and these facilities allow us to research crop plant nutrition and environment conservation.

We carry out the analysis of plant and soil nutrients such as nitrogen, phosphate, potassium, magnesium. Additionally, we implement the analysis of methane gas concentration emitted from paddy fields using gas chromatography. We are also engaged in development of information network system for crop cultivation by exploitation of remote sensing techniques

We implement analysis of ingredient fertilizers and feeds as the inspection station of Miyagi prefecture. An open laboratory is prepared for farmers to do their analysis of soils, rice quality checking and other research activities by themselves.

Some of the main research tasks are as described bellow;

Development of remote sensing technologies towards establishment of easy and wide

measurement methods for soil and plant properties and growth diagnosis of rice plants

- □ Development of technologies for farmland consolidation in consideration of the multiple functions of paddy fields, such as prevention of flood and soil erosion, preservation of rural landscape and recreational amenities

6. Dep. of Crop Protection

research area : Disease Control and Pest Control

The research objectives of the division are to develop protection technologies for crop plants, mainly rice, wheat, barley, and soybean, against insect pests and diseases. The stages and periods of occurrence of insect pests and diseases vary according to various conditions, therefore we research the effect of weather conditions, cultivation conditions and cultivation circumstances on their occurrences.

Based on the results, we improve predictive accuracy for the occurrence of pests and diseases. And the results will give us the grounds for development of technologies towards "Integrated Pest Management (IPM)" with exploitation of field husbandry technologies such as water management, fertilization management, selection of cultivars, utilization of natural enemies and other non−chemical pest control methods. The IPM is expected to control the degree of occurrence of causal microbes and insect pests below the economic acceptable level, and it will provide advances in pest control methods alternative to "Exhaustive Pest Eradication Method".. Some of the main research tasks are as described bellow

- □ Researches on the role of native natural enemies such as spiders, tree frogs in paddy fields
- □ Investigation of effective blast disease control method by cutting off the source of infection by use of DNA finger print method

Compiled by Yoshikazu Takeda

Introduction of Research Institutes for Aquatic and Marine Science in Miyagi Prefecture

Akihiro Kijima

Oyster Research Institute/Tohoku University, Japan

In Miyagi Prefecture, there are four research institutes for aquatic field science. These institutes have been advanced basic and applied research for fisheries management system not only by themselves but also with Tohoku University. Here, I introduce these institutes briefly on behalf of them and discuss some future joint programs as alliance of Miyagi regional aquatic field science.

1. *Miyagi Prefecture Freshwater Fisheries Experimental Station (MPFFES)*

The Station is located in the mountain area of Miyagi Prefecture as shown in photograph(1). The aims of the MPFFES are development of freshwater fisheries and conservation of aquatic environment around rivers, ponds and lakes in Miyagi Prefecture. For example, effective production of salmonid fishes by using aquatic biotechnology, basic and applied study for freshwater fish diseases, and study for conservation of freshwater and brackish water bio−resources.

2. *Miyagi Prefecture Fisheries Research and Development Center (MPFRDC)*

The Center faces Ishinomaki Bay (northwest part of Sendai Bay) as shown in photograph(2). The aims of the MPFRDC are planning and regulation of fisheries research, promotion of fisheries based on rational resource management system, exploitation of information processing system for fisheries, and development of advanced technology for fisheries in Miyagi Prefecture. Three research vessels belonging to this institute have been exploited for field survey in coastal and offshore water.

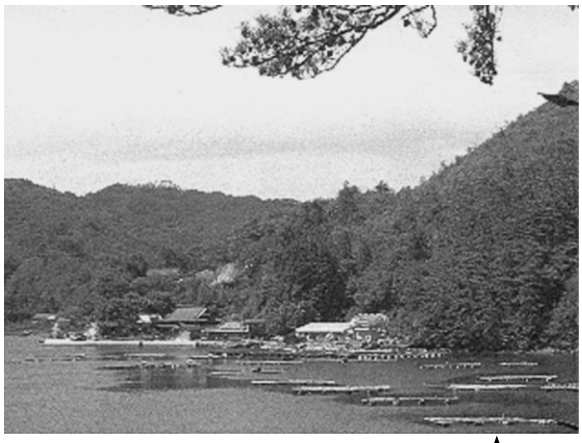
3. *Fisheries Research Agency Tohoku National Fisheries Research Institute (TNFRI)*

The institute exists in the face of Matsushima Bay (middle part of Sendai Bay) as shown in photograph(3). Areas of responsibility of the TNFRI are the Pacific coastal and offshore areas extending from Nozima Peninsula (Chiba) to Tappi Peninsula (Aomori), called "Mixed Water Region". With the aim of contribution to development of fisheries based on utilizing characteristics of the oceanographic environment, studies on estimation of TAC and stock assessment, comprehensive studies on biological reproductivity, and fundamental research on sea farming and resource management have been carried out.

4. *Oyster Research Institute (ORI)*

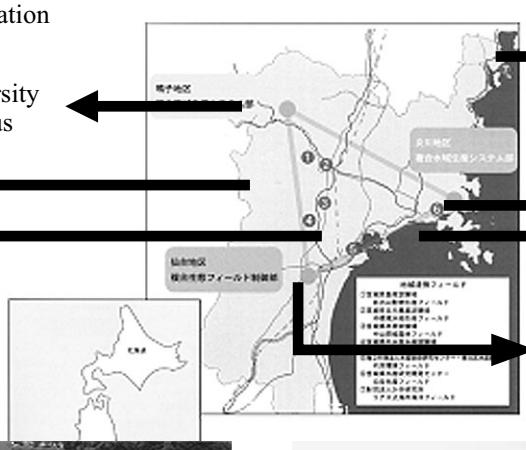
Field Research Laboratory of the Institute faces Moune Bay (north part of Miyagi) as shown in photograph(4). The major aim of the ORI is basic and applied studies on oysters and marine invertebrates by the view point of ecology, physiology and genetics. Also ORI enlighten a scientific fruition of fisheries for civilian including fisherman. Up to now, many studies and many projects have been carried out under tightly cooperative to Tohoku University.

Miyagi Prefectural Freshwater Fisheries
Experimental Station



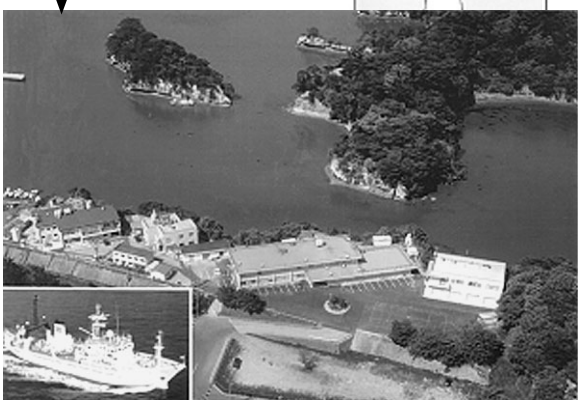
Oyster Research Institute

Tohoku University
Naruko Campus



Tohoku University
Onagawa Campus

Tohoku University
Sendai Campus



Fisheries Research Agency
Tohoku National Fisheries Research Institute

Miyagi Prefecture Fisheries
Research and Development Center

Current situation on research core of Integrated Field Control

Masahiko SAIGUSA

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Food production systems have been studied in order to improve production capacity and quality in individual bio−production fields, and these advances have contributed to establishing a sufficient food supply to meet the needs of the increasing world population since the industrial revolution. However, it has also been clarified in the last two decades that agricultural activity has also contributed to increases in environmental loading such as global warming gas increase, stream and subterranean water pollution, soil degradation, etc. The development of environmentally friendly bio−production systems that integrate high production efficiency with the ecosystems, including human society, is expected to be of great interest.

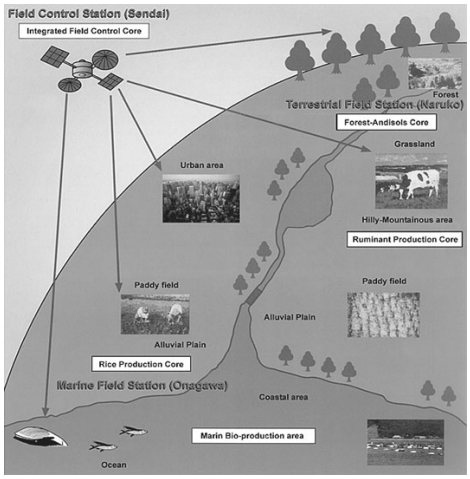
To facilitate the development of environmentally friendly bio−production systems that consider the ecosystem, the new Field Science Center was established in 2003 through the merger and reorganization of two former educational and research facilities for field science : the University Farm, and the Education and Research Center of Marine Bio−resources. The new center has three educational and research stations: the Field Control Station (Sendai), the Terrestrial Field Station (Naruko), and the Marine Field Station (Onagawa). It also has five following research cores : the Forest−Andisols Research Core, the Ruminant Production Research Core, the Rice Production Research Core, the Marine Bio−production Research Core, and the Integrated Field Control Research Core.

The **Integrated Field Control Core** was formed to promote an environmentally, friendly, high quality and high yielding bio− production and to hasten the integrated field science in terrestrial−marine ecosystems.

[Recent topics in field control core]

1). Occurrence and significance of silicon in integrated eco−systems : Silicon is one of the main components in the soil and occupied about 33% of it in average. Silicon exists generally as opal such as plant opal (phytoliths) in the leaf of tree (Morikawa and Saigusa 2004) and leaf of Gramineae plant (Saigusa et al 2000), opaline silica in Andisols (shoji and Saigusa 1978) and diatom in stream and ocean (Ichinomiya 2004). It is not one of essential elements for higher plants but is agronomically essential for rice cultivation because of its multi−functions, such as accelerating photosynthesis, increasing rice blast resistance, water use efficiency, and lodging resistant, etc (Saigusa 2002). Diatom is also important as a feed of "Ayu" fish (*Plecoglossus*), or animal−plankton (feed for fishes in the food chain) and as an environmental index.

2). Transported soils distributed in integrated eco−systems : Both Alluvial soils(paddy soils) and volcanic ash soils (Andisols) are transported soils, and their soil−type and distribution pattern depend on topography, geology, climate, and distance from the source volcano or stream. Allophanic Andisols are distributed in the area close to the source volcano, whereas nonallophanic ones are located far from it and are very much influenced by the wind deposition of loess materials from China (Saigusa and Matsuyama 1998). On the other hand, the soil type and clay mineralogical composition of paddy



soils depend on their topography and geology of upper stream. Fine heavy clay soils with smectite and/or halloysite are located in the back swamp, whereas coarse sandy soils with kaolinite, zeolite and chlorite are located in natural levee (Saigusa 1979). The paddy soils located in Tohoku Districts are generally abundant in 2:1minerals reflecting upstream tertiary green−tuff geology and show fertile soil characteristics.

3). Bio−diversity in integrated ecosystem : Both "Wakasagi" fish (*Hypomesus*) and "Ayu" fish (*Plecoglossus*) living as landlock fishes are relatively smaller in size compared to those of fresh water−sea water type ones (Ikeda et al 2002). However, both the landlock type and freshwater−sea water types of each fish are genetically identical. On the other hand, "Sujiebi" shrimp (*Palaemon paucidens*) has genetic polymorphism and shows different tolerance in salt stress (Fidhiany et al 1990).

4). Bioorganic waste and cycling Agriculture : Bioorganic waste is produced in great extent in terrestrial−marine ecosystems, and the amount of its nitrogen is worth three times of nitrogen fertilizer consumed in Japan(Ito et al 2003). Therefore, both recycling agriculture and increase of self−sufficiency rate of agricultural products are urgent subjects in Japanese agriculture for environmental preservation.

5). Others : 1) Development of techniques to maintain secondary natural environment in hilly−mountainous area and strategy to maintain farmer's livelihood (Saigusa et al 2002) 2) comparative study on remediation system of agricultural environment in reference to Japan and Korea field survey (Kudo et al 2001)) and 3) establishment of ideal model adapted to cycling society by integrating multi−cycling systems were also studied.

[Future Prospects] The feasible projects in this research core are as follows: 1) Development of both ideal techniques and systems for composting and generating electricity from bioorganic waste. 2) Promoting precision agriculture using remote sensing techniques with GPS and GIS 3) Effects of riverside forest on environment prevention in integrated eco−systems. 4) Evaluation of material and energy flows and land use in terrestrial−marine ecosystems.

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Japan−Russia International Workshop for Microelements 2003

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Japan−Russia International Workshop for Microelements 2003 was held at the Field Science Center Kawatabi, Graduate School of Agricultural Science, Tohoku University on September 23, 2003.

This workshop was the first international meeting in the Field Science Center, which was founded by combining the Experiment Farm with the Education and Research Center of Marine Bio−resources on April 1, 2003. Three speakers were invited from Russia and Japan, and delivered following papers.

1. Mineral−Salt Block : Efficient and Unique Supplemental Method of Trace Mineral for Cattle in Japan. Mr. Takashi Abe, Animal Nutrition Reseach Team, ZENOAQ−Nippon Zenyaku Kogyo Co., Ltd, Fukushima, Japan.

2. Method of Diagnostics of Chronic Microelementoses in Farm Animals Based on the Chemical Elemental Composition of Their Hair and Correction of Such Microelementoses. Professor Vadim V. Ermakov, Project leader, International Science and Technology Center (ISTC), Russian Academy of Sciences, Verrnadsky Institute of Geochemistry and Analytical Chemistry, Laboratory of Environmental Biogeochemistry, Moscow, Russia

3. Effects of polyolefin−coated fertilizer containing NPK and micro−elements on copper deficiency in barley and wheat in acid high humic Andisol. Professor Masahiko Saigusa and Dr. Toyoaki Ito, Director/Professor and Associate Professor, Field Science Center, Tohoku University, Miyagi, Japan.

Professor Nakai arranged the workshop and chaired. Twenty five researchers and students from Russia, Hungary, China and Japan participated in the workshop, including distinguished guests, Dr. Dieter Nietzold, ISTC Secretariat, Moscow and Dr. Svetlana I. Usenko, Project Manager ISTC, Russian Federal Nuclear Center, Sarov, Russia.

METHOD OF DIAGNOSTICS OF CHRONIC MICROELEMENTOSES IN FARM ANIMALS

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Introduction

Under the conditions of technogenic transformation of the biosphere, it is of critical topicality to comprehensively examine highly dangerous biogeochemical endemies in animals and humans, their genesis, evolution, prediction of their manifestations as a result of natural disasters and anthropogenic factors. Misbalance of essential and accumulation of toxic chemical elements in animals and humans are known to depend upon their genetic basis and local biogeochemical elemental cycles. The latter are determined by the processes of airing and transformation of matter. Deficiency or excess of specific chemical elements in plants, fodder and in animals causes reduction of their reproducibility and diseases known as microelementoses. The most widely spread of such diseases are cardiovascular and tumor pathologies. Their genesis is mainly attributed to the deficiency of trace elements, for example selenium. Iodine deficiency causes various forms of endemic goiter and cretinism. Excess of strontium, fluorine and molybdenum is responsible for the development of pathologies in bones and joints [4, 8, 17].

At that, **chronic microelementoses** constitute a complex of subclinical and clinical attributes caused by deficiency, excess or misbalance of macro−and microelements in animals attributed to malnutrition of animals and heterogeneity of habitats (table 1).

At diagnosing MTOSes in farm animals and humans and identifying biogeochemical provinces or environmentally unfavorable areas specialists more and more often resort to integrated system research approaches. First of all, this applies to the biogeochemical indication of environmental status of territories. For example, based on critical concentrations of trace elements, their tolerant levels in plants and fodder, there were developed biogeochemical criteria for environmental assessment of territories. Levels and correlations of normed chemical elements in organs and tissues of wild animals are also used at assessing the environmental status of specific trace elements [8]. One of them implies utilization of data on the chemical elemental composition of hair (CECH) that forms depending on the chemical elemental composition of the environment, fodders and general fitness of the body (table 1).

Objectives of the Project :

- Develop an express−method of system diagnostics of chronic microelementoses in farm animals based on the chemical elemental composition of hair;
- Reveal disbalance of standardized macro−and microelements in fodders based on the CECH data;
- Identify natural and man−affected biogeochemical provinces using the data on the elemental composition of hair;
- Develop a technology to produce special fodder additives to correct microelementoses in farm animals.

Table 1. Indicator capacity in relation to trace elements of six selected organs and tissues [2]

Organ, tissue	Zn	Mn	Cu	I	Se	Mo	Cd	Ni	Li	As
Liver	−	+++	+++	+++	+++	+++	++	+	+	+++
Kidney	−	+	−	+++	+	++	+++	++	−	+++
Brain	−	−	+++	−	−	+	−	+	−	+
Rib	+++	−	−	−	−	+	−	+++	+	−
Serum	(+)	−	+	+++	+++	+++	−	(+)	+++	+
Hair	+	+	+	+++	++	+++	+	++	++	++

Composition of hair

On the whole, the chemical composition of hair is determined by genetic, neuro−humoral factors, metabolism and hair formation features, and a number of exogenous factors.

Endogenous factors : metabolism and blood supply features, functioning of sebaceous and sweat glands, neuro−humoral regulation, genetic factors.

Exogenous factors : sticking of mechanical particles (dust) and air aerosols, effects of precipitation and watering, washing using detergents, treating with different actoparasite−killing agents, contamination with feces, urine, soil and bedding particles, living and nutrition conditions.

Technique

The technique comprises the following stages :

1. Collection of data about an animal and its living conditions.
2. Examination of the animal.
3. Taking hair samples.
4. Purification of hair from impurities.
5. Drying the purified hair samples.
6. Grinding of hair samples.
7. Mineralization of hair samples.
8. Instrumental analysis of hair.
9. Data processing.
10. Comparing the data obtained with the range of concentrations of chemical elements ranked according to the environmental status (deficient, normal, excessive).
11. Decision on the status of macro−and microelements and correction of environmentally unfavorable conditions.

First, the following data about an animal need to be obtained : species, breed, sex, age, color, conditions (fatness, lactation stage), type of nutrition and living conditions (pasture, stabling period, etc.). These data are entered in a special sampling card specifying the attributes of a sample (place of sampling, contamination), date of sampling, owner of the animal, address and name of the sample taker.

As a rule, hair samples are taken is a special cattle pen. Samples can be taken by the animal's owner. Places of sampling : withers, middle of back, femur, side under withers, middle of body side, body side under femur, chest, middle of belly, belly under femur, elbow, wrist, knee, heel, bunch of tail. Based on investigations carried out, we recommend using the tail bunch, because its hairs are long, they rarely contain admixtures, it is easy to take samples, when samples need to be large, and concentrations of a number of metals in the tail hairs are higher than in other types of hair.

A sample of hair (about 1.5 to 2 g) is taken along the full length of the tail bunch. A section of the bunch is sheared at a distance of 1−2 cm from the skin by means of scissors (preferably with titanium coating). The sample with a label is placed into a paper or plastic bag and delivered to the laboratory.

Purification of hair is one of the key stages of the technique. Note that there are no unified procedures for hair cleaning from impurities today.

We have performed experiments to prepare and analyze hair samples of cattle in compliance with project objectives. We have looked at the variation of level of chemical elements depending on the degree of hair homogenization (length of fragments cut), temperature of drying, time of washing and other factors [11, 16].

Analytical methods

Different methods are used for quantitative determination of chemical elements in hair: from ICP−mass−spectrometry to electrochemical methods [15]. As applied to the elemental analysis of hair, it is recommended to use mainly atomic absorption (with and without flame). Iodine and fluorine can be detected using ion−selective potentiometry, and selenium can be measured by the specrofluorimetric option and the 'graphite' cell method. In order to improve the validity of data, it is recommended to analyze each time both clean and dirty portions of one hair sample, and a standard sample.

Concentration ranges of chemical elements in hair

The most critical stage of investigations is determining the ranges of concentrations of chemical elements in hair of health animals taking into account their age (calves, mature animals), sex, color and physiological conditions, and animals living in the environment of deficient and excessive macro−and microelements [1, 3, 14].

We have tried to establish such ranges based on literature data and data available at the moment. It becomes clear that there is a definite dependence of CECH on the season and hair color in case of calcium, magnesium, phosphorus and manganese

(Fig.1, table 1). To a smaller degree, this can be observed in the case of copper, zinc and other trace elements (table 2). It is worth noting that there is shortage of data on the levels of selenium, molybdenum, iodine and fluorine in animal hair.

Further tasks

− make a bank of comparative data on CECH of cattle from different regions of Russia with manifestations of microelementoses and from favorable regions;

− correlate CECH with physiological conditions and pathologies;

− correction (prophylaxis) of microelementoses.

Experimental sites and layout

Moscow region, Eastern Transbaikalia and Northern Caucasus were chosen to be experimental sites. It is possible to get samples from Dagestan, Vladimir, Voronezh and Chelyabinsk regions. Environmental and biogeochemical assessment (sampling and analysis of soils, waters, pasture plants, blood of farm animals) of some experimental sites has been performed already.

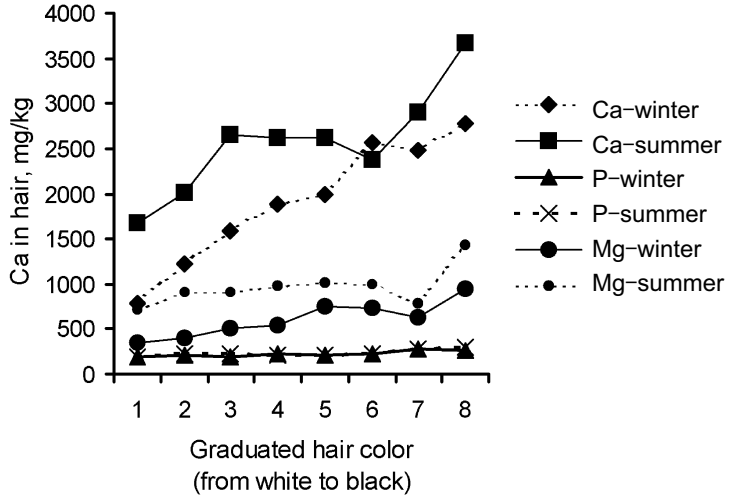

Fig. 1. Change of macro element concentration in cattle hair of graduated colour in winter and in summer by indoor keeping (mg/kg) (cows per colour degree = 50). Graduatrd hair colour : 1− white, 2−7 from yellow to dark red, 8 black [14].

Table 2. Trace element concentrations in cattle hair of graduated colour in winter and in summer by indoor keeping (mg/kg) (Cows per colour degree = 50) [14]

Colour degree+		Mn		Cu		Zn	
		winter	summer	winter	summer	winter	summer
1	mean	4.46[a]	9.01[a]	7.83	8.00	119	134
	± SE	1.59	4.69	1.56	2.03	30	48
2	mean	6.73[b]	8.99[a]	7.71	8.16	170	223
	± SE	2.97	3.98	1.51	1.59	47	86
3	mean	6.35[ab]	8.42[a]	8.04	8.68	172	181
	± SE	3.81	3.77	1.09	1.38	75	78
4	mean	8.30[c]	10.00[a]	7.77	8.76	161	155
	± SE	5.30	4.69	1.65	1.40	64	66
5	mean	8.84[cd]	9.98[a]	8.61	9.32	140	140
	± SE	5.47	5.22	1.28	1.34	37	42
6	mean	11.45[d]	10.63[a]	8.39	8.31	131	139
	± SE	8.49	7.75	1,23	1,36	17	43
7	mean	9.57[cd]	13.01[b]	7.43	8.24	123	157
	± SE	6.29	8.99	1.32	1.65	30	76
8	mean	13.11[d]	19.77[c]	7.73	9.25	145	138
	± SE	7.34	12.30	1.65	1.76	29	50

+ = graduated hair colour : 1 white, 2−7 from yellow to dark red, 8 black;
abcd = means within each column with different superscripts are significantly different.

Studying the chemical elemental composition of soils, fodder plants and hair of cows during the pasture period on one of the farms in Moscow region has demonstrated that hair of cows can be used for general assessment of the agroecosystem in terms of sustainable development. For example, average levels of copper (5.9 mg/kg), zinc (70 mg/kg) and manganese (5.5 mg/kg) in the analyzed hair samples of the cows on this farm was lower than optimal concentrations. Deficient levels of mobile forms of the above elements have also been detected by means of soil analysis (1.8 mg/kg for zinc; 1.5 mg/kg for copper; 35 mg/kg for manganese).

Table 3. Maximum and minimum concentration of some chemical elements in hair of cattle and man (mg/kg)

Chemical element	Cattle, Russian data		Cattle, data of authors		Cattle, European data		Man, different countries	
	min	max	min	max	min	max	min	max
Ca	480	3148	690	2060	780	3794	50	7100
Mg	232	287	130	990	257	1447	9	252
P	180	590	150	630	174	282	94	273
Fe	33	403	18	156	15	72	4	750
Zn	70	297	84	140	59	223	15	961
Mn	5	59	3	13	1	26	0.2	7
Cu	4	25	7	11	2	14	3	91
Sr	3.4	11.7	0.8	10.8	–	–	0.1	18
Pb	1.0	1.7	–	–	–	–	0.2	13.4
I	0.13	0.20	–	–	0.06	1.65		

In summer 2003, environmental and biogeochemical assessment was performed in the territory of the Tyrnyauz ore field in the vicinity of a molybdenum mining and processing enterprise; samples of soils, plants, waters, blood and hair were taken, specific response of animals at the production cone of ore elements was revealed. In addition, hair samples of cattle were received from other regions of the RF (Dagestan, Chita region, Vladimir region). Data on the chemical elemental composition of soils, waters and plants, which are characterized by increased levels of phosphorus, manganese and strontium and reduced levels of selenium were obtained for some regions in the Eastern Transbaikalia (Chita region).

Correction of microelementoses

The most acceptable ways to correct microelementoses in animals is to use medicines containing trace elements; to control chemical composition of animal diets by means of additives; to produce mixed fodder with controlled content of trace elements; to spray fodder crops with solutions of trace elements; to add compounds of trace elements to the soil of fodder croplands or to block their assimilation by plants. In case of deficiency, most efficient are the methods associated with correction of local biogeochemical cycles of biologically active chemical elements taking into account the genotype of animals and their macro- and microelement requirements by adding deficient essential chemical elements to the soil of fodder croplands. This method is being developed at two experimental sites in Odintsovo district, Moscow region–Moskvoretsk and Nemchinovka farms. Particular attention is paid to the selection of cows and heifers for hair sampling for chemical elemental composition analysis taking into account their age, physiological conditions and the season. Hair samples were taken from the tail bunch, withers and back of animals. The total number of hair samples taken on the Moskvoretsk farm made 160. The number of hair samples taken on the Nemchinovka experimental farm made 38, including 30 hair samples from the tail bunch being in the process of preparation for analysis. Also, hair samples of cattle

were taken on private farms near the city of Pokrov and other farms located near Moscow taking into account the status of lactation.

We have tested sodium thiosulfate and recommend using it if it is necessary to neutralize fodder overloaded with mercury, cadmium and lead. Introducing 10g/kg of this substance into the diet of cattle during the period of fattening makes it possible to sharply reduce concentrations of the metals in organs and tissues, and to increase the growth of biomass [9, 10, 12, 13].

Conclusions

On the whole, the problem of CECH as applied to diagnosis of microelementoses is in the focus of keen attention of scientists and active exploration of optimal solutions. Considerable analytical difficulties are associated with the choice of biomaterial, its preparation for analysis and interpretation of data obtained. Using unified hair analysis methods and correlating elemental chemical composition of hair with clinical and subclinical manifestation forms of chronic microelementoses in large areas of the RF will allow enhancing the capabilities of the method as applied to real diagnosis and correction of mineral dysbolism in animals.

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−Mineral−Salt Block− Efficient and Unique Supplemental Method of Trace Mineral for Cattle in Japan

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Introduction

"KOEN (Mineral−salt block)" is a kind of synonymous with cattle salt licks in Japan. This was marketed to the Japanese livestock industry in 1958, and has been the most successful product. It was used in almost of dairy and beef farms to supply macrominerals [1], trace minerals [2] and vitamins [3] to cattle. The solidified salt can be handled easily and insures uniformity of supplying ingredients to cattle. This group of solidified salts is devided in 4 categories;

1. "*KOEN E−100"* and *"KOEN E−250"* contains vitamin E and selenium for antioxidant.
2. "*FOOTBIO*" contains biotin and Zinc for maintaining healthy hooves.
3. "ALKALIX" contains sodium bicarbonate for preventing rumen acidosis.
4. "COWSTONE A" contains ammonium chloride for preventing urolithiasis.

Trace Mineral Excretion

The mineral−salt blocks supply many kind of nutrients to cattle; Ca/P/Mg/Mn/Cu for bone development, P/S/Zn/Se for muscle development, Ca/P/Mg/Zn for milk production [4]. Recently we are striving to reduce the trace mineral excretion to prevent environmental pollution [5] (Fig.1).

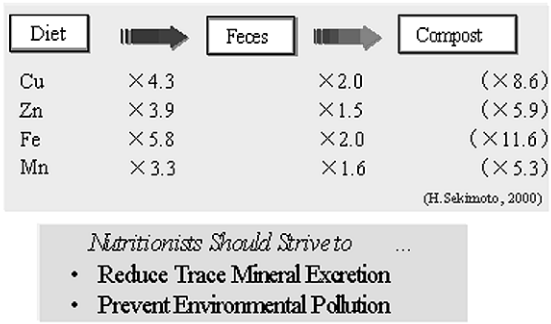

Fig.1 Trace Mineral Excretion and Concentration (Swine)

There are some strategies to reduce the trace mineral excretion from cattle fed with the mineral−salt block. One of the strategies is to increase bioavailability of trace minerals. It means metabolic improvement of the mineral−salt block. Second one is to use trace minerals with higher bioavailability. Organic trace minerals are the best candidates [6].

Licking mineral−salt block for cattle has advantage in metabolic improvement [7] (Fig. 2−4). It promote salivary secretion and rumen movement, and improve digestion rate to increase bioavailability of trace minerals.

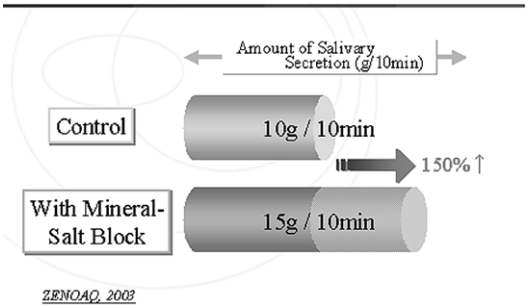

Fig. 2 Promotion of Salivary Secretion

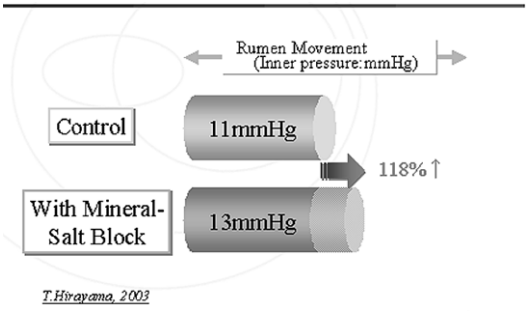

Fig. 3 Promotion of Rumen Movement

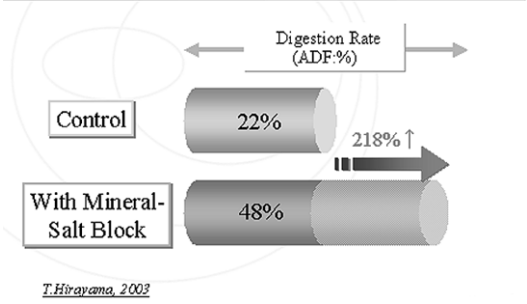

Fig. 4 Improvement in the Digestion Rate

Organic trace minerals have following advantages; 1) They avoide the antagonistic action of other cation. 2) They are absorbed directly. 3) They can be used at lower level than inorganic sources (Fig. 5−6, Table 1). The largest advantage of organic trace minerals is the reduction of the level of trace mineral excretion.

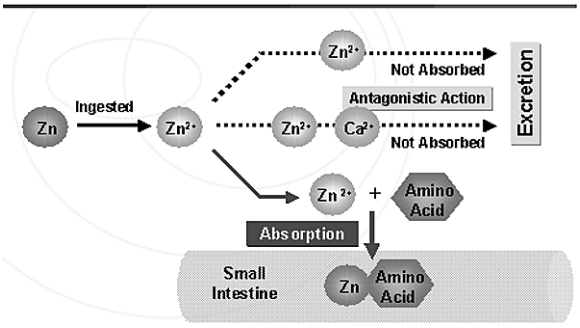

Fig. 5 Proposed Theory of *Inorganic* Trace Mineral Absorption

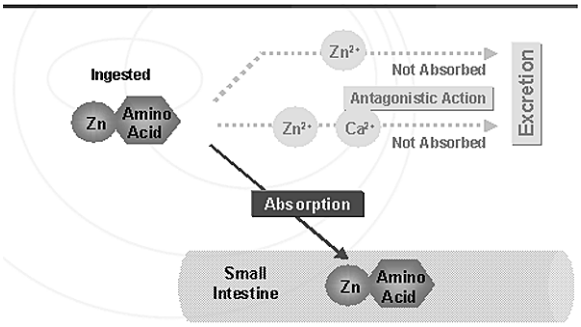

Fig. 6 Proposed Theory of *Organic* Trace Mineral Absorption

Table 1. Effect of Copper Source and Level on Copper Balance in Cattle

Item	Copper Sulfate[1)]	Copper−Amino Acid Complex[2)]
Copper intake, mg/d	92.5	125.5
Fecal Cu excretion, mg/d	83.8^{y}	81.3^{y}
Fecal Cu excretion, % of intake	90.3^{y}	65.8^{z}
Cu retention, mg/d	6.9^{x}	40.4^{y}
Cu retention, % of intake	7.8^{y}	32.7^{z}
Cu absorption, %	9.8^{y}	34.2^{z}

1) 125 mg Cu/d from Copper Sulfate
2) 125 mg Cu/d from Copper Amino Acid complex

xyz) Means within a row lacking a common superscript differ ($P < 0.05$)

Conclusion

"KOEN (Mineral salt block)" was originally developed as the mineral supplement, but recent modification of the components gave the potential activity to the product to contribute for preventing environmental pollution of trace minerals. They were modified to increase bioavailability of trace minerals by metabolic improvement (improvement of salivary secretion, rumen movement and digestion rate). They can supply organic trace minerals with higher bioavailability, and reduce the level of trace mineral supplementation and excretion.

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No−tillage Transplanting System of Rice with Controlled Availability Fertilizer in a Nursery Box −Nitrogen Use Efficiency of Controlled Availability Fertilizer of Rice Plant in Three Different Paddy Fields−

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key words : nitrogen−use efficiency, no−tillage transplanting system, 15N sigmoid type of polyolefin−coated urea, soil types

Abstract

The fate of polyolefin ^{15}N coated urea (POCU S−100) in a nursery box for the no−tillage transplanting system as compared with ^{15}N ammonium sulfate (AS) in the conventional tillage system had been investigated in light clay alluvial soil, sandy loam alluvial soil, and clay loam soil (Andisol) in 1994 and 1995. Rice (Oryza sativa L. cv. Hitomebore) was used as the test plant.

The nitrogen concentration of the leaf blade of the rice plant in the no−tillage without rice straw (NT) and no−tillage with rice straw (NTS) treatments tended to be greater than those of the conventional tillage with rice straw (CTS) treatments in all types of soil at all growth stages, and there was no definite increasing or decreasing tendency in the N concentration of the leaf sheath and stem, and panicles of the rice plant among the treatments in all types of soil. Nitrogen recoveries from POCU S100 in the NT and the NTS systems were 77−79% and 78−83%, 61−73% and 66−78%, and 74−76% and 80−81% for light clay soil, sandy loam soil and clay loam soil, respectively, which is around 65.5−96% of the nitrogen released from POCU S100. Thus, this could reduce the environmental pollution. The straw application in the NT system increased the N recovery of POCU S−100 by 1−5%. On the other hand, nitrogen recoveries from ammonium sulfate applied as basal fertilizer in the CTS system were 35−43%, 20−29% and 23−32% for light clay soil, sandy loam soil and clay loam soil, respectively. Whereas those applied as a top dressing were 50−83%, 49−73% and 40−65%. Nitrogen uptake by the rice plant in the NT system was relatively higher than that in the CT system. The uptake of soil nitrogen by the rice plant in the NT system was lower than that in the CT system.

Introduction

Nitrogen is the most important nutrient element in controlling rice production worldwide. However, farmers usually apply an excessive amount of readily available nitrogen fertilizers for the NT transplanting system in order to stimulate fast development of the rice during the early growth stage and to obtain high yield. However, this may be disadvantageous in terms of its recovery. Because of such fertilizer practices, the recovery of nitrogen from the fertilizer with a basal application in the surface layer is very low (<10%) (Kaneta, 1995), and these practices promote N losses, especially through leaching and denitrification (Alison, 1966; Rao and Prasad. 1980). These losses of fertilizer N lead to an increased concentration of nitrous oxide in the tropospheric atmosphere and contribute to destruction of the stratospheric ozone layer (Bremner and Blackmer, 1978). Multiple−split applications of N fertilizer can reduce N losses (De Datta and Buresh, 1989), but this increases operating costs as well. Alternatively, controlled availability fertilizer (CAF) developed in Japan shows a much higher recovery compared to readily available fertilizer. A single basal application of the total N fertilizer as a CAF can supply enough N to the rice crop for the whole duration of the growth period in order to achieve satisfactory grain yield. By using a sigmoid type of CAF with 100 days release in the NT transplanting system of rice, polyolefin−coated urea (POCU S100) in a nursery box had been practiced; however, literature providing data ^{15}N−POCU S100 and rice under different field conditions is limited (Kaneta, 1995). Several cultivation practices in northeastern Japan

has shown a superior yield potential in the NT transplanting system with POCU S100 in a nursery box over conventional tillage practices in clay soil. However, soil and climatic conditions can influence the growth and yield of rice, the mineralization of soil−organic nitrogen and the absorption of fertilizer and soil nitrogen by the rice plants. Although, the accumulation and distribution of N in the vegetative and reproductive organs of rice are important processes in determining grain yield (Norman et al., 1992). However, absorption and accumulation of N varies with the development stages of the rice crop. Maximum N demand periods occur during active tillering and early reproduction, with absorption being near completion by panicle emergence (Wada et al., 1986; Wilson et al., 1989). Schnier et al. (1990) reported that plant N status, beginning at panicle initiation, influences spikelet differentiation and, thus, yield potential. Therefore, the objectives of this experiment are to determine the efficiencies of POCU S100 by rice at the young panicle initiation stage and at harvest time in the no−tillage transplanting system and to compare these with different soil types at the same stages.

Materials and Methods

Field ^{15}N experiments were conducted in 1994 and 1995 on light clay and sandy loam alluvial soil at Furukawa (flat area) and clay loam Andisol at Kawatabi (hilly area), Miyagi Prefecture, Japan. The properties of these soil types and the climatic conditions during the growing season of the rice have been reported in the previous paper (Hossain et al., 2000). Rice (Oryza sativa. L. cv. Hitomebore) was used as a test crop. Three treatments, conventional tillage with straw (CTS), no−tillage without straw (NT) and no−tillage with straw (NTS) were tested through three replications. For this experiment, 0.09 m^2 (30 cm x 30 cm) micro plots were set with metallic frame in the main fields. Land preparation had been reported in the previous paper (Hossain et al., 2000).

Sigmoid type of ^{15}N POCU (Polyolefin Coated Urea) S100 (3.24 atom % ^{15}N) as a source of CAF was used as a single basal application of total nitrogen at the rate of 7 g N m^{-2} in a nursery box at the time of sowing for the NT treatments. In the CTS treatment, readily available ^{15}N AS (3.03 atom % ^{15}N), supperphosfate and KCl were applied at the rate of 5 g N m^{-2} at the transplanting time as a basal source of N, P_2O_5 and K_2O. ^{15}N AS of 1 g N m^{-2} was top dressed twice at 15 and 25 days before heading for the CTS treatment. Three micro plots were used per treatment and each micro plot contained two hills of rice. Five seedlings were transplanted from each hill.

At the young panicle formation stage (12 July) and at harvest, plants from three micro plots per treatment were sampled and separated into leaf blade, leaf sheath and stem, and panicles. Each part was oven−dried at 70 oC for 48 h and weighed. The total N of each part of the plant (leaf blade, leaf sheath and stem, and panicles) was determined by the method of Bremner and Malvaney (1982). The ^{15}N content of samples were analyzed by the JASCO ^{15}N analyzer (MODEL N−151). Statistical differences in the results among the treatments were determined by Least Significant Difference (LSD) at a 5% level of significance.

Results and Discussion

Nitrogen concentration and partitioning

The N percentages of each part of the plant at the young panicle initiation stage and at harvest time in 1994−1995 are shown in Table 1. The N concentration of each part of the plant at the young panicle initiation stage was higher than that at harvest time. Sims and Place (1968) and Yoshida (1981) have reported that N concentration of the rice plant was directly related to the age of the plant, which is high in the early growth stage and declining towards maturity. The N concentration of the leaf blade of the rice plant in NT and NTS treatments tended to be greater than those in the CTS treatments. And there was a clear tendency for the N concentration to increase in the leaf blade of the rice plant in the NTS treatments more than that in the NT treatments. This may serve as an important source of N for the next cropping season. However, there was no definite increasing or decreasing tendency in the N concentration of the leaf sheath and stem of the rice plant among the treatments in all soil types (Table 1). The N concentration of the panicles of the rice plant was almost the same among the treatments in all soil types.

Table 1. Nitrogen percentage of each part of rice plant at young panicle initiation stage and at harvest time

Type of soil	Treatment	Panicle initiation stage				Harvest time					
		Total N (%)				Total N (%)					
		Leaf blade		Stem and leaf sheath		Leaf blade		Stem and leaf sheath		Panicle	
		1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Light clay (Alluvial soil)	NT	3.56	3.44	1.46	1.61	1.10	1.13	0.44	0.42	0.99	1.07
	NTS	3.19	4.30	1.66	2.01	1.27	1.36	0.38	0.48	0.95	1.17
	CTS	2.94	3.24	1.66	1.51	0.88	1.00	0.38	0.41	1.00	0.92
	LSD at 5%	0.501	0.373	–	0.249	0.187	0.095	–	–	–	0.10
Sandy loam (Alluvial soil)	NT	3.19	3.15	1.22	1.37	1.18	1.14	0.46	0.54	1.13	1.05
	NTS	3.79	3.65	1.34	1.35	1.30	1.38	0.62	0.53	1.08	1.34
	CTS	3.89	2.51	1.32	1.31	1.08	1.16	0.47	0.55	1.03	1.20
	LSD at 5%	0.312	0.486	–	–	0.15	0.11	0.043	–	–	–
Clay loam (Andisol)	NT	3.13	3.72	1.63	1.63	1.40	1.50	0.52	0.44	1.17	1.01
	NTS	3.40	3.83	1.37	1.58	1.56	1.55	0.86	0.54	1.26	1.07
	CTS	3.50	3.31	1.87	1.37	1.53	1.16	0.48	0.44	1.28	1.07
	LSD at 5%	0.031	0.373	–	–	–	0.25	0.275	–	–	–

NT − No−tillage without rice straw NTS − No−tillage with rice straw
CTS − Conventional tillage with rice straw
LSD − Least significant difference

Recovery of controlled availability fertilizer

Recoveries of POCU S−100 N in the NT and NTS treatments in comparison with AS in the CTS treatments are shown in Fig.1 and Fig. 2. In 1994, at the young panicle formation stage (12 July), the N recoveries of POCU S−100 in the NT and NTS treatments were 46.1 and 44.2%, 41.0 and 44.8%, and 44.9 and 42.5 % in light clay soil, sandy loam soil and clay loam soil (Andisol), respectively, whereas, the recoveries of basal ammonium sulfate N were 43.1%, 32.8% and 31.1%, respectively. On the other hand, in 1995, the results in the NT and NTS treatments were 38.3 and 40.5 %, 36.7 and 40.0%, and 39.1 and 39.6 % in light clay soil, sandy loam soil and clay loam soil (Andisol), respectively; whereas the recoveries of basal ammonium sulfate N in the CT treatment were 38.8%, 21.4% and 23.0%, respectively. Namely, the difference of recoveries between the three soil types was much higher in the CTS treatments than in the NT treatments (Fig. 1). In 1994, at the harvest stage, the N recoveries in the NT and NTS treatments were 76.6 and 78.3%, 61.4 and 66.2%, and 74.2 and 80.0% in light clay soil, sandy loam and clay loam soil (Andisol), respectively, which were around 66−96 % of the nitrogen released from CAF at harvest time. On the other hand, in 1995, the results in the NT and NTS treatments were 78.8 and 82.7%, 72.8 and 77.6%, and 75.8 and 81.1% in light clay soil, sandy loam soil and clay loam soil (Andisol), respectively, which were around 84.6−96.2 % of the nitrogen released from CAF at harvest time. Kaneta (1995) reported that the recovery of the POCU S −100 in heavy textured, poorly drained clay soil was 79% at the maturing stage. The recoveries of CAF in the NTS treatments at harvest time were 1−5% greater than those in the NT treatments. It seems that the rapid decomposition of straw in the NT system may cause temporary immobilization of fertilizer N by promoting the microbial activity in the early growth stage. However, in the long run, there will be an increase in the contents of soil ^{15}N due to mineralization of ^{15}N fixed by microorganisms. However, the recoveries of basal ammonium sulfate N at harvest time were almost the same as they were at the young panicle formation stage. The recoveries of top−dressed AS were 40.0 − 76% in the 1st top dressing and 43 − 82.7% in the 2nd top dressing which were much higher than those in the basal application. The recoveries of ammonium sulfate were higher in the 2nd top dressing than in the 1st one, and those in clay alluvial soil were much higher than those in sandy alluvial soil and clay loam soil (Andisol) reflecting on the different drainage conditions and cation exchange capacity as are shown in the previous paper (Hossain et al., 2000). Takahashi et al., (1976) reported that almost all of the N disappeared at the commencement of ear−primodia formation, and the recoveries of basally applied N are generally about 30%. On the other hand, top−dressed N are absorbed rapidly within a week after application because the rice plant has already developed an extensive root system by the time of the top dressing. Therefore, the recoveries of top−dressed N are generally about 50% (Shoji and Gandeza, 1992).

Nitrogen uptake from soil and fertilizer

Nitrogen uptake by the rice plant is affected by N concentration and dry matter production. The N absorbed by the rice plant from the soil and fertilizer at the young panicle formation stage and at harvest time in 1994 and 1995 are shown in Fig. 3 and Fig. 4. In 1994, N absorbed by the rice plant in the NT and NTS treatments were lower than those of the CTS treatments in light clay soil, but they were statistically the same at harvest time. In 1995, the N absorbed by the rice plant in the NT and NTS treatments were significantly greater than those in the CTS treatments at the young panicle formation stage. However, they were statistically the same at harvest time. In 1994 and 1995, the N absorbed by the rice plant in the NTS treatments was almost the same as in the NT treatments.

In sandy loam soil, there were no significant differences among the total absorbed N of the rice plant in each treatment in 1994 at both stages. However, in 1995, the N absorbed by the rice plant in the NT and NTS treatments were statistically greater than those in the CTS treatments at both stages (Fig. 3 and 4).

In clay loam soil, there were no significant differences among the total absorbed N of the rice plant in each treatment of both years at the young panicle initiation stage. However, at harvest time, the total absorbed N of the rice plant in the NT and NTS treatments were greater than those in the CTS treatments in both years.

In 1994, the N absorbed from soil at the young

panicle formation stage in the CTS treatments of all types of soil were greater than those of the NT or NTS treatments. However, opposite results were obtained in light clay soil and sandy loam soils in 1995. At the harvest stage, the N absorbed from soil in the NT and NTS treatments was relatively lower than in the CTS treatment of all soils types, and the absorbed soil N of all treatments in all soil types in 1994 was greater than those in 1995 reflecting on the climatic conditions (Hossain et al., 2000). Phillips et al., (1980) reported that the native soil nitrogen of the NT system has a lower mineralization rate as compared to conventional tillage and the soil temperature in the NT system is lower than that in the CT system. However, higher soil temperature can hasten the mineralization rate of soil nitrogen.

The total nitrogen absorbed from ammonium sulfate (AS) in the CTS treatments of light clay soil, sandy loam soil and clay loam (Andisol) were 3.76 and 2.74, 2.85 and 2.03, and 2.86 and 1.96 g /m2 in 1994 and 1995, respectively, whereas nitrogen from POCUS −100 in the NT and NTS treatments were 5.36 and 5.52, 4.30 and 5.10, 5.19 and 5.31, and 5.48 and 5.79, 4.63 and 5.43, 5.60 and 5.68 g/m2, respectively, which were about two folds greater than nitrogen from AS. The total nitrogen absorbed from soil was about 50% more than the total nitrogen absorbed. Koyama (1971) and Broadbent (1978) have reported that fertilized rice obtains 50%−80% of its N requirement from the soil.

These results indicate that the application of CAF in a nursery box for the NT system increases the recoveries of fertilizer nitrogen by the rice plant in each type of soil compared to basal AS−N in the CT system, and thus could reduce environmental degradation caused by nitrogen fertilizer and have an effect on the growth and yield of the rice plant in different paddy fields.

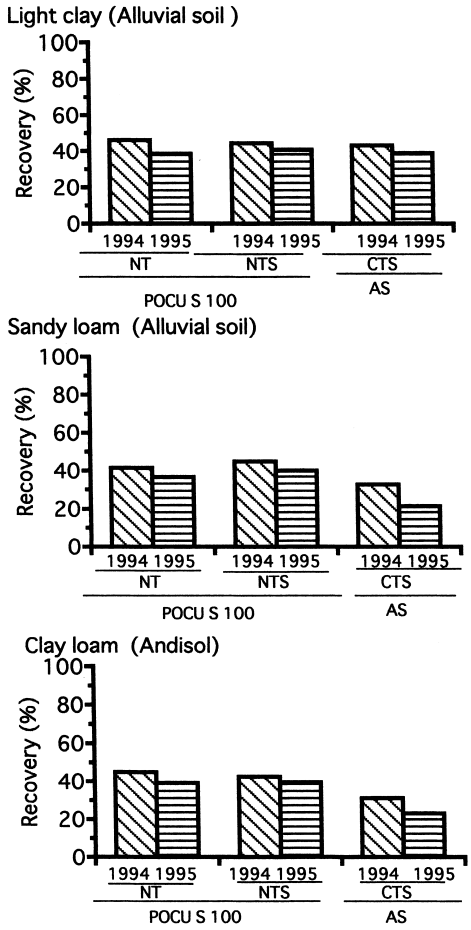

Fig. 1. Recoveries of fertilizer nitrogen by rice plants at young panicle initiation stage
NT-No-tillage without rice straw;NTS-No-tillage with rice straw; CTS-Conventional - tillage with rice straw; POCU S -Sigmoid type of Polyolefin Coated Urea; AS- Ammonium sulfate

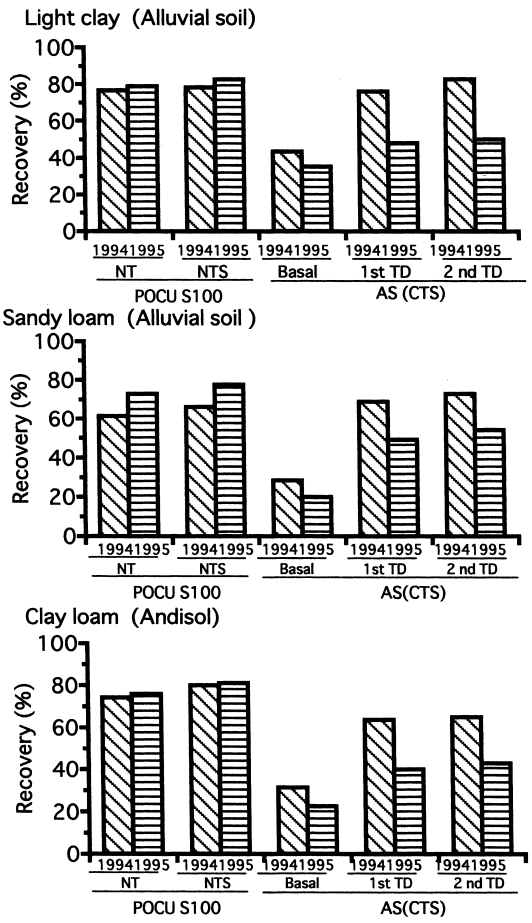

Fig. 2. Recoveries of fertilizer nitrogen by rice plants at harvest time
NT-No-tillage without rice straw;NTS-No-tillage with rice straw; CTS-Conventional - tillage with rice straw; POCU S -Sigmoid type of Polyolefin Coated Urea; AS- Ammonium sulfate;TD-Top dressing

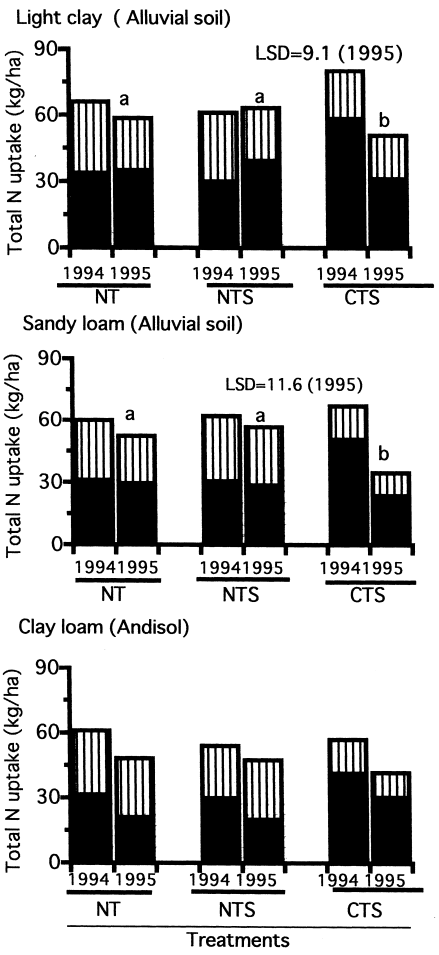

Fig.3. Nitrogen uptake of rice plant from soil and fertilizers at young panicle initiation stage

CTS- Conventional tillage with rice straw; NT - No-tillage without rice straw; NTS-No-tillage with rice straw

Fertilizer-N Soil-N

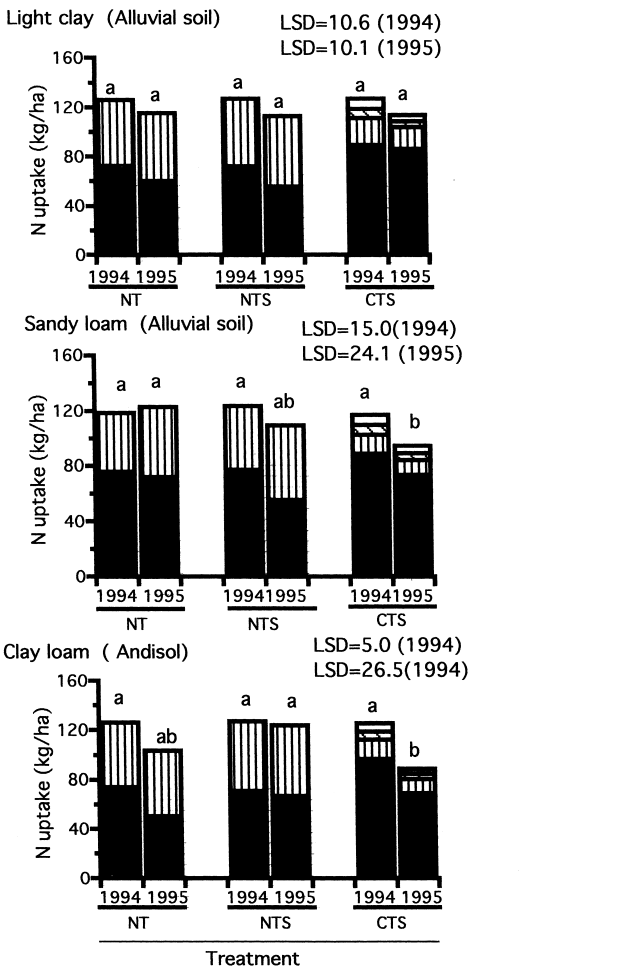

Fig.4. Nitrogen uptake of rice plant from soil and fertilizer at harvest time

NT - No-tillage without rice straw; NT-No-tillage with rice straw
CTS- Conventional tillage with rice straw;

2nd top dressing 1st top dressing Fertilizer-N Soil-N

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