

1.3 Joint Research

(1) List of joint research

Title of Joint Research Project

** A representative of joint research to carry out each project*

A-1) Land-atmosphere interaction in arid regions

Research on the atmosphere - ground surface interaction in arid region

Masao MIKAMI, Masahide ISHIZUKA, Yutaka YAMADA and Masato SHINODA*

An Estimation of the sand-storm conditions in Gobi Region in high spatial resolution

Dai MATSUSHIMA and Reiji KIMURA*

The ground thermal characteristic estimation from the satellite dataset

Masao MORIYAMA and Reiji KIMURA*

A-2) Advanced utilization of water resources and water conservation for irrigation

Developing a water-saving irrigation system using a vertically-installed TDR probe and a simulation model (2nd phase)

Kosuke NOBORIO, Hiroyuki OCHIAI, Tomotsugu YAZAKI and Hisao ANYOJI*

Irrigation management and related material dynamics in large irrigation scheme

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A-3) Physiological and morphological responses to dry and saline conditions in plants

Improvement of nutrient uptake and economic yield by silica application to agricultural plants under drought conditions.

Jun ABE and Wataru TSUJI*

Mechanisms of drought and salt tolerance among millets

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Responses to environmental stresses of some plant species grown in desertified grassland in North-East Asia

Hideyuki SHIMIZU, Yasumi YAGASAKI, Shoko KOBAYASHI, XU Zhenzhu, ZOU Chunjing and Wataru TSUJI*

A-4) Monitoring and modeling of plant production and ecosystem change in drylands

Evaluation of drought and salinity tolerance in wheat with alien chromosomes

*Hisashi TSUJIMOTO**, *Hiroyuki TANAKA* and *Atsushi TSUNEKAWA*

Interaction between biotic and abiotic factor in dry grassland - A case study in both allelopathy and drought-

*Eiji NISHIHARA** and *Mitsuru TSUBO*

Cultivar Differences for Maintenance Capacity of Green Leaves in Crop Plants under Desiccated Soils - Information for Improvement of Crop Production Model

*Tohru KOBATA**, *Fumihiko ADACHI* and *Mitsuru TSUBO*

A-5) Eco-physiology of tree tolerance to water deficiency and salinity

Drought, salinity and anaerobic stress tolerances of Populus species widely planted in China

*Fukuju YAMAMOTO**, *Huiping MAO* and *Norikazu YAMANAKA*

Specific characteristics for salt tolerance mechanism of halophilous plants

*Shingo TANIGUCHI**, *Tsuneo NAKASUGA* and *Norikazu YAMANAKA*

A-6) Soil degradation in arid areas

Temporal and spatial variation of salt profile of upland field in semi-arid region under intermittent irrigation.

*Taku NISHIMURA**, *Chihiro KATO* and *Mitsuhiro INOUE*

Characterization of soil degradation process by direct infiltration water sampling

*Yasushi MORI**, *Tadaomi SAITO*, *Junichiro IDE*, *Tahei MORISAWA*, *Naokazu EGUSA* and *Mitsuhiro INOUE*

Prediction and control of salt accumulation in the upper root zone under sub-surface drip irrigation

*Haruyuki FUJIMAKI** and *Mitsuhiro INOUE*

B-1) Joint research on the prevention of desertification and the development and application of drylands through network of research institutes

Studies on the 'Grain for Green' project and Social Development in the Loess Plateau

*Hiroshi NAWATA**, *Ryouta NAGASAWA*, *Renya SATO*, *Buhou HOSHINO*, *Koichi MURAMATSU*, *Kanako KODAMA*, *Ruichen JIA* and *Norikazu YAMANAKA*

An Interdisciplinary Study on the System of Egyptian Irrigation

*Hiroshi KATO**, *Mitsuru TSUBO*, *Nobuhiro MATSUOKA*, *Eiji NAGASAWA*, *Erina IWASAKI* and *Reiji KIMURA*

C) Free Subject

Developing a database of vegetation in the dry steppe of Mongolia

*Nachinshonhor URIANHAI** and *Masato SHINODA*

Reconstruction of Environmental Changes at Arid Regions

*Kaoru KASHIMA** and *Masato SHINODA*

Wind tunnel experiments on a critical angle for wind ripple climbing and descending

*Yoshinori KODAMA** and *Masato SHINODA*

Climatological dynamics of drought and dzud in Mongolia

*Yuki MORINAGA** and *Masato SHINODA*

Experimental study on carbon dioxide exchanges for a semi-arid grassland ecosystem

*Tomoko NAKANO** and *Masato SHINODA*

Mechanism and its seasonal variation of the rainfall in Mongolia

*Keiji KIMURA** and *Masato SHINODA*

Trends of Sustainable Urban Development in Arid Land

*Hiroki YAMASHITA** and *Masato SHINODA*

Trends of Industrial Development in Arid Land

*Hirofumi KITAGAWA** and *Masato SHINODA*

The landscape preservation activities and change of geographical feature and vegetation of Tottori sand dunes.

*Naru TAKAYAMA**, *Toshinari YAMAZAKI*, *Kiyoshi IWAYA*, *Haruhiko YAMAMOTO* and *Reiji KIMURA*

Nondestructive estimation of leaf water potential of citrus by NIR spectroscopy

*Haruhiko YAMAMOTO**, *Kiyoshi IWAYA*, *Naru TAKAYAMA*, *Youko HARADA*, *Shie IJIMA* and *Reiji KIMURA*

Measurement of Latent Heat Flux by Eddy Correlation Method with Sonic Anemometer and Fine Thermocouple

Nobuhiro MATSUOKA and Reiji KIMURA*

Estimation of reference evapotranspiration in slanting surfaces using GIS technique

Masahiro TASUMI, Toshikazu OHSHIMA and Reiji KIMURA*

A Study on Water Making System Available for Improvement of Living Environment in Arid Land

Kotaro TAGAWA, Yutaka HARA, Tsutomu HAYASHI and Reiji KIMURA*

Saturated-unsaturated water flow to investigate solute movement

Tadao AODA and Hisao ANYOJI*

Ecophysiological studies on noxious weeds in semi-arid areas

Yukihiro SUGIMOTO and Tomoe INOUE*

Influence of aeolian sediment on carbon and nitrogen dynamics of surface soil in the steppe region, Mongolia

Maki ASANO, Kenji TAMURA and Atsushi TSUNEKAWA*

Comparative study on soil factor affected to biological production at desert

Kazuhisa HASEGAWA, Kensuke KONDO and Atsushi TSUNEKAWA*

Viscoelastic analysis of root cell walls under different growth conditions and humidity changes in vitro

Eiichi TANIMOTO and Wataru TSUJI*

Interactions between gas exchange rate and soil water regime of defoliated crops exposed to water stresses

Hideki ARAKI and Wataru TSUJI*

Evaluation of growth and drought tolerance under strong irradiance of the transgenic plants with higher aldehyde-detoxification ability

Junichi MANO and Wataru TSUJI*

Relationship of Groundwater Flow and Electric Conductivity -Case Study of BYOUBUSAN Sand Dune Area, Aomori Prefecture-

Koh KATO, Miyoshi KADONO, Choichi SASAKI and Mitsuhiro INOUE*

Vegetable growth and quality under saline water irrigation

Kensuke KONDO, Ould Ahmed and Mitsuhiro INOUE*

Alternative selection to prevent salinity accumulation in soil by using capillary barrier of sand-gravel layers.

Toshihiro MORII and Mitsuhiro INOUE*

Evaluation of pore-air behavior in unsaturated soil and its influence to hydraulic conductivity

Kohji KAMIYA and Mitsuhiro INOUE*

Long term changes of soil physical properties by adding sulfar materials into alkaline soil.

Yuichi ISHIKAWA and Mitsuhiro INOUE*

Research on Non-destructive measurements of unsaturated seepage flow by using Ground-penetrating radar in arid land

Yuji TAKESHITA, Seiichiro KURODA, Kosuke KODANI, Yuuki NAKAMURA ,
Taku YAMASHITA, Masafumi NAKAMURA, Shinya MORIKAMI and Mitsuhiro
INOUE*

Development of measurement method of continuous air content and air permeability in soil using the principle of sound resonance

Kimihito NAKAMURA, Kohtaro FUKADA and Mitsuhiro INOUE*

Quantification of water and solute balance in a shallot field using a direct sampling method

Koji INOSAKO and Mitsuhiro INOUE*

Preferential flow effect on solute leaching for sandy soil in arid land

Hiroyuki CHO and Mitsuhiro INOUE*

Studies on grape vine growing by drip irrigation

kennji TANABE, Shippin WANG and Mitsuhiro INOUE*

Research on groundwater management using plant transpiration and water uptake

Yoshinobu KITAMURA, Katsuyuki SHIMIZU, Atsushi KIDO, ABOU EL HASSAN
and Mitsuhiro INOUE*

Solution transport driven by the density in soil under the salt accumulation

Yasutaka KIHARA and Mitsuhiro INOUE*

The Utilization of Indigenous Technology for Water Resources and Rural Socio-Economic Development - Iran, Oman, Inner Mongolia-

Ryuichi HARA and Mitsuhiro INOUE*

Fine root distribution pattern semi-arid area

Ryunosuke TATENO and Norikazu YAMANAKA*

Experimental studies on the salt tolerant characteristics of halotolerant plant and remediation and conservation of the saline soil

Kenji IWAMA, Mami Sakai, Kohji KOBAYASHI and Norikazu YAMANAKA*

Hydraulic capacity of xylem and stomatal response for drying in two *Salix* species, *Salix psammophila* and *Salix matsudana* growing in arid and semi-arid area, China

Ken YOSHIKAWA, Naoko MIKI, Lingli YANG, Mayumi OGASA and Norikazu YAMANAKA*

Analysis of control factor for decomposition in arid systems

Nobuhiro KANEKO and Norikazu YAMANAKA*

Evaluation of salt tolerance and water and nutrient use of coastal plants using stable isotopes

Naoko MATSUO, Nobuhito OHTE, Rina KOYAMA and Norikazu YAMANAKA*

Ecohydrological comparisons between natural and artificial forests in Loess Plateau, China

Kyoichi OTSUKI, Tomonori KUME and Norikazu YAMANAKA*

The effect of the soil eutrophication caused by pine wilt disease on a ecosystem.

Kazuyoshi FUTAI, Norikazu YAMANAKA, Fukuju YAMAMOTO, Ryohta KATAOKA, Takashi Mii, Takeshi TANIGUCHI and Norikazu YAMANAKA*

(2) Summary of Joint Research

A-1) Land-atmosphere interaction in arid regions

Research on the atmosphere-ground surface interaction in arid region.

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An analysis of threshold friction velocity of dust outbreak, which is important for the atmospheric environment in East Asia, was made using data obtained at a fallow wheat field in Australia. Friction velocity evaluated at a fallow wheat field did not show a strong particle size

dependency, although it was found in the laboratory experiment and saltation theory. It is due to multi-sized particle size distribution at actual land surface. And suppression of saltation sand flux due to weak crust, which was formed after weak rainfall, was also observed.

We have conducted intensive and long-term monitoring of dust outbreak processes at semi-arid grassland in Mongolia from 2008 Spring. Using long-term monitoring data from 25 April to 26 May, we analyzed the basic characteristics of dust outbreak at this area. Totally 38 events were monitored and total amount of saltation sand flux was evaluated. It was found that large event will control the total amount of sand flux. The spectrum peak of flux was around 300 μ m in diameter and it was larger than that of the Taklimakan desert and Austraria fallow wheat field. This also correlated with parent soil size distribution at this area. For this, it was suggested that, for better representation of saltation sand size distribution, information of parent soil size distribution is one of the key information.

An Estimation of the sand-storm conditions in Gobi Region in high spatial resolution

Dai MATSUSHIMA and Reiji KIMURA***

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This study aims to show feasibility of estimation of soil moisture of subsurface and wind erosion on surface in semi-arid region, using the thermal inertia which retrieved from a surface heat budget model. Meteorological and wind erosion data employed to this study were acquired at Bayan-Unjuul, Tov Aimag, Mongolia from April to June, 2008, in order to investigate the feasibility. The results showed the thermal inertia correlated with the volumetric soil moisture content, and wind erosion events almost occurred when values of the thermal inertia were less than $1100 \text{ Jm}^{-2} \text{ K}^{-1} \text{ s}^{-1/2}$ and the wind was high. Consequently, the feasibility was verified. In this study, satellite data was subjected to be used as the surface temperature instead of ground level data in the method employed to estimate distribution of soil moisture around the observation site. This objective was not accomplished during the study period.

The ground thermal characteristic estimation from the satellite dataset

Masao MORIYAMA and Reiji KIMURA***

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Two kinds of surface thermal characteristic monitoring methods are established. The first one is the ground measurement based thermal admittance estimation. This is based on the energy balance formula at the surface. From the 4 components radiometer which can observe the

upward/downward shortwave/longwave radiation, the admittance can be estimated. By using the ground measurement data at the ALRC MONGOL site, this method shows the possibility of the thermal characteristic estimation. The second is the satellite based thermal characteristic monitoring method. Some thermal factors which contained in the satellite detected thermal radiation are analyzed and the maximum shortwave radiation divided by the day/night temperature difference shows the good correspondence with the total outgoing energy from the surface.

A-2) Advanced Utilization of Water Resources and Water Conservation for Irrigation

Developing a water-saving irrigation system using a vertically-installed TDR probe and a simulation model (2nd phase)

Kosuke NOBORIO, Hiroyuki OCHIAI*, Tomotsugu YAZAKI* and Hisao ANYOJI***

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** Arid Land Research Center, Tottori University

Soil water content and matric potential were measured under a drip irrigation using a multi purpose time domain reflectometry probe. After soil water content reached a quasi steady state, irrigation water was switched to a KCl solution (0.2 g/L). When electrical conductivity, EC, was almost constant, the KCl solution was switched back to tap water. In this manner, solute and water front location was estimated. Using the solute and water front location, a characteristic length for unsaturated water flow and saturated hydraulic conductivity were estimated using analytical solutions. The values estimated with solute and water front location agreed well with those estimated using water content and matric potential measured with the multi purpose TDR probe.

Irrigation management and related material dynamics in large irrigation scheme

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For improving water management in irrigation districts in the arid areas, a new technique for diagnosis of water quality with use of isotope tracers was developed and hydrological models were developed to represent salinity dynamics.

It became possible to determine whether salinity problem in the coastal area is attributed to sea water intrusion or not by analysis of strontium isotope ratio of irrigation, shallow water table and drainage water in that area. High correlation between strontium content, isotope ratio and salt

content was found in the water in the surface zone.

The two-dimensional groundwater hydrology model was improved to represent saltwater dynamics with better precision. A three dimensional model was also developed and its precision is being tested.

Analysis by use of the irrigation management performance assessment model revealed the dominant influence of canal seepage water and tail water on shallow water table fluctuation.

A-3) Physiological and Morphological Responses to Dry and Saline Conditions in Plants

Improvement of nutrient uptake and economic yield by silica application to agricultural plants under drought conditions.

Jun ABE and Wataru TSUJI***

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As silicon deposition was found in surface structure of juvenile fruit of cucumber and hairs of juvenile pods of soybean, we assumed that silica application may enhance the survival rate of fruit and pods until harvest under drought. A pot experiment was performed to confirm this hypothesis. In results, no significant effect was detected in soybean. In cucumber, the number of juvenile fruit was not affected by silica application in either normal and drought conditions. However, the survival rate of fruit until harvest was improved by silica application under drought condition.

Mechanisms of drought and salt tolerance among millets

Asana MATSUURA and Wataru TSUJI***

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Seeds of *Setaria italica*, *Panicum sumatrense*, *Panicum miliaceum* and *Setaria glauca* were sown in sandy soil in PVC tubes (7.5 cm × 70 cm). Water stress treatment was conducted by changing water table 30 days after sowing. For the wet treatment, PVC tubes were submerged in the nutrient solution as water table was 45 cm at harvesting. The PVC tubes were also submerged in the nutrient solution as water table was 65 cm for the stress treatment at harvesting. At heading, a half plant was exposed to another treatment, water stress treatment was conducted on only after heading (WD). Water stress treatment was only conducted before heading (DW).

Water stress treatment significantly reduced soil water content at 0-40 cm depth of the PVC tubes. Drought susceptible index (DSI) of *S.italica* and *S.glauca* was 0.25 and 0.53 and those of

P.miliaceum and *P.sumatrense* was 1.30 and 1.63, respectively. This result showed that *S.italica* was most drought tolerance and *Setaria* was more drought tolerant than *Panicum*. DSI of *Panicum* species were larger than 1.0 that showed drought susceptible plant. Grain yield of *S.italica* decreased to 90 % of the control and that of *S.glauca* decreased to 70 % by the water stress treatment. Contrastingly, grain yield of *P.miliaceum* and *P.sumatrense* remarkably decreased to 36 and 20 % of the control by the water stress treatment. Grain yield largely decreased by the stress treatment before heading in *S.italica*, *S.glauca* and *P.sumatrense*, however, similar decrease in *P.miliaceum*. The reduction of grain yield was attributable to number of grain per panicle for *S.italica* whereas number of panicles for *S.glauca*, *P.miliaceum* and *P.sumatrense*. Significant correlation was observed between total dry weight and grain yield for all species. Rooting depths were deeper for *S.glauca*, *P.miliaceum* and *S.italica* by the stress treatment but not for *P.sumatrense*. Total root weight and root weight in available water content at dry treatment for *Setaria* were larger than *Panicum*. There was significant correlation between total root weight and total dry weight in *S.glauca*, *P.miliaceum* and *P.sumatrense*. There was also significant correlation between the root weight in available water content and total dry weight in *Panicum*. Dry matter increase during all growing period significantly correlated with plant growth rate before heading (PGRbh) in *S.italica*, *S.glauca* and *P.sumatrense*, and with plant growth rate after heading (PGRah) in *S.italica*, *P.miliaceum* and *P.sumatrense*. Both net assimilation rate (NAR) and mean leaf area (MLA) were attributable to PGR in *S.italica* and *P.sumatrense*, MLA was attributable to PGR in *S.glauca* and NAR in *P.miliaceum*.

In conclusion, a drought tolerance of *S.italica* is considered to increase root growth at available water for maintenance of water and nutrient uptake, and keep photosynthesis and leaf growth to maintain plant growth.

Responses to environmental stresses of some plant species grown in desertificated grassland in North-East Asia

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Desertification is one of the most serious ecological/environmental problems in arid/semi-arid region. The most effective way for desertification combating and ecological restoration is the vegetation rehabilitation. However, we have less knowledge on the growth of key species grown in desertificated area. *Salsola collina*, *Chenopodium album*, *Artemisia frigida* and *Artemisia ordosica* are such important key species in Horqin sandy land, Inner Mongolia, China. In this study, we investigated growth responses to water stress of these species. Under the conditions of 25/15C (light/dark) in air temperature, 50/60 % in relative air humidity, plants were treated with different water supply, such as 30, 60, 90 and 120 mm per month. Each species showed the tendency of growth decrease as water stress increased, while the extent/significance was differed

among species. The growth of *S. collina* and *C. album* were not significant among the water treatments of 60-120 mm. *A. frigida* showed the significant growth reduction with increasing water stress, while the maximum growth was observed in plants treated with 90 mm water supply. From these results, we consider the effective way how to use these plants for desertification rehabilitation.

A-4) Plant Production and Utilization in Arid Lands and Salt-Accumulation areas

Evaluation of drought and salinity tolerance in wheat with alien chromosomes

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Some strains of *Aegilops tauschii*, a wild species of wheat, grow naturally in dry lands where wheat cannot survive, and thus these seemed to carry drought tolerant genes. Here we analyze drought-tolerant related physiological characters of synthetic hexaploid wheat strains that were produced by hybridization between *Triticum durum* cv. Langdon and *Ae. tauschii* collected from different regions. In addition, we isolate SSR markers linking to the QTLs of drought tolerance by linkage disequilibrium analysis.

Materials and methods

(Experiment 1) Evaluation of drought tolerance in vegetative stage: Nineteen strains of synthetic hexaploid wheat (SW) (Matsuoka et al. 2007) and common wheat cultivar 'Chinese Spring' (CS) as genetical control were cultivated in glasshouse in ALRC. The water content of the soil was controlled in the range of 6 ? 9% (unstressed condition) till 20 days after sowing. The plants were then stressed by shortage of water (2 ? 5 %). Photosynthesis speed at uppermost leaves was measured in 33, 34 and 35 days, and dry weight of the stem and leaves at 36 days were measured.

(Experiment 2) Linkage disequilibrium analysis: Using SSR markers known to be located on the D genome of common wheat, we analyzed polymorphism of SW, CS and durum wheat cultivar 'Langdon'. The data in Experiment 1 and this molecular analysis were input in a software GGT2.0 and selected molecular markers that associated with the drought-tolerant characters.

(Experiment 3) Based on the information of Experiment 1, here we use four SW (three tolerant and one sensitive), CS and another common wheat cultivar 'Cham 6' that was released from ICARDA as drought tolerant cultivar. The condition of cultivation is the same as Experiment 1.

Results and discussion:

(Experiment 1) All of the stressed strains showed reduction of the dry weight. From the reduction rate comparing to environmental controls, we chose four drought tolerant strains and three sensitive ones.

(Experiment 2) Of the 31 markers showing polymorphism, three showed tight link with the

characters of drought tolerance.

(Experiment 3) In all strains drought stress caused reduction of dry weight, photosynthesis speed, stomata conductance and water potential. One strain of SW showed less reduction of photosynthesis speed and dry weight in stressed condition than those found in 'Cham 6' that is a practical cultivar tolerant to drought. Furthermore, significant correlation between photosynthesis speed and stomata conductance in SW indicated that the genetic variation was mainly controlled by stomatal movement.

**Interaction between biotic and abiotic factor in dry grassland
- A case study in both allelopathy and drought -**

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Interaction between biotic and abiotic factor in grassland was conducted by using *Artemisia adamsii*, which is expanding in Mongolian grassland. The allelopathic activity and pathway of *A. adamsii* were investigated while comparing to the growth of the other plants. As a result, the strongest allelopathic pathway of *A. adamsii* was shown from the volatile compounds than the other pathways like from root exudate and leaching. EC50 of the volatile compounds released from *A. adamsii* was about 0.035g in the experiment. In addition, the compounds inhibited the growth of seedling development and seed germination in the other plants. The six candidate allelopathic compounds from *A. adamsii* leaves were mainly identified by GC-MS. After conducting the bioassay by six identified volatile compounds, cineol, bornel and camphor in six volatile compounds completely inhibited seed germination of test plant. The phenomenon was the same as the bioassay result by volatile compounds from *A. adamsii* leaves. Therefore, we considered that three volatile compounds from *A. adamsii* leaves were candidate allelopathic compounds.

**Cultivar Differences for Maintenance Capacity of Green Leaves in Crop Plants under
Desiccated Soils - Information for Improvement of Crop Production Model**

Tohru KOBATA, Fumihiko ADACHI* and Mitsuru TSUBO***

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The effect of soil desiccation during the post-anthesis period in rice (*Oryza sativa* L.) on green leaf area was evaluated to develop a simple base model of crop production. Seven rice cultivars originated from different locations were grown in pots: diameter of 0.08 and depth of 1.0 m filled back and sand soil mixture. At the anthesis watering was terminated from half of the pots.

Fraction of transpirable soil water (FTSW) as relative soil water content decreased from around 1.2 to 0.3-0.4 within 40 day after anthesis. Responses of relative leaf area of the initial area at heading to FTSW differed among cultivars. The relationship between the relative value and FTSW was shown by an exponential equation in each cultivar. Therefore, the maintenance capacity of green leaf would differ among cultivars and the difference could be indicated by the several parameters of the equation.

A-5) Eco-physiology of Tree Tolerance to Water Deficiency and Salinity

Drought, salinity and anaerobic stress tolerances of Populus species widely planted in China

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Growth, photosynthesis, and Na⁺, K⁺, Mg²⁺, and Ca²⁺ distribution were examined in 2-year-old hydroponically cultured *Populus nigra* and *Populus alba* cuttings exposed to salt stress (0, 50, or 100 mM NaCl) for 4 or 6 weeks and to non-aeration stress for 1 or 3 weeks, followed by a 3-week aeration period in 2/5 Hoagland solution. Salt stress with 100 mM NaCl totally inhibited shoot elongation in *P. nigra* cuttings. Combined salinity and non-aeration inhibited height increase to a greater degree than either stress alone in both species. Simple salt stress did not affect diameter increase in *P. alba*, whereas combined high salinity (100 mM NaCl) and non-aeration inhibited diameter increase. Growth and biomass accumulation were more sensitive to salt stress in *P. nigra* cuttings than in *P. alba*, although *P. alba* showed a more rapid decrease in photosynthesis in response to non-aeration stress. Ion distribution in the leaves and roots differed between species. In plants exposed to 100 mM NaCl, Na⁺ content in leaves was 55.6 mg/g (6W(+O₂)) and 67.1 mg/g (6W (-O₂)) in *P. nigra*, compared to 8.8 mg/g and 12.3 mg/g, respectively, in *P. alba*. *P. alba* was superior to *P. nigra* in terms of Na⁺ exclusion capacity, such that most of the absorbed Na⁺ was confined to the root system, with little reaching the leaves. The distributions of K⁺, Ca²⁺, and Mg²⁺ in the leaves and roots of each species under the two stressors were also analyzed.

Specific characteristics for salt tolerance mechanism of halophilous plants

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This research group has continuously executed investigations on the tolerance to salinity of mangrove species in Okinawa. In this study, componential analysis of materials with a high tolerance to salinity among five families and seven kinds of mangrove growing in Japan was conducted on individual Hirugidamashi (*Avicennia marina*) that formed a zonal colony in the area nearest the sea where the influence of the tide was the strongest, and output from leaf salt glands to the outside of the body was measured. The results are expected to serve as basic material to clarify analysis of studies on the excretion mechanism involved in the water intake function of Hirugidamashi (*Avicennia marina*) to be executed in the future (in relation to flood frequency and time of exposure to seawater), as well as for investigation of salt-related behavior, change patterns and the salt-proofing features of the mechanism.

Investigation in the Shioya area of Okinawa Prefecture's Uruma City extracted healthy leaves as mentioned above from the apex module of side branches in five Hirugidamashi (*Avicennia marina*) specimens (ground-side diameter 1.2 ? 3.5 cm, tree height 105 ? 170 cm). The leaf areas were 14.24 ? 21.36 cm². The individual leaves were put into sample bottles, both sides were rinsed for 30 seconds in distilled water, and the material exhausted from the salt glands was gathered. The collection period was November 28 ? 30, 2008, and a total of four collections were made at intervals of twelve hours from 23:00 p.m. during the first day's ebb tide. Thus, collections were made only in ebb tide conditions. The density of Na, Ca, K, and Mg in the gathered samples was analyzed using an atomic absorption spectrometer.

The results showed the dominance of Na (collection time average: 48.83 ? 61.49 ppm/100 cm²), followed by Ca (collection time average: 4.61 ? 7.82 ppm/100 cm²), K (collection time average: 3.40 ? 4.00 ppm/100 cm²) and Mg (collection time average: 1.06 ? 1.47 ppm/100 cm²). This tendency was the same for all collection times, regardless of whether they were during the day or at night. No great disparity was found in the values of salt analysis among the five samples, and the collection method for execution in the present study was identified as an effective way of gathering salt exhausted from salt glands.

In future studies, it will be necessary to increase the number of samples gathered, observe daily and seasonal changes in the amount of salt exhausted in ebb tide and flood tide conditions, and analyze the relationships between salt exhaust and external habitat factors such as flood frequency (i.e., tide changes), temperature, humidity, wind velocity and sunshine duration.

A-6) Soil Degradation in Arid Areas

Temporal and spatial variation of salt profile of upland field in semi-arid region under intermittent irrigation.

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We have 2-years' in situ solute and moisture monitoring data at irrigated maize fields in Gansu

province, PR China. To evaluate conventional irrigation practice and propose alternative, higher efficiency irrigation scheme we conducted numerical simulation using Hydrus-2D and 1-D version 4. Even without any consideration on hysteresis response of soil moisture to irrigation practice was well represented by numerical simulation. However, quantitative evaluation of rise in soil moisture following to irrigation practice and transport and accumulation of solute was not satisfactory. This would make water and solute balance in the simulation worse and thus less reliable. Thus, upon discussion with collaborator in the ALRC we decided to consider contribution of hysteresis on numerical analysis. We arranged soil water retention data and derived a primary hysteresis function of soil water retention curve. Numerical simulation is still going on and upon the results will be summarized we will prepare article for submitting journal.

Characterization of soil degradation process by direct infiltration water sampling

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Soil infiltration water and runoff water were sampled and analyzed to characterize pollutant load from non-point source in two planted forests (SR1: delayed thinning operation, SR2: thinning operation). Especially, this study focused on the heavy rain which is reportedly increasing because of global warming. Glass fiber wick samplers were used for infiltration water sampling. As results, stream water analysis resulted that low infiltration property of SR1 showed higher and more scattered pollution load than SR2 which has well-infiltration properties. Infiltration water quality was positively correlated with pollutant load in stream water. During the rainfall, in general, environmental pollution load density in soil infiltration water was negatively correlated with sampled soil water volume. This could be caused by dilution effect. However, after the heavy rain, the efficiency of infiltration water sampling was recovered showing soil pores were almost saturated. Moreover, infiltration water quality showed higher concentration than other rainfall events. The trend was clear in SR2(with thinning operation). Because of high infiltration properties, pollution load from the soil surface easily reached to the depth of glass fiber wick.

Prediction and control of salt accumulation in the upper root zone under sub-surface drip irrigation

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We have conducted a greenhouse experiment using two soil tanks in each of which 16 TDR probes were inserted horizontally. Tottori dune sand was filled and soybean was sown. After the leaf area became about 300cm², subsurface drip irrigation from a porous pipe inserted at a depth of 12 cm with saline water 3000 ppm NaCl solution was started. When the soil was salined enough to retard transpiration, leaching through the subsurface porous pipe was performed. In spite of large amount of irrigation, the saline water did not reach to the soil surface: most of the irrigated water flew downward. We have also incorporated root water uptake submodel into our numerical model for two-dimensional water and solute movement. We have added thermal vapor diffusion by plainly inter/extrapolating measured soil temperature. Although we have obtained fair agreements between measured and simulated water content and salinity, handling of hysteresis for sand remains a difficult task.

B-1) Combating Desertification and Developmental Utilization in inland China

Studies on the 'Grain for Green' project and Social Development in the Loess Plateau

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The purpose of this study is to examine effects and problems of the 'Grain-for-Green' project of China, which progressed halfway through the onset, from the viewpoints both of ecological recovery and of changes in land use as well as rural subsistence economy. The 'Grain-for-Green' project tries for ecological recovery of the upper reaches of the Huang-He and the Yangtze River, by prohibition of grazing and transformation of cultivated field in steep slopes into afforested areas. This project aims at not only ecological recovery but also rural economic development, because improvement of peasant economy is regarded as a key for future sustainability of the forests. The authors used remote sensing analysis to examine the extent of ecological recovery after the onset of the project on the one hand, and conducted intensive field research in Beisongta Village, Ansai Province, Shanxi to investigate the extent of change of traditional land use and subsistence economy on the other hand. The result of remote sensing analysis showed marked recovery of land cover, that indicates the effect of afforestation and the prohibition of gazing. Though peasant subsistence economy were greatly affected by the prohibition of sheep and goats grazing and decrease of cultivated land, hothouse cultivation which started at the same time as the

project, seems to make up for them so far.

An Interdisciplinary Study on the System of Egyptian Irrigation

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An interdisciplinary study on the system of irrigation in Rashda village of Dakhla Oasis

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Rashda village is one of the villages in Dakhla Markaz, Wadi Gedid governorate. We conducted field survey, especially on the irrigation and drainage system in March 2009. Different to the Nile delta of Egypt where the cultivation depends on access to land, the cultivation in Rashda depends on the access to the water source (well). Arrangement of irrigation and drainage system at the examined irrigation block was similar with the Japanese standard. Four wells in the irrigation block were examined. Groundwater gushed out continuously from three wells, and groundwater was pumped up from one well by a diesel engine for 12 hours per day. So far as we examined, there was enough water for irrigation at the irrigation block. In the summer season, paddy rice is planted in this area. Treatment of drainage water was much difficult because there were no natural rivers in this area. A punping station was built at the end of the drainage system. Then, drainage water was pumped up to a drainage pond at a higher place. We also examined the similer drainage system and a pumping station near Rashda village. Sewage water from Rashda village was treated with a different drainage system from agricultural water.

C) Free Subject on Arid Land Studies

Developing a database of vegetation in the dry steppe of Mongolia

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This study as a part of a long-term monitoring research for the relationship between rainfall,

grassland productivity and nomadic pastoralism in the Mongolian grasslands.

We got following results in this research:

1. The rainfall has a significant effect on the grassland productivity and species composition of the plant community.

It was clarified that annual rainfall and productivity of grassland community had a positive correlation, the above-ground biomass significantly changed year to year. Rainfall also strongly affected the species composition of the grassland communities.

2. We found the following relationship between rainfall, grassland productivity and grazing intensity:
A large rainfall → Higher plant productivity → relatively high grazing intensity and,
a small rainfall → poor plant productivity → low grazing intensity

It is shown that grazing intensity is well adjusted to the natural conditions by the nomadic pastoralism. There are very important functions on the sustainability of the grassland vegetation use, which was suggested.

3. A detailed investigation is needed: an exact relationship between grassland productivity and the grazing intensity which is adjusted by nomadic pastoralism in the Mongolian grasslands.

Reconstruction of Environmental Changes at Arid Regions

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The field surveys to reconstruct the environmental changes at arid regions were done in Mongolia, North-western China and Egypt in 2008. The sedimentary studies of inland lakes and peat lands presumed the fluctuations of precipitation and evaporation rates in millennium scale. The comparison surveys at Koyam-ike and Tougo-ike, Tottori Prefecture have started in 2008. The drilling at the both lakes will be done in 2009.

Wind tunnel experiments on a critical angle for wind ripple climbing and descending

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The critical angles of wind ripples for climbing up or descending down on various slopes in the

Tottori Sand Dunes were surveyed using a digital protractor. In addition, inclined wind tunnel experiments were conducted to observe wind ripple formation and movement. The field survey documents that the critical angles of wind ripples are 24 degree for climbing and 17 degree for descending, while in the wind tunnel experiments, 18 degree for climbing and 14 degree for descending in our experimental conditions. A simple model for explaining the critical angles was proposed using the angle of repose and windward & leeward slope angles of wind ripples.

Climatological dynamics of drought and dzud in Mongolia

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Monthly temperature and precipitation from 25 stations for 1940-2002, 10-day snow depth for 300 stations during 1980-2003, archived by the Institute of Meteorology and Hydrology, were used for the statistical analysis to assess the recent dzud of 1999/00 to 2001/02. Using the winter and summer average temperature and precipitation data, Syear, the dzud index was calculated. High Syear means severe dzud conditions from meteorological point of view .

Results are as follows:1)Syear and the number of dead livestock over Mongolia during the 63 years show good correlation. 2) Both Syear and the number of dead livestock were high during the three years of the recent dzud. 3) Syear were high during 1940' and 1950's mainly due to the severe(cold and snowy) winter years. 4)Severe drought which continued for three years since 1999/2000 were the cause for the high Syear during the recent dzud. 5) Though the Syear were high during the recent dzud years, winters were not so severe as winter temperature increased since the end of 1980's. However, winters are becoming more snowy indicating the increased risk of snowy dzud.

Experimental study on carbon dioxide exchanges for a semi-arid grassland ecosystem

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Carbon dioxide exchanges between the atmosphere and land ecosystems are important to figure out the global carbon budget. We focused on the ecosystem respiration from a semi-arid grassland ecosystem. In our study, the ecosystem respiration was measured in the growth chamber of ALRC, Tottori University by a closed-chamber technique. Along with the respiration measurements, soil temperature, soil moisture, and plant biomass were determined. From the measured data of ecosystem respiration and environmental variables, their relationships were examined. Individual

rates of respiration showed significant rank correlations with soil temperature, soil moisture and plant biomass. We will continue the experimental measurement and examine the quantitative relationships between the ecosystem respiration and environmental variables in the future.

Mechanism and its seasonal variation of the rainfall in Mongolia

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The present study investigated the seasonal variation of cyclone activity from 1993 to 2002 in relation to drought occurrence in Mongolia during summer. This study also examined the moisture source of rainfall related to the cyclone activity.

Firstly, National Centers for Environmental Prediction / National Center for Atmospheric Research (NCEP/NCAR) reanalysis data were used to trace cyclone tracks. Secondly, these cyclone tracks were classified into two types, N-track-type and S-track-type. And then, cyclone tracks producing rainfall were classified into five types based on the directions of cyclone track and water vapor transport to the rainfall area by the cyclones. Thirdly, the rainfall factors for the five types of cyclone tracks were clarified considering the upper tropospheric trough, upper tropospheric temperature and rainfall region.

As a result, it was first found that 56% of S-track-type cyclones producing rain had water vapor transport from the south on average over the 10 years. And, this study found a phenomenon about rainfall factors of five type cyclone activities.

Trends of Sustainable Urban Development in Arid Land

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I am analyzing about the trends of urban development and population change in dryland by the statistics of UN and so on now. The growth and decline of cities have been divided by the social and economic environment change in many developing countries. But there are many cities that the growing cities such as the cities of Sunbelt in USA and Dubai in UAE and the like in the advanced countries. These cities dealt successfully with the demerit of drying by the developments of diverse technology. It is confirmed that the appearance of Megalopolis, over the ten million inhabitants in dryland consequently.

Trends of Industrial Development in Arid Land

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The purpose of this study is to investigate the trends of industrial development in arid land. It was found that few industrial sectors were located in these areas. We analyzed the possibility of industrial development in arid regions to take the case of the new industrial location in India.

The landscape preservation activities and change of geographical feature and vegetation of Tottori sand dunes.

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The Tottori sand dune which has been specified natural monument had become glass land owing to planting the sand drifting protect windbreak from 1970s to 1980s. However, landscape of sand dune is recovering through the rehabilitation activities such as weeding glass land and felling windbreak. In this study, effect to rehabilitation of sand drifting by a change of distribution of vegetation through the rehabilitation activities was analyzed by using vegetation maps, air plane survey maps, the records of landscape conservation activities and satellite remote sensing data which was acquired from 1962 to 2001.

The front and the back in the three of sand dunes which were parallel to coastal line was erosive and accumulative tendency, respectively owing to transferring of sand from seaside to inland by winter monsoon in the ordinary Tottori sand dune. However, the movement of sand was reduced and vegetation was spread from the west logging area to the center of sand dune during vegetated period. The vegetated area was rapidly decreased, and also the movement of sand was rehabilitated after the start of landscape conservation activities.

Nondestructive estimation of leaf water potential of citrus by NIR spectroscopy

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In citrus cultivation, there are problems concerning the quality of fruit, stability of production, and training of new bearers. To solve such problems, cultivating fruits and trees in optimum water conditions as well as saving labor, reducing costs by using precise diagnostic tools. In this research, which has already been practically applied in nondestructive measurement, the leaf water potential was estimated as an index of water stress. A correlation was found between near infrared spectroscopy and leaf water potential, and furthermore, accurate calibration models were obtained. These models were used to estimate the leaf water potential with ranges of about -0.6 ± 0.3 MPa and -1.8 ± 1.0 MPa.

Measurement of Latent Heat Flux by Eddy Correlation Method with Sonic Anemometer and Fine Thermocouple

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Estimation of reference evapotranspiration in slanting surfaces using GIS technique

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In this research, we investigated impacts of solar radiation on estimating reference evapotranspiration (ET_{ref}) for sloping surfaces. Oyodogawa-basin of Miyazaki was selected as the research area. As a result of ET_{ref} computation using GIS model, we found that the annual solar radiation at south-facing slope was almost double of those at north-facing slope when surface slope was more than 30 degrees. Thus, accurate estimation of solar radiation at sloping surfaces is necessary to improve estimation accuracy of ET in mountain areas. Also, impacts of other weather parameters on ET estimation were evaluated through sensitivity analyses. As a result, variation of air temperature according the elevation difference in the basin degraded the accuracy of ET estimation. Estimation accuracy of ET will improve by using the model proposed in this research, which contains solar radiation estimation at sloping surface and air-lapse rate correction by elevation.

A Study on Water Making System Available for Improvement of Living Environment in Arid Land

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In this work, the development of electric power and water production system utilizing renewable energy such as wind and solar energies was performed to combat the desertification and to support greening the desert. The main researches on wind turbines suitable for desert environment and water maker for obtaining fresh water from the moisture air were carried out.

In the development of the wind turbine suitable for desert environment, the response has been analyzed under the condition of either constant rotational speed or constant load torque in order to know the transient response of a straight-bladed vertical axis wind turbine to change of wind velocity. Wind that instantaneously increased like a step was generated as the input power.

Experiments under the condition of a constant rotational speed revealed the flow around a rotor followed the wind velocity change of the main flow very quickly. In the case of constant load torque condition, effective torque of the wind turbine abruptly increased up to the value on the torque curve of the final wind velocity, with turbine rotational speed kept almost constant. After that, the effective torque decreased along the torque curve of final wind level to reach the final stage.

On the other hand, in the development of the water maker for obtaining fresh water from the atmospheric air, the novel multi-stages water maker using the Pertier device has been developed. The water maker unit which the Pertier devices are placed is stacked vertically. Experiments were conducted in a controlled chamber under several conditions of constant temperature and relative humidity with the same absolute humidity. The effects of the electric power supplied to the Pertier device, the equipment configurations and the air-flow rate in the cooling channel on water production rate were investigated in the experiments.

From the results, it was found that the optimum conditions of those parameters of water maker existed suitable for the variation of temperature and relative humidity of the air. The other experiments also were carried out in the case of setting the annual change of the temperature and relative humidity in the Loess Plateau, China. It was confirmed that water production per day of the multi-stages water maker was 1.2 kg from the experimental results in the case of the temperature and relative humidity in summer season,

The numerical analysis was carried out about the phenomena of cooling and condensation of the moisture air in the cooling channel of the device. The model for numerical analysis was proposed by simplifying the channel configuration. The numerical results of the air temperature in the channel were qualitatively agreement with the experimental results. The correlation between the numerical and experimental results of water production was within $\pm 20\%$, the numerical model and calculation program will be improved.

Saturated-unsaturated water flow to investigate solute movement

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We measured pressure head, volumetric water content, electric conductivity and temperature in saturated-unsaturated coarse glass beads media during steady state flow. The average diameter of glass beads was 1.0mm. We made steady flow using de-aired water (Experiment One) and NaCl solution (Experiment Two) in 2-D model. From the result of experiment, we found that a) water pressure distributed in hydro-static in capillary water zone, and dispersed unsystematic in pendular water zone, b) electric conductivity was not change at pendular water zone during steady flow of NaCl solution.

We verified that liquid water as solvent moves in capillary water zone. Liquid water did not play as solution at pendular water zone. Therefore, we are able to apply Darcy's law only at capillary water zone where pressure transmits by liquid water under gravitational force field.

Ecophysiological studies on noxious weeds in semi-arid areas

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The parasitic weed *Striga hermonthica* is a major biotic constraint to cereal production in the semi-arid sub-humid tropics of Africa. *Striga* attach to the host roots via haustoria, and rely upon the host plants for most of their nutrients, carbohydrates and water supply. We isolated a gene which encodes FCA homolog from *S. hermonthica* using RT-PCR and RACE. Compared with *Arabidopsis thaliana* FCA, a candidate protein for an ABA receptor, the *Striga* FCA was found to be deficient in the ABA binding domain. Incompleteness of the putative ABA receptor of *Striga* may cause poor sensitivity of the parasite to ABA and allow the parasite to keep stomatal aperture larger than that of host plant.

Influence of aeolian sediment on carbon and nitrogen dynamics of surface soil in the steppe region, Mongolia

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Steppe soils distributed in Mongolian plateau has been affected by climate change and the increase in land use intensity. These changes might interfere with the dynamics of soil carbon pool the form of SOC. But there is a less understanding of soil carbon dynamics, because the accumulation process of SOC has been for a long term. The isotopic technique is a powerful tool for studying the dynamics of SOC over time. So, this study reported the origin and time scale of soil carbon in studied sites using stable and radio C isotopes.

The soil samples were collected from forest steppe, steppe, and desert steppe in Mongolia. SOC contents were decrease with southern site. The $\delta^{13}\text{C}$ values of SOC suggested they were derived from mixture grassland of C3 and C4 grasses. That was a same result as vegetation survey at studied sites. The $\Delta^{14}\text{C}$ values were decrease with soil depth, and show correlation with SOC contents ($r=0.9$). There were remarkable differences in the distributions of the soil carbon contents and $\Delta^{14}\text{C}$ values between forest steppe and desert steppe soils. The turnover time of SOC, A1 horizon at forest steppe was shortest, 928 yr, and the A horizon at desert steppe site was longest, 1927 yr. Thus the difference of turnover of SOC between each vegetation zone was indicated. For the next step, we should try the OSL analysis to clarify the absolute age of surface soil.

Comparative study on soil factor affected to biological production at desert

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Growth of crop applied with new ferrous iron fertilizer were comparatively observed at alkaline soil (pH9.0, origin shell fossil) in vinylhouse. Application of new fertilizer was suited granular type $\text{Fe}5.0\text{g}/\text{m}^2$ at upland rice. Further in liquid type containing 2.6% Fe (used by drop-irrigation 0.05% water solution) was shown better growth at legume.

Viscoelastic analysis of root cell walls under different growth conditions and humidity changes in vitro

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Environmental stress such as aridity and acidity suppress the growth of plant roots. This research aimed to investigate biochemical, mechanical, and morphological characteristics of root

cell walls in relation to the root growth response to the environmental stresses, and finally understand the physiological response in the apoplast of plant roots. In the normal water-stress condition, cell walls are wet but symplast feels water stress. But in the arid land environment, outer cell walls of roots may partially be dry. Thus, mechanical properties of root cell walls must be examined under the dry condition without liquid water. Our interest was what happens when root cell walls lost liquid water molecules. In this research, we investigated mechanical properties of dry cell walls as well as morphological characteristics of root cell walls with special interests in hydrophobic suberin layer development in the exodermis which plays a barrier against water movement.

Results and discussion

Morphological changes in tissue structure in tea roots:

- 1) Crack structure was found in ancymidol (Anc: an inhibitor of gibberellin biosynthesis)-treated roots. Anc suppressed root elongation by the inhibition of epidermis cells but enhances expansion or thickening of cortex cells.
- 2) Unusual lining of endodermal cells: Endodermis is usually a well organized line of cells. Hydroponics cultured tea roots sometimes showed unusual line of endodermis, partially overlapped line of endodermis was observed.
- 3) Thickening of outer cell walls of epidermis and suberin layer in exodermis cell walls were observed by an electron microscopy.
- 4) Suberin layer development in exodermal cell walls was observed by fluorol yellow staining. Exodermal cell walls were specifically stained by fluorol yellow. This staining corresponds suberin layer-like structure of electron micrographs.

Humidity-dependent extension of dry cell walls

Pea roots: Extensibility of dry pea root cell walls increased by the increase of relative humidity. Plastic extensibility mostly contributed to the total extension, and elastic extensibility did not change by the increase in humidity.

One of the major cell wall component, pectic polysaccharides was tested for the contribution of this humidity-dependent increase in extensibility. Cell-wall extensibility was compared between hot CDTA (a chelator)-treated roots and simple acetate buffer-treated roots (Control). Hot CDTA-treated roots showed 40-100 % higher extensibility compared to the Control roots. Pectic polysaccharide was suggested to suppress the extensibility of dry cell walls. This suppression was found stronger at lower humidity (30 %) than higher humidity (90 %). This result indicates pectin suppress extension of cell walls in dry condition but the suppression become weaker in higher humidity (90%). Such control of dry cell wall extensibility was suggested to occur in surface-dried roots in arid environment.

Tea roots: Tea roots develop suberin layer in exodermal cells. Since the suberin suppress the movement of water, humidity dependent changes of dry cell walls must be measured as well. However, due to unknown reason, we could not obtain many tea roots this year by the bad root development in hydroponics. Then we have observed simply the time course changes in cell wall extension under changing humidity by using some tea roots. We confirmed humidity-dependent changes in extension and shrinking of dry cell walls of tea as well as pea roots. High humidity (90%) increased extensibility and dry condition (30 % humidity) brought about the shrinking of

root cell walls.

Although such a change in humidity-dependent extension may not take place under wet soil conditions, mechanical changes in extensibility of dry cell walls may contribute the extensibility of surface cell walls of roots growing in the air and or in the extremely dry soil.

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Interactions between gas exchange rate and soil water regime of defoliated crops exposed to water stresses

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Defoliation of crop leaves alleviates water deficit and reduction in carbon assimilation in shoots under water limited conditions. In a pot experiment conducted in the last fiscal year, pot-grown sorghum plants defoliated 60% of leaf area at the heading stage showed water consumption identical to control plants. In addition, the defoliated plants showed high biomass and yield production as they delayed wilting and loss of leaf greenness. It is unlikely that effect of the defoliation could simply come from saving soil water by decreased leaf area. Thus, we monitored the water consumption of individual plants with or without defoliating for field grown sorghum.

The diurnal change in water consumption rate was successively monitored by sap flow sensors attached on base of stem for transpiring sorghum. Design of the sensors is based on heat balance method. The sorghum was grown under a water-shaded vinyl house. Limiting irrigation was initiated two weeks before heading. Approximately sixty percent of leaf area was defoliated by removing leaves from low nodes. Severe and moderate drought treatments were arranged.

In the moderate drought treatment, soil water content at 30 cm deep was 2-3% after irrigation. The water regime allowed the plants consuming water at rate of 50 g d⁻¹ before irrigation, and 100-150 g d⁻¹ after irrigation. In the moderate drought rearmament, transpiration rate per plant was higher in the defoliated plants than in control plants, indicating high gas exchange rate in the defoliated plants. However, the transpiration rate was almost same level in defoliated and control plants in the severe drought treatment, due to heavy closure of stomata. Similar was happened to plants in the moderate drought treatment when the soil was heavily dried before irrigation.

This study proved that, in some conditions, defoliated plants with limited leaf area take up more water than ones without defoliation. This effect of defoliation will lie on complex relations among physics of soil and climate, and physiology of plant water relation. Specifying environments in which the defoliation can avail requires integrated consideration on water movements through soil-plant-atmosphere continuum.

Evaluation of growth and drought tolerance under strong irradiance of the transgenic plants with higher aldehyde-detoxification ability

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Environmental stresses on plants enhance the formation of reactive oxygen species in chloroplasts, and resulting lipid peroxides decompose to various aldehydes, which includes very toxic 2-alkenals. We have recently demonstrated that the transgenic tobaccos overexpressing 2-alkenal reductase (AER) showed tolerance to strong light. In this study, we examined whether the AER-overexpressing tobaccos (lines #11, #14 and #18) show greater productivity than the wild type (SR1) under strong light, using the global warming chamber. The CO₂ fixation rate in middle-position leaves, total leaf area and the shoot dry weight of 8 week-old plants grown under 1,000 $\mu\text{mol}/\text{m}^2/\text{s}$ were not significantly different among the tested lines (5 plants per line). A larger growth space or a reduced number of plants or both will be necessary to prevent the shading of plants each other during growth, otherwise the difference in light conditions may cause larger deviations among plants. New series of experiments with improved conditions were not done by the limited availability of the growth chambers. We will do them in the next fiscal year.

**Relationship of Groundwater Flow and Electric Conductivity
-Case Study of BYOUBUSAN Sand Dune Area, Aomori Prefecture-**

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Byoubusan region is the area of sand dunes on the western part of Aomori Prefecture. This region, in spite of its being a sand area, has the unusual characteristic of wetlands. The groundwater level was about 1.5m from the surface. Therefore, we could obtain the groundwater and find the direction of water flow, and the values of EC and pH in this groundwater in this area.

The summary of the results obtained in this study is as follows:

- (1) The gradient of the groundwater level was parallel with that of the ground surface.
- (2) The EC values in the groundwater were affected by the flow of the groundwater. We realized that changes of the EC values were related with the difference in fertilizers, pesticides and crops etc.
- (3) Generally, the range of pH changes were between 7 and 8. We realized that those values were of the neutral to slightly alkaline values. We also found that the changes of the pH values were small.

Vegetable growth and quality under saline water irrigation

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The objective of the efficient water management is to conserve soil water and maintain lower level of salts in the root zone. Experiment 1 was conducted in a greenhouse to evaluate effects of mulching types on water use efficiency, evapotranspiration of Swiss chard (*Beta vulgaris* L.) and salts accumulation in clay soil irrigated with saline water. The experiment indicated that mulching practice affected favorably the movement of salts and water in the soil and mitigated the adverse effects of saline water on Swiss chard. In addition, these effects of gravel and pine-needle mulch were better than rice-straw and no-mulch. Experiment 2 was conducted to get basic data for studying to effects of growth and quality of Mizuna (*Brassica rapa* L. Japonica Group) with sparing irrigation method using porous- α which has function of isolating capillary, and subirrigation method. Using porous- α and different irrigation methods and mount was effected growth and quality of Mizuna. It will study sparing irrigation method using porous- α and saline water irrigation to be consistent with better yield and quality of vegetable referring to these results.

Alternative selection to prevent salinity accumulation in soil by using capillary barrier of sand-gravel layers.

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It is well known that a simple soil layer system which is composed of a fine soil layer underlain by a coarse soil layer has a characteristic property of capillary barrier. Water infiltrated into soil is stored just above an interface between the fine and coarse soil layers due to a physical difference in water retention characteristics of the fine and coarse soils. As their roots can easily utilize the water stored in the upper soil layer, it may think that plants grow effectively even under water saving irrigation. In the preliminary study started from 2008, effect of water stored in the upper soil layer by the capillary barrier of the soil layer system on the plant growth was investigated in the sand soil field. The soil layer 3 m in width and 2 m in lengthly was constructed by compacting gravel soil in 20 cm depth of sand soil. Potherb Mustard was planted in the soil layer plot and the sand plot. Soil water changes in the soil were measured during about two months after the plant seeding. Results are obtained: (1) It was observed that the infiltrated water was effectively stored in the upper soil layer by the capillary barrier of the soil layer system, and (2) the water stored in the upper soil layer affects significantly the plant growth. Further studies

are required to examine the effect of the capillary barrier of soil on the plant growth more precisely and to investigate the barrier property against salt concentration caused by capillary rise of groundwater.

Evaluation of pore-air behavior in unsaturated soil and its influence to hydraulic conductivity

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The hydraulic properties are important for evaluation of the seepage behavior of unsaturated soil. The objective of this research was to develop a simple method for estimating the water characteristic curve from the drying characteristic curve of a soil. The drying characteristic curve is represented by the relationship between volumetric water content and evaporation rate, and is measured by the laboratory evaporation test in which the unsaturated soil sample is dried under heat at a constant temperature. The drying characteristic curves were obtained in a short time within two hours. As a result, the residual volumetric water content of water characteristic curve was determined from the drying characteristic curve. The inverse solution of the two undetermined parameters and the saturated volumetric water content of van Genuchten's equation for expressing the water characteristic curve were applied to the drying characteristic curve data. The water characteristic curve in the drying process estimated by the van Genuchten's equation was in good agreement with the measured one.

Long term changes of soil physical properties by adding sulfur materials into alkaline soil.

Yuichi ISHIKAWA and Mitsuhiro INOUE***

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Saline-alkaline soil is mainly spread in northeast China, which causes poor soil physical properties in addition to growth difficulty by high pH. Addition of sulfur materials was proposed in order to improve alkaline soil. The objective of the present study was to clarify the effect of mixture of sulfur and organic matter on grape growth in saline-alkaline soil in Gansu Province, P. R. China.

As the results in the FY, soil samplings on several fields in urban area from Lanzhou city to Yinchuan city were carried out. Field test to fresh soil showed that pH was 7.9 ~ 8.6 and electric conductivity was 0.16 ~ 7.6 dS/m, which can exceed criterion of saline-alkaline soil.

By adding the sulfur material, increase of soil temperature in pots in a grape nursery in urban Lanzhou city was observed from a native researcher. The increase of soil temperature was confirmed with 0.2-0.5C for more than a month with the sulfur material in a pot experiment in Japan. Improvement of soil physical properties, especially water holding capacity in the nursery was not clear because the position of sprinklers was much more effective to soil physical properties than addition of the sulfur materials.

Seedlings were transplanted on saline-alkaline soil where seedlings used to have poor survival, i.e. less than 20%, whereas by addition of sulfur materials, the survival rate increased up to 80%.

Research on Non-destructive measurements of unsaturated seepage flow by using Ground-penetrating radar in arid land

*Yuji TAKESHITA**, *Seiichiro KURODA***, *Kosuke KODANI****, *Yuuki NAKAMURA****, *Taku YAMASHITA****, *Masafumi NAKAMURA**, *Shinya MORIKAMI** and *Mitsuhiro INOUE*****

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The potential of surface ground-penetrating radar (GPR) for measuring unsaturated seepage flow in sandy soils was evaluated. It is shown from field infiltration experiments performed in homogeneous unsaturated dune sands. Non-steady behavior of the wetting front caused by two-dimensional seepage flow from the infiltration tests was nondestructive measured by using GPR in profile survey modes with the antennas on the surface. The utility of our proposed GPR profile survey was demonstrated by using seepage flow analysis of field infiltration experiments. There was good agreement between computed and measured wetted zone movements in two-dimensional unsaturated seepage flow.

Development of measurement method of continuous air content and air permeability in soil using the principle of sound resonance

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Soil Air content is important to describe a movement of air in soil as a parameter such as air permeability. However, there is no measurement method for soil air content in a nondestructive manner in fields. We proposed resonance method and investigated its practicality. We used standing waves to obtain the acoustic impedance of soil and translated the acoustic impedance

into the soil air content using mechanical model. Glass beads in dry condition and Soma silica sand in various moisture conditions were used. As a result, resonance method gave a correct value for some samples of glass beads, but as the sample become longer, the measured value differed from the true value, showing that the resonance method was useful and that our calculation procedure was not perfect. We also found comparison of energies at the boundary of the standing wave to be useful for determine the limitation of resonance method. As for the sample of sand, the results suggested that we can measure the volume of entrapped air and permeable air respectively. Improving calculation procedure, making sure the ability for measuring entrapped and permeable air content respectively is the future works.

Quantification of water and solute balance in a shallot field using a direct sampling method

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In this study, we made two wick samplers with soil water storage tank, and installed a shallot field. The measurement period was August 24, 2007 to June 24, 2008. Micro-meteorological data and volumetric water content of a 30-cm root zone were automatically observed at every 5 minutes and recorded in a datalogger. Moreover soil water sampled by this sampler was collected by a small portable pump. As results, total 902 mm/a sampler, of soil water was collected in this period. It was 1.6 times of percolated water in this root zone. On the other hand, ranges of nitrate concentration were 0.11- 4.06 and 0.19 - 27.6 mg/l, respectively. The great difference was caused by a broadcast fertilizing. It suggests that multi-observation is conducted at a sand dune field and the average should be taken as the representative value.

Preferential flow effect on solute leaching for sandy soil in arid land

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In initially dry coarse soil, it is noted that a uniform and nonponding surface water flux causes an unstable wetting front when the flux rate (q_0) is less than the saturated hydraulic conductivity (K_s). To investigate the relationship between q_0 and the pressure gradient with time ($\partial h / \partial t$) in the wetting layer under the condition of unstable water flow, we carried out one-dimensional infiltration experiments by applying non-ponding water fluxes to the surface of soil packed homogeneously in an acrylic tube. We filled the tube with four different soils; sand, volcanic clay

soil, loam and silt and installed microtensiometers to measure pressures in these materials. The results showed that (1) negative pressure head gradients with space ($\partial h / \partial z$) and time ($\partial h / \partial t$) appeared clearly only for sand and the equation derived by Cho et al.(2005) agreed well to the pressure measurement with time, (2) the $\partial h / \partial t$ was provided as a quadric function of q_0 and fitted well the experimental data for sand. From this result, it was found that the smaller q_0 becomes, the closer $\partial h / \partial t$ approaches 0 and the flow becomes more stable. This trend could explain the experimental results of Yao and Hendrickx(1996).

Studies on grape vine growing by drip irrigation

kennji TANABE and Mitsuhiro INOUE***

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Grapevine is widely planted in arid areas, but vineyards in these areas are facing the problems such as large evaporation, serious water leakage of irrigation, which causes waste of precious water resource. Current year (from 1st June 2008 to 31st March 2009), we carried out 4 Experiments about grapevine water-saving techniques in dry areas as following: Experiment 1, The influence of irrigation style and mulching with rice straw on vine growth and berry development of grapevine cultured in sandy land; Experiment 2, Study on critical value of the soil water potential for irrigation-beginning in berry growth stage of grapevines; Experiment 3 Study on critical value of the soil water potential for irrigation-beginning in berry maturity stage of grapevines; Experiment 4, Development of self-watering technique for container-grown grapevine base on capillary wicking water cultivation. In Experiment 1, through the study on the irrigation mode using weighing lysimeter and mulching with rice straw, we can see that the treatment of Surface with Rice-straw mulching(SIM) presented better shoot growth and berry development, higher soluble total solute solid content(TSS), better coloring and higher yield, compared with other treatments such as Sub-surface irrigation with Rice-straw mulching(SSIM), Sub-surface irrigation(SSI) and surface irrigation(SI). Results of Experiment 2 showed that during the berry growth stage the critical value of soil water potential was around -50mbar for irrigation-beginning. For Experiment 3, by testing the daily changes of photosynthetic rate, stomata conductance and berry diameters in the process of water potential decreasing, we found that during the berry maturity stage the critical value of soil water potential was around -140mbar for irrigation-beginning. Results of Experiment 4 showed that capillary wicking water cultivation (CWWC) could meet the water demand of grapevine growth and berry development and is proved to be a grapevine cultural technique as water-saving, easy-carrying, environmental friendly and with a promise future in the arid areas.

Research on groundwater management using plant transpiration and water uptake

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For sustainable irrigated agriculture in arid zone, water-logging is one of the biggest concern. In recent years, "biological drainage", which is a drainage method to lower the groundwater table by using plant transpiration, is a remarkable technique as countermeasure against water-logging.

Considering the establishment of technique to control groundwater table, impact of evapotranspiration and transpiration on groundwater level is analyzed.

An experiment was conducted using a salt movement monitoring system in Arid Dome of ALRC. Evaporation, evapotranspiration and groundwater level were monitored from late August to early September, 2008. Second-year *Populus alba* L. was planted in two lysimeters. To measure transpiration, mulching is applied to the one lysimeter to prevent from evaporation from surface soil.

The result shows that the significant correlation between transpiration rates and lowering groundwater level. This result shows that we should consider the depth of root zone and soil water content in order to find the relation between the transpiration rate and lowering speed of groundwater level. For further study, depth and spatial distribution of root and soil water content and its movement should be clarified. On the other hand, sap flow monitoring is applied for new technique to directly measure the transpiration rate. The monitoring system is to be improved by introducing advanced tools for accurate measurement for next step.

Solution transport driven by the density in soil under the salt accumulation

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When a salt accumulation causes by evaporation at a soil, a condition of a density instability being a high density solution over a low density solution occurs in a soil profile. The aims of this study are to investigate transport characteristics occurred by the density instability. Evaporation experiments in the laboratory are conducted with the column in 20cm diameter and 40cm height, packed with Tottori dune sand. To estimate the size of the flow, soils were sampled at 25 points in the same depth level. Experimental results show that the high concentration solution descends from the surface of soil and the size of the flow is 8cm diameter in 5cm depth.

The Utilization of Indigenous Technology for Water Resources and Rural Socio-Economic Development - Iran, Oman, Inner Mongolia-

Ryuichi HARA and Mitsuhiro INOUE***

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The field surveys conducted in 2008, August in the Inner Mongolia autonomous regions, the people's Republic of China for the preliminary research "The impact of natural resources development and socio-economic changes for ecology and settled pastoral people".

It is important to compare with the Xinjiang Uigur autonomous regions which the Inner Mongolia autonomous regions both of which are located at arid and semi-arid zone.

The field surveys are also conducted in 2008, September at Fars Province, southern Iran for the supplementary research "the socio-economic changes of Kor river regions during 40 years.

Fine root distribution pattern semi-arid area

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This study aimed to investigate the vertical root distribution pattern in an exotic black locust plantation and an indigenous oak forest near Yan'an on the Loess Plateau, China. In oak forest about 90 % of fine roots were concentrated in surface soil (0-30cm), however in black locust plantation about 70 % of fine roots were concentrated in surface soil (0-30cm). Thus oak roots were more concentrated in surface soil than black locust roots. Such difference in root distribution pattern may be reflected to the differences in nutrient and water use strategy of two species.

Experimental studies on the salt tolerant characteristics of halotolerant plant and remediation and conservation of the saline soil

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***Arid Land Research Center, Tottori University

It is important to evaluate the salinity tolerance of *Tamarix Austromongolica*, which grows

naturally in arid regions, in order to utilize it for the improvement of halomorphic soil. To clarify relations between the amounts of salt in soil and growing conditions of *Tamarix* from May through November, a greenhouse cultivation experiment was conducted. Soil, in 45L containers in four experimental sections of 9 containers each, was saturated for a week with saline water in concentrations of 0% (tap water), 1%, 4%, 7%, and *Tamarix* cuttings were transplanted in each container. Relative to growth in the 0% section, the growth of a few individual plants in the 1% section was delayed and deformities of shoots were observed, but all of the plants survived to the end of the experimental period. On the other hand, growth was highly inhibited in the 4% section, with survival rates of 56% in the 4% section and 0% in the 7% section. The result therefore demonstrated that the growth of *Tamarix* was limited to a salinity of under 7%.

Hydraulic capacity of xylem and stomatal response for drying in two *Salix* species, *Salix psammophila* and *Salix matsudana* growing in arid and semi-arid area, China

*Ken YOSHIKAWA**, *Naoko MIKI**, *Lingli YANG**, *Mayumi OGASA**
and *Norikazu YAMANAKA ***

*Graduate School of Environmental Science, Okayama University

** Arid Land Research Center, Tottori University

Vulnerability in hydraulic conductivity, refilling capacity and leaf transpiration were compared among three *Salix* species; *Salix psammophila*, *Salix matsudana* and *Salix integra*. Vulnerability to water-stress-induced embolism for stems of *Salix integra* was clearly high comparing with them in other species. Percentage loss of hydraulic conductivity in *S. integra* and *S. matsudana* was recovered up to the values of before drying after 12 hours and 24 hours, respectively, while, it of *S. psammophila* did not recover up to the values before drying in 24 hours. Daily transpiration per unit leaf area was small in *S. integra* and was large in both *S. psammophila* and *S. matsudana*. However, leaf area and total leaf area per shoot were increased in order as *S. integra*, *S. matsudana*, and *S. psammophila*. Thus, daily transpiration per shoot in *S. psammophila* was low in comparison with them of other species. These results suggested that *S. integra* distributed in temperate zone had a high transpiration activity derived from high leaf area value, although it had a risk of loss conductivity, and could recover the conductivity using rehydrating like a rainfall (refilling type depending on much rainfall). While, *S. psammophila* distributed in arid area tended to reduce the losing water by adjustment of the amount of leaf and avoided, because of low capacity of refilling (avoidance type in response to the poor rainfall). *S. matsudana* also distributed in arid area could reduce losing hydraulic conductivity although it had a high activity of leaf transpiration; moreover, it had the recoverability in hydraulic conductivity (tolerance and refilling type).

Analysis of control factor for decomposition in arid systems

Nobuhiro KANEKO and Norikazu YAMANAKA ***

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Evaluation of salt tolerance and water and nutrient use of coastal plants using stable isotopes

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Since coastal plants are affected by seawater, sea-salt aerosol, and saline groundwater, it is expected that the distribution of coastal dune plants were related with their salt tolerance and water/nutrient use. We are investigating the relationship between the environmental conditions and the salt tolerance and water/nutrient use of several coastal dune species on the Tottori sand dune to find the factors controlling plant distribution. Wells, rain gauges, ion-exchange resin columns, and soil moisture sensors were installed in three plots, which have different distances from shoreline to monitor the environmental conditions. We are now preparing to investigate the salt tolerance and water source using carbon and oxygen isotopes.

Ecohydrological comparisons between natural and artificial forests in Loess Plateau, China

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Robinia pseudoacacia L.(hereafter Robinia) has been extensively planted in the southern Loess Plateau in China since 1960's and become the major plantation tree species in the region. Although Robinia has a great deal of advantages such as drought tolerance and symbiotic nitrogen fixation, its expansion has brought debates on its adverse effects such as deterioration of the native ecosystem and reduction of stream flow by excessive soil water use. To clarify the

impacts of the plantation on water and nutrient cycling in this region, ecohydrological measurements have been conducted since January 2003 in a Robinia plantation and the nearby native forest of *Quercus liaotungensis* on Mt. Gonglu near Yan'an, Shanxi Province. In 2008, the relationship between sapwood area and diameter at breast height (DBH) of Robinia was investigated and found that DBH could be a good predictor of sapwood area of individual trees and explained 94% of the variations. Thermal dissipation probe (TDP) method was applied to the 27 trees of Robinia during the growing season. The results show that 1) the diurnal cycle of average sap flux density among seven DBH classes differed markedly, 2) daily transpiration can be predicted from mean daily daytime vapor pressure deficit (VPD_m) using a fitted exponential saturation model, while 3) the model parameters were different among seasons probably owing to different soil water conditions and leaf phenology. By using the derived model for each month, stand total transpiration over the growing season (24 April-21 October) was estimated to be 73.8 mm, with an average daily value of 0.41 mm day⁻¹ and a maximum of 0.89 mm day⁻¹ (occurred on 16 May). The relatively small amount of stand-scale transpiration estimates might be related to a degradation of the middle-aged plantation and a significant contribution of evaporation from under vegetation, soil surface, and wet canopy to the total amount of stand water use.

The effect of the soil eutrophication caused by pine wilt disease on a ecosystem.

*Kazuyoshi FUTAI**, *Norikazu YAMANAKA****, *Fukuju YAMAMOTO***, *Ryohta KATAOKA**,
*Takashi Mii**, *Takeshi TANIGUCHI**** and *Norikazu YAMANAKA****

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In order to establish the available technique for revegetation using symbiotic ectomycorrhizal (ECM) fungi, we collected ECM fungi from sporocarps and ectomycorrhizas in a coastal pine (*Pinus thunbergii*) forest in Tottori, Japan. As the result, *Pisolithus tinctorius*, *Suillus granulatus*, *Russula* spp. and *Amanita ibotengutake* are frequently occurred and we can collect 44 isolate. When *Pisolithus tinctorius* and *Suillus granulatus* were inoculated with *Pinus sylvestris* seedlings, Na content in the leaves were more lower than those of control (non-mycorrhizal) seedlings.

(3) Summary of Open Seminar

Topic of Open Seminar (Date)

Name of Speaker

Occupation of Speaker

Summary of Open Seminar

1. Green Revolution: the past and future (9 SEP. 2008)

Masa IWANAGA

Director General, National Institute of Crop Science, Tsukuba

Drastic yield increase of wheat and rice production had occurred in south Asia in mid-60's to 70s, following successful adoption of high yielding modern varieties, developed by International Maize and Wheat Improvement Center (CIMMYT) and International Rice Research Institute (IRRI). This 2-3 folds productivity increase directly contributed to alleviation of hunger in the region and it was coined as Green Revolution. Dr. Norman Borlaug, wheat breeder and director of CIMMYT's Wheat Program then was awarded Nobel Peace Prize in 1970. Green Revolution is considered as the most important contribution to humanity made by agricultural science in the 20th century.

The world community is now facing with major crisis of global food security, prompted by soaring food prices during the last 2 years. Food productivity of major cereals such as rice, wheat and maize has been stagnated during the last decade. Consequently, food supply is not catching up with food demand increase, corresponding to steadily-increasing world population and gradual shift of eating preference to animal-based foods such as meat and dairy products in developing countries, especially in India and China. The agricultural sciences have to take up the new challenge of sustainable food productivity increase in this world. If successful, this challenge can be called Second Green Revolution. Technical nature, geographical focus, social environment and global context are quite different from the time of the previous Green Revolution.

2. Recipe for Success: How to set yourself up for a fruitful time abroad (8 & 9 OCT. 2008)

Asako STONE

Postdoctoral Fellow, Desert Research Institute, USA

3. Recent Climate Extremes and Disasters in Africa's Drylands - A Continent-wide Outlook and Lessons Learned (29 MAY 2007)

Hiroshi KADOMURA

Emeritus Professor, Tokyo Metropolitan University

Ongoing global warming has recently increased the frequency and magnitude of such climate extremes and disasters as floods, droughts, storms, and anomalous temperatures in many parts of the globe. African continent, including its drylands which are most vulnerable to climate change impacts because of various unfavorable natural and socio-economic situations, is no exception. The talk is intended to outlook what is actually happening in Africa's drylands under changing climate and to suggest gaps in disaster reduction both at operational and research contexts.

In reality, drylands across Africa have been experienced increased flooding; even deserts are vulnerable to flash floods, as exemplified by the events at the Bilma oasis in August 2006, Air Mountains in August 2006 and 2007, and M'Zab Valley (Ghardaia) in early October 2008, all in the Sahara, and at Sossusvlei in the Namib Desert in January 2006. The drought-prone Sudano-Sahelian zone has increasingly been affected by heavy rains and floods in recent years. In the drylands of Kenya, droughts since 2003 were followed by a large-scale flooding during October-December 2006 which was caused by El Niño-teleconnected heavy rains. Then, drought conditions came back and continued until now with localized heavy rains and floods. In 2007 exceptionally widespread severe floods occurred across Africa, including portions of humid areas; more than two million people in 24 countries were affected in northern summer and about one million people in 10 countries in southern summer. Most affected people were faced difficult access to food, water, sanitation and health care, and were exposed to various water-borne diseases.

Main requirements emerged from recent events can be summarized as follows: 1) Greater enhancement of meteorological and hydrological services at national and local levels, 2) Accelerated enhancement of community-level preparedness for today's early actions, 3) Scale-down of scientific studies to more short-term, community-level detailed analysis, 4) Intimate collaboration among climate change, disaster reduction, humanitarian affairs and other societies at all levels. 5) More attention to diluvial events in drylands.

4. Several recent greening projects in China – Challenges for the future (26 NOV. 2008)

Yukihiro MORIMOTO

Professor, Graduate School of Global Environmental Studies, Kyoto University

After the establishment of People's Republic of China, greening policy sometimes had played an important role in the land resource management policy of the government, such as “Greening four sides: housing-side, village-side, road-side and river-side” and “Stop cultivation and restore forest”. Since I visited China for the first time in 1977, I have been looking at China through being involved in several research projects on ecological restoration and afforestation. I had a chance to visit Daido, the loess plateau in Shanxi Province, and Anhui Province this September. What I saw there was completely different from my experience in China so far. I had been also involved in the greenery project aiding nomad society in Xinjiang Uyghur Autonomous Region a decade ago. I would like to suggest issues to be considered for sustainable development.

Xinjiang Uyghur Autonomous Region is a dry and semi-dry region, where nomadic lifestyle had been still existed. But so harsh environment of their lifestyle made them to wish to establish irrigated grassland in the desert. My role was to advise for the establishment of windbreak forests around the settlement and grassland. The purpose of the grassland is only for breeding season, which is quite sensitive for nomads to help fight desertification. I suggested not only to use limited fast growing species but to use many indigenous species considering the risk of catastrophes by the climatic fluctuation. In this case, water management could be the key issue for consideration.

In Daido, I saw quite different situation of forests, fields, villages and cities as compared to those of thirty years ago. “Natural forest regeneration” policy and “Stop cultivation and restore forest” policy seems to have been achieved quite successfully. The yellow hill became green, but pollutions, land degradation and disaster in relation to mineral mining seems to become serious problems. Influx of young migrants into cities seems to causes the increase of abandoned field due to lack of labor in rural areas.

In Anhui Province, still existing the deteriorated areas without sufficient vegetation, people are willing to plant fast growing species or special purposes which could contribute local economy in short term, rather than ecology in long term. And, the use of fossil fuel seems to be a driver for the fundamental ecosystem change in China; we may reconsider the strategy of re-vegetation projects in China.

5. Habitat prediction on halophyte in the dry sea bed of the Big Aral Sea (26 NOV. 2008)

Tamaki MATSUMURA

M.Sc. Student, Graduate School of Agriculture, Kyoto University

The Aral Sea, a large terminal lake in the deserts of Central Asia, has steadily dried since 1960s by the extensive use of water. The dry sea bed was expanded to 54,000 km² by 2006. Since strong windstorms with salty dust blow from the bed to the surrounding area, the ecological and socio-economical conditions have been degraded.

To decrease these impacts, halophytic and wind-tolerant tree plantations have been planned by several international authorities.

For practical planting, we tried to reveal influential factors for vegetation distributions quantitatively and to identify the potential habitat using satellite remote sensing and developing statistical methods.

Firstly, vegetation types and their distributions were determined by field survey and the supervised land-cover classification using MODIS/TERRA images of 2006. Secondly, relationships between halophyte distributions and environmental factors were clarified based on the developed model. By doing so, we identified the potential habitat of halophyte and suitable plantation area in the dry sea bed using GIS.

6. Application of carbohydrate analysis to quality improvement of soybean seeds (12 DEC. 2008)

Ryoichi MASUDA

National Institute of Crop Science, NARO

Soybean seeds, as Edamame in the development, as 'boiled seeds' after drying, are available. In the quality of these items, soluble sugars contributing to the sweetness of cooked seeds, pectin believed to be involved in the texture of cooked seeds, and various glycosides as functional

components in health are evaluated as sugars or sugar components. According to required information (quantitative accuracy, form, composition, localization), the various analytical methods are developed. In the seminar, I will explain about several analytical methods for sugars and sugar components.

7. Overview of Mongolian rangeland degradation and some trials of its restoration (19 DEC. 2008)

UNDARMAA Jamsran

Head, Center for Ecosystem Study, Mongolian State University of Agriculture

Serious rangeland degradation is endangering the environment of the Mongolia. There is urgent need to analyze and review the grassland resources, status of grassland degradation, factors causing grassland degradation, and measures for grassland protection and restoration so as ensure sustainable development in Mongolia.

Degraded rangeland occupies approximately 70% of the total area of Mongolia. Over the past two decades, rangelands have suffered degradation, and it has become increasingly clear that the Mongolian rangeland is reducing its ability to support sustainable development of livestock husbandry. In the face of this serious situation, there is necessary to assess current situation of rangeland and find out the methods of restoration and conservation of rangelands.

In this presentation will be discussed results of case studies on current situation of main types of rangelands in mountain steppe, steppe and desert steppe zones, and on restoration trials of those of degraded.

8. Soil carbon dynamics of steppe soils in Mongolia (19 DEC. 2008)

Maki ASANO

Assist. Professor, Faculty of Law, Keio University

Both of soil organic carbon (SOC) and pedogenic carbonate (PC) in soil profile of semi-arid regions serve as an important reservoir of carbon in the terrestrial ecosystem. Steppe soils distributed in Mongolian plateau has been affected by climate change and the increase in land use intensity. These changes might interfere with the dynamics of soil carbon pool the form of SOC and PC. But there is a less understanding of soil carbon dynamics, because the accumulation process of SOC and PC has been for a long term. The isotopic technique is a powerful tool for studying the dynamics of SOC and PC over time. So, this study reported the origin and time scale of soil carbon in studied sites using stable and radio C isotopes. The soil samples were collected from forest steppe, steppe, and desert steppe in Mongolia. The $\delta^{13}\text{C}$ values of SOC suggested they were derived from mixture grassland of C3 and C4 grasses. The $\delta^{13}\text{C}$ values of PC among each vegetation zone exhibited the amount of carbon supply from biological activity. There were remarkable differences in the distributions of the soil carbon contents and $\Delta^{14}\text{C}$ values between

forests and desert steppe soils.

9. Agricultural Applications of Weather Science, Modeling and Prediction (5 FEB. 2009)

Michael L. KAPLAN

Professor, Desert Research Institute, USA

10. Degradation of persistent pesticides by using bacterial consortium and the application to contaminated sites (9 FEB. 2009)

Kazuhiro TAKAGI

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In recent years, both scientists and policy makers have shown great interest in technologies for bioremediation of various recalcitrant organic pollutants. Especially, microbial degradation is a promising effective way to remediate environmental pollutants, including POPs (Persistent Organic Pollutants). As a material for *in situ* bioremediation, we have developed a special charcoal named A100 (specific surface area 100 m²/g, pH 7.8) enriched with degrading bacterial consortium (Takagi & Yoshioka, 2000). By mixing the material with pesticide-contaminated soils, persistent pesticides (e.g. simazine, PCNB, PCP, HCB) were adsorbed onto the charcoal and rapidly degraded by the bacteria living within it under laboratory conditions (Takagi & Yoshioka, 2000). However, it has been obscure whether the charcoal enriched with degrading bacteria has been effective or not under field conditions. To demonstrate this, we conducted a field experiment by laying charcoal enriched with simazine-degrading bacterial consortium (CD7) under the subsoil of a golf course to prevent the contamination of subsoils, rivers, and groundwater with the herbicide simazine, which is widely used on golf courses throughout Japan and frequently detected in river water.

11. International Cooperation for Nature Conservation: Case Study of JICA projects in African semi-arid and Amazon rain forest (9 FEB. 2009)

Mitsuru WATANABE

Chief Advisor, JICA Project in Brazil

Desertification and loss of biodiversity are serious environmental problems on the earth. Then Japan International Cooperation Agency (JICA) has been implementing projects for conservation in many developing countries. However, sometimes it happens conflicts between governments which execute projects and local communities because of different interests. So it is very important to consider social aspects in every project.

In Tanzania, located in Eastern Africa, there is a development project from the 1970's which aims relocation of the capital from Dar es Salaam to Dodoma located in semi-arid area. There is only about 600mm annual rainfall and it was concerned desertification due to intensive deforestation and livestock grazing by the local people. Then, the Tanzanian government started forest conservation and afforestation activities in the city and its surroundings. To support such activities, JICA dispatched a team of the Japan Overseas Cooperation Volunteers - JOCV, from 1986 to 1998, and conducted a forest conservation project in Dodoma.

Amazon region of Brazil, there is the greatest rainforest in the world. Its rich biodiversity is closely related to the Amazon River which is the world's largest freshwater flows. Except in big cities along the Amazon River, about 1.5 million people are living and using the flooded forest resources. But these natural resources are being lost due to unplanned use and have threatened the livelihood of local people. So, JICA has implemented a project about conservation and sustainable use for forest resources since 2005 with Brazilian government in the state of Amapa.

In this lecture, these two projects' cases will be presented by JICA expert, especially from social aspects. It will be expected to increase interest about international cooperation for natural environment conservation and to discuss it with participants.

12. Materialization of green revolution and desertification control by dissemination of lowland Sawah based farming systems in Sub Sahara Africa (16 FEB. 2009)

Toshiyuki WAKATSUKI

Professor, Faculty of Agriculture, Kinki University

Even 40 years after the success in tropical Asia and Latin America, the green revolution is yet to be realized in Sub Sahara Africa (SSA). The lecture discussed the Sawah hypothesis (I) and (II). The first Sawah hypothesis (I) explains that the central to the realization of the rice green revolution in SSA is eco-technologies, which can improve farmers rice growing environment, such as lowland sawah eco-technologies. The second Sawah hypothesis (II) explains that sustainable rice productivity of lowland sawah is more than 10times than that of upland rice fields, if appropriate lowlands are selected, developed and managed. The sawah based rice farming can overcome both low soil fertility and scarce water resources through the enhancement of multi-functionality of sawah type wetlands as well as geological fertilization processes in watersheds. The sawah systems can even enhance the restoration of degraded watershed through the sustainable expansion of afforestation to form a watershed agro-forestry, i.e. the creation of African SATOYAMA systems, which will combat global warming in future. SATO means villagersU habitat and YAMA means multipurpose forest managed by villagers. Both terms are from Japanese. Because of intensive sustainability of lowland sawah systems, the degraded upland fields can be converted to multipurpose forests, which will eventually contribute the global warming.

13. Human Security in Semiarid area: Experiences of International Development Cooperation in Post-Conflict Guatemala (5 MAR. 2009)

Tomomi KOZAKI

Professor, Senshu University

A 36-year armed internal conflict in Guatemala (1960-96) made great deal of havoc particularly in rural Mayan communities. The direct victims reach, at least, into 200,000 deaths, 45,000 disappeared, and hundreds of thousands of refugees and internally displaced persons, the total number is estimated to surpass 10% of the entire population. Among the victims, the Maya indigenous population accounted for 83%. Their 626 communities were eradicated literally from the map.

According to the World Bank, over half of all Guatemalans – 56% or about 6.4 million people – lived in poverty in 2000. About 16% lived in extreme poverty. Over 81% of the poor and 93% of the extreme poor live in the countryside. Poverty is also significantly higher among the indigenous (76% are poor) as compared with the non-indigenous population (41% are poor).

In the seminar, further analysis of poverty and vulnerability of Guatemala was explained in detail from the view point of Human Security. The current situation analysis highlights the urgent necessity to address the Human Security issues of the indigenous population.

To cope with the Human Security issue, we believe that it is imperative to coordinate the following two activities at the micro and medium level:

- (1) Elaborate research on the pressing human security issues
- (2) Empowerment of local communities

Our general framework for action-oriented research with the food security as its central pillar was presented. Among others, we focus attention to the cultivation of amaranthus, which is a species of crop of Mesoamerican origin, and because of its high nutritional value and fertility. Cultivation of this crop provides not only food but also good opportunities of non-formal education and improvement of living conditions for adults, especially for adult women who generally have received little formal education. Furthermore, it is worthwhile to note that, if appropriately processed and coordinated, the crop has a potential for commercialization.

As an empowerment of local communities, we organized a JICA's training course "Capacity Development for Guatemalan Public Policy Planning" from 2005 for three years. The results and impacts of the training were also presented.

14. Marginal-quality Water Resources and Salt-affected Soils in Dry Areas (5 MAR. 2009)

Manzoor QADIR

Senior Researcher, International Center for Agricultural Research in the Dry Areas, Syria

15. Bread Wheat Breeding for Tolerance to Abiotic and Biotic Stress (5 MAR. 2009)

Osman ABDALLA

Senior Researcher, International Center for Agricultural Research in the Dry Areas, Syria