

2.3 Joint Research

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

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An estimation of soil moisture conditions in an semi-arid region using satellite data incorporated in a numerical model

Dai MATSUSHIMA and Reiji KIMURA*

Growth Examination of Crops with Spectral Characteristics

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

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*Kotaro TAGAWA**, *Tsutomu HAYASHI*, *Makio KAMICHIKA* and *Reiji KIMURA*

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*Choichi SASAKI** and *Tahei YAMAMOTO*

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*Koichi TAKEYAMA**, *Akira HIGUCHI* and *Tahei YAMAMOTO*

Sandy soil conservation by recycled non-wood fiber trays application

*Ikuo FURUKAWA**, *Yoshinori SHIMOHURO*, *Shogo MATSUNAGA*, *Hisao SONE* and *Tahei YAMAMOTO*

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*Roy KINGSHUK** and *Tahei YAMAMOTO*

Importance of surface soil in arid area on fertility conservation - germination and growth characteristics of pioneer plant and soil properties

*Yuichi ISHIKAWA** and *Tahei YAMAMOTO*

Research on the mechanism of soil surface evaporation and salt accumulation

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*Nobuo TORIDE** and *Mitsuhiro INOUE*

Sampling mechanism of a wick sampler for percolating water on a sand dune field

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Preferential flow effect on solute leaching

Hiroyuki CHO, Delroy GERRIT, M. A. MOJID and Mitsuhiro INOUE*

Evaluation of infiltration capacity of unsaturated soil considering behavior of pore-air

Koji KAMIYA and Mitsuhiro INOUE*

Characterizing Hydrological Processes in Degraded Lands by Direct Infiltration Water Sampling

Yasushi MORI, Nao TAKADA, Yuko MATSUMOTO and Mitsuhiro INOUE*

Study on Efficient Water Harvesting Using Capillary Barrier of Soil

Toshihiro MORII and Mitsuhiro INOUE*

Research on field-scale estimation of near-surface soil water content using ground-penetrating radar in arid land

Yuji TAKESHITA, Hayato SUWA, Akihiko HIROMATSU, Masato USHIO and Mitsuhiro INOUE*

Effect of amount of supplied water on yield and quality of cucumber grown in vinyl house

Satoshi YAMADA, Koji INOSAKO and Mitsuhiro INOUE*

Prediction and control of salt accumulation near the soil surface wetted by drip irrigation

Haruyuki FUJIMAKI and Mitsuhiro INOUE*

Effects of various mulching materials on the growth and quality of vegetable irrigated with diluted sea water

Kensuke KONDO, Qingtao ZHANG and Mitsuhiro INOUE*

Poverty reduction programmes in arid regions in Africa

Fumiko HAKOYAMA and Hiroshi NAWATA*

Resource use and resource management in the semi-arid lands :the case of cattle pastoralism

Kazunobu IKEYA and Hiroshi NAWATA*

Study of the Material Culture on the Sinai Peninsula of Egypt

Mutsuo KAWATOKO, Yoko SHINDO, Risa TOKUNAGA and Hiroshi NAWATA*

Sand drift control by surface irrigation on Yumigahama sandy field

Makio KAMICHIKA, Takayuki KAWAI and Tahei YAMAMOTO*

Study on methods of transplanting improved mulch and green manure varieties, *Lippia* sp., for the

purpose of land reclamation in arid and semi-arid areas

Hitoshi KURAMOCHI, Hideo MIYAMOTO and Mitsuru TSUBO*

(2) Summary of Joint Research

A-1) Land-atmosphere interaction in arid regions

Measurement of Latent Heat Flux by Sonic Anemometer and Thermo Couple

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Measurement of latent heat flux with sonic anemometers (SAT) and fine thermo-couples was proposed (Hanafusa et al., 2004) but has not applied to practical use because of response time of thermo-couple and it's recording. We applied to high response amplifier and resolved this problem.

Spectrum of temperature measured by fine thermo-couple is comparable with that by SAT. Therefore, we concluded that the response of fine thermo-couple is reasonable for this purpose.

Daily total latent heat flux by our method is 10% smaller than that with SAT and IRGA but regime of our method was parallel to that by SAT and IRGA and this means our method is valid for measuring latent heat flux.

An Estimation of Soil Moisture Conditions in an Semi-arid Region Using Satellite Data Incorporated in a Numerical Model

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The spatial distribution and the seasonal change of the thermal inertia, which is the product of the heat capacity and the thermal conductivity of soil, was investigated in terms of the estimation of the soil moisture in the Mongolian steppe region. The thermal inertia is appeared as a parameter in the prognostic equation of the earth surface temperature, which appears a strong function of soil water content in principle. An improved surface heat budget model which can incorporate the thermal-infrared brightness temperature from a satellite into the own model.

The results suggest the estimation of the thermal inertia retrieved from the heat budget model was correlated with the soil moisture in the Mongolian steppe in the summer of 2003, but the estimation was still qualitative, and was not suitable for practical use on the daily basis. The monthly average of the retrieved parameter and the soil moisture, which was product of the AMSR-E satellite sensor, agree well.

Growth Examination of Crops with Spectral Characteristics

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The cultivation style of tea is so differently other crop. So, it was most significant factor to estimate optimum harvest period with real time. Spectral reflectances of tea canopy were measured by 2 different installments during the new leaves growing period. Additionally, due to investigate yield and quality after time of the harvest, 2006 year was investigated longer than usually.

From the spectrum measured by difference installment, it confirmed that there were similar tendency with 3 years repeat investigation. It was suggested that determination of the most optimum picked day associated with yield and quality of tea leaves. These results showed the possibility of the determination of the most suitable picked day with quality and yields of these new leaves.

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

Studies on the Flow Meter Using Pipe Bend

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There have been a number of studies on measuring methods and instruments, but their costs were very high. On request of lower production costs and low energy, studies on the use of 90° bend pipe flow meters have been done, but the installation of equipment was disadvantageous. By installing 180° bend pipes on any main straight pipe section without influencing flow direction or constructing pipeline system, the main flow discharge will be defined by the proportion of the bypass flow discharge. Procedure of designing bypass flow meters was brought out by introducing orifices with different diameters into bypass route based on the obtained experiment results. As bypass flow discharge is very small in comparison with main pipe flow discharge, using a small flow meter installed on bypass route will considerably reduce system costs. Moreover, flow meter of float type is also installed on bypass route in order to rapidly and accurately determine flow discharge consequently the control and management of the quantity of water irrigated become easier and more convenient. This matter is really meaningful, especially when it is applied in large scale to irrigating systems in agriculture.

Keywords. Bend pipe, low cost, flow meter, irrigation system, orifice

Reduction of Vaporization at Ground Surface Using Hydraulic Discontinuity

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Reduction of vaporization at soil surface is the control of phase transition of water, from liquid to gaseous. Hence, that is to control of hydraulic continuity of liquid water at the soil surface.

Soil dries in certain condition, so-called pendular saturation, we can see catenoid shaped liquid water at contact points of soil particles. At this condition, water in liquid phase (pendular ring) held by own surface tension against gravity, and isolated each other in pressure. In this pendular saturation, driving force of soil water movement is not pressure gradient but potential one. Hence there still remain unclear in the study of adsorbed water. Therefore the definition of technical term of pendular ring is important for the progress of water movement in soils.

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

Physical and Biochemical Characterization of Plant Roots in Tolerance Response against Environmental Stresses

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Environmental stresses such as draught, salinity, acidity and alkalinity of soil strongly affect plant growth. This research aims to unveil the working process of these environmental stresses on the mechanical and chemical properties of cell walls in plant roots. The cell wall of plant roots provides mechanical strength on roots and its extensibility finally limits the elongation growth of the roots. Thus cellulose and other cell wall components are conceived to change their composition by these stresses. The roots of woody plants are able to develop woody cell walls in soil and make mechanically harder cell walls than herb plants, thus the cell wall changes in woody plants may be more remarkable.

We used white adventitious roots of tea cuttings, which bears soft cell walls and matures woody cell walls, and cell wall compositions were compared among soil-grown, hydroponics-grown, mist-spray-grown roots.

Materials and methods: Cuttings of tea [*Camellia sinensis* cv. Yabukita], six months - one year-old cuttings grown in the field of NARO Kanaya Station, Shizuoka Prefecture, were transplanted to soil in plastic pots(soil-roots), hydroponics with Konishi's medium (hydroponics-roots) with or without the inhibitor of gibberellin biosynthesis (ancymidol)(ancymidol-roots), and mist spray culture(mist-roots) with Konishi's medium without growth regulators. Apical 8 mm segments of secondary branched newly

appeared adventitious roots were collected and every one mm segments were consecutively excised for the quantification of cell wall polysaccharides.

Quantification of cell wall polysaccharides were carried out according to the previous methods used for pea roots (Tanimoto and Huber 1997). High molecular-weight pectin was extracted by mild-CDTA and low molecular weight by hot-CDTA extraction. Then hemicellulose 1 and 2 were sequentially extracted by 1 M and 4 M KOH solutions, respectively. Alkaline-insoluble fractions were dissolved in 70% sulfuric acid and solubilized sugars were quantified as cellulose.

Results and Discussion: The most apical 1-mm zone contained highest content of pectin and the pectin content in the mist-roots and hydroponics-roots were higher than soil-roots and ancymidol-roots. High pectin level in the tip of mist- and hydroponics-roots declined rapidly towards basal zones, whereas cellulose content complementarily increased to the basal parts of these roots. Cellulose contents of soil- and ancymidol-roots were higher than mist- and hydroponics-roots throughout the 8-mm roots. Hemicellulose 1 changed in parallel with pectin content, i.e. complementary to cellulose content but hemicellulose 2 showed little change along root zones and among growth conditions. According to the neutral sugar analysis of hemicellulose, xylose-containing polymers such as arabinoxylan was suggested to change in response to mechanical stresses and to gibberellin-deficient stress.

These results suggest that the formation of cellulose microfibrils and embedding of pectin in the cell walls of apical part of roots are regulated by the culture conditions of roots with changes in mechanical stress and gibberellin-deficient stress.

Silicon Deposition and Its Contribution to Stress Tolerance in Agricultural Plants

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Silicon deposition in plants was investigated using the X-ray microanalysis. In addition to the Si accumulation to specific tissues of some agricultural plants (e.g., cereal crops, soybean, sunflower) reported in our previous studies, we found some wild plants deposit silica to species-specific positions in leaves. Analysis of Si content and distribution in seeds of some *Artemisia* species, which are expected as greening plants in desert areas of Western China, and investigation of the eco-physiological meanings of Si accumulation in seeds are in progress.

Si deposition induced by wounding was detected in leaves of sorghum and cucumber. The Si deposition proceeded in several hours after the injury with deposition of lignin around the injured part. The result suggests that silica as well as lignin plays important role to the dressing of the injury in leaves of Si-accumulator plants. On the other hand, Si deposition was not detected around the injury in roots of Si-accumulator plants.

Characterization of Water Use Properties in Cowpea (*Vigna sinensis* Endl.) Varieties

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In crop species, expression of deep rooting has been thought to be efficient in enhancing drought tolerance. This conventional understanding, however, does not seem standing on demonstrations indicating that deep roots are as efficient in water uptake as shallow roots. In this study, patterns of water uptake or stomatal response were examined in relation to root length and leaf area for upland rice and soybean.

Plants that have high proportion of root length to leaf area show high water uptake rate, in turn, that results in high transpiration and stomatal conductance. Supposed some plants possess low ability of water uptake, the plants would show low transpiration rate or stomatal conductance compared with plants with high water uptake ability at a given root length/leaf area ratio (RL/LA). According to this theory, the relationship between RL/LA and water uptake (or transpiration rate) or stomatal conductance was examined in the plants whose effective rooting depth was differed. Upland rice and soybean plants were grown in double layer pots in which soil culture was used in upper tubes, and hydroponics in lower pots. Length of the upper tube was differed by 0.15, 0.4 and 1.0m. One to two months after sown with adequate water supply, irrigation to the upper pots was withheld before measurements. Afterward, water uptake from the lower pot, stomatal conductance and root length/leaf area ratio were measured.

The transpiration rate and stomatal conductance generally increased with increase of the root length/leaf area ratio. In soybean, there was no or less difference in the relationship, that is, the plant with the same RL/LA showed similar transpiration rate or stomatal conductance irrespective of the effective rooting depth. However, in upland rice, the transpiration rate and stomatal conductance were reduced as the effective rooting depth (length of the upper tube) increased. Stomatal conductance of soybean plants peaked at lower RL/LA than that of upland rice.

The observations above indicated that the water uptake ability of upland rice is low compared with that of soybean, and more root density is essential to take up water from deep soil in upland rice.

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

Evaluation of Salinity Tolerance in Wheat with Alien Chromosomes

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Leymus racemosus is a wild perennial species of Poaceae that can grow in seashore and sever environmental condition. We previously produced the hybrids between this species and common wheat by wide hybridization techniques, and obtained, from the offspring, many strains of common wheat with a pair

of the alien chromosomes. This study was aimed to evaluate tolerance to salinity and drought in these strains and to select the strains for breeding materials. We used common wheat cultivar 'Chinese Spring' and eight alien chromosome addition lines carrying different chromosomes of *Leymus* in the genetic background of this cultivar. Salinity tolerance was evaluated by hydroponic culture with NaCl from 20-250 mM. Drought tolerance was evaluated as osmotic stress using medium with PEG from 15 to 23.1%. In conclusion, we did not find strains showing remarkable tolerance to the stresses. However, we identified strains that showed less effect by the stresses comparing to the effect by aneuploidy. More detailed analysis is necessary using better materials as alien chromosome substitution lines that show lower effect by aneuploidy.

Comparative Study on Soil Factor Affected to Biological Production at Desert

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Natural growth of grass applied with material containing iron (new compound ferrous iron organic) was comparatively observed at alkaline soil (pH9.0) in TAKAOKA NIHONKAI mine.

The result of the experiment showed that these material (TypeB, TypeC...FeO 7.5%) were useful in fertilizer response.

Further, these materials were clearly effective at upland rice cultivation on alkaline sandy soil shown pH9.0 in vinylhouse. Application of new ferrous iron compound "TETSURIKIAGURI" was suited from 2.5Kg to 5.0Kg Fe/m².

Characteristics of Soil Carbon Profiles in the Steppe Region, Mongolia

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Characteristics of soil morphological and soil carbon profiles were studied at steppe region in a vegetation transition zone, Mongolia. The presence of a mollic horizon and the accumulation of calcium carbonate (CaCO₃) characterized the soil profiles. The depths of the CaCO₃ accumulation horizon (Bk horizons) differed among the study site. The soil were classified as Calcic Kastanozems. The organic carbon content was high on the A horizon then decreased rapidly with soil depth. The organic carbon content ranged from 10.4 to 21.4g kg⁻¹. The total nitrogen content showed a similar tendency. The organic carbon and total nitrogen contents were related to the results of vegetation coverage. Inorganic carbon was detected in the Bk horizons, but not the A horizons. The presence of inorganic carbon reflects carbonate abundance. These results reflect the amount of precipitation and potential evapotranspiration at study sites.

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

Specific Characteristics for Salt Tolerance Mechanism of Halophilous Plants

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In Okinawa islands, we have typical mangrove species, which are belonged to halophilous plants in the world. These species are *Kandelia candel*, *Bruguiera gymnorrhiza* and *Rhizophora stylosa* in Rhizophoraceae, *Avicennia marina* in Verbenaceae, *Lumnitera racemosa* in Combretaceae and *Sonneratia alba* in Sonneratiaceae.

In this report, we described tolerance of salinity of three tree species in Rhizophoraceae, in Okinawa. These results were observed to use seedlings under the greenhouse conditions. At first, root systems of these tree species prevented absorption salt water into the root, but they did not block entrance of salt water entirely. And second step, overstocked salt ion flowed up in stem to leaves and it was stocked in them. On *Bruguiera gymnorrhiza* seedlings, leaves in which salt stocked fell off and salt was discharged outside the body of the plants. But, *Kandelia candel* and *Rhizophora stylosa* seedlings, leaves did not fall and they wilted up on the plant body. In the flowing of salt water from soil to plant, the behavior of salt stocking was different in these tree species and this fact has deep connection to the tolerance of salinity in them. The order of tolerance of salinity was *Rhizophora stylosa* > *Kandelia candel* > *Bruguiera gymnorrhiza*. And tolerance of salinity was affected by light conditions; this fact indicated that there was a connection with tolerance to salt and tolerance to light.

Studies on the Salt Tolerant Characteristics of Plant and the Desalting of Saline Soil

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The experiments were carried out to clarify the limit of the salt tolerant, the rate of the tree growth, the extent of the evapotranspiration(ET), the saline integration to the upper soil layer, and others by planting *Tamarix* under the different salt concentration. The soils used were the sandy soils which sand and Kuroboku soil mixed with the ratio of 1:1 by volume. The experimental containers are the cylindrical pot of 38cm diameter and 48cm depth. The treatments were four regimes made from the sea-water salt solution diluted. with water and were three regimes made from the NaCl solution diluted. The former regimes were based on as an index of the salt concentration at 0, 1.0, 3.0, and 5.0% and the latter regimes were based on as an index of the salt concentration at 1.0, 3.0, and 5.0%. The ground water level was applied

to about 40cm under the earth surface. Measurement items were the tree height, the tree diameter of base, water supplied to five replications, and the salt distribution. The results obtained are as follows.

Firstly, the largest development of the shoot was observed from 1% experiment pot made with the NaCl solution, and the smallest development of the shoot was observed from 5% experiment pot made with the NaCl. However, the phenomena of the wilting were not observed from all experiment pot. Secondly, the largest ET was observed from 0% experiment pot, and the smallest ET was observed from 5% experiment plot made with the NaCl solution and the sea-water salt solution. Thirdly, more saline integration was observed to the upper soil layer in proportion to the extent of the salt concentration given.

Physiological Studies on Drought and Salt Tolerances in Woody Species

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The purpose of this study is to inspect the salt tolerance of *Populus alba* trees using hydroponic culture. Hoagland solution was used during the exposure of salinity stress. In early growing season, the effect of the 150mM NaCl was drastic and roots of cuttings were killed within 2 days. The photosynthesis (Pn) under the 150mM NaCl rapidly declined soon after the stress initiation. In contrast, other concentrations of salt at 0.15, 1.5 and 15mM did not affect the Pn during the experimental term. In late growing season, dry weights of roots and total plants were increased by the application of 85mM NaCl to the culture solution. However, 150mM NaCl significantly inhibited growth of shoots and stem diameter and dry weight increment of leaves, stems and total plants. The 150mM NaCl suppressed the rate of photosynthesis (Pn) on and after the 8th Day. Salt concentrations at 50 and 100mM gradually decreased the rate of Pn in the latter period of the experiment.

A-6) Soil Degradation in Arid Areas

Fate of Eutrophic Components of Surface Applied Compost and Effect on Surface Mulching on Soil Erosion

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A field study was conducted to investigate the effective application method of composted cattle manure to sloped field for reducing sediment and nutrients losses to runoff. We measured runoff and sediment loss from erosion plots established on Andisol soil with 3.6° slope, with different compost

application methods including: no application; incorporation at 20 t ha⁻¹ and 40 t ha⁻¹; surface mulching at 20 t ha⁻¹. All the plots were maintained on bare for the 1-year monitoring period. Significant runoff events initiated six months after the compost application due to increased frequency of high intensity rainfall in summer season. The runoff and sediment loss from the plots with no compost application were greater than other plots. A trend of runoff and sediment-loss increasing was observed on the plot with the 20 t ha⁻¹ of incorporated compost. The surface mulching and the incorporation with the 40 t ha⁻¹ of the compost showed very few runoff through the monitoring period.

**The Experimental Research on the Replanting Basis Creation
-Application to the Pot and Planter Cultivation-**

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In this study, the base of the new irrigation-replanting technology was established as follows.

The SIMERUS irrigation system is the continuous irrigation system of energy saving, low cost, water saving.

There are two types of tube and tape on this irrigation system.

The tube type suits the field of large scale from the medium scale.

And the tape type suits the field of medium scale from the small scale, as from the pot culture to the planter cultivation.

By this combination, it is possible to maintain the soil moisture environment for the vegetation to the large scale from small scale well.

SIMERUS is Soil Integrated Moisture Environment for Rural and Urban Sustainability.

Mechanism of Transfer of Water, Solute and Heat in Soil

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The solution density at the soil surface is higher than that in the lower zone in salt accumulation phenomena. This problem is called Rayleigh-Taylor instability. It had been considered that the solute transport by this effect was negligible. Recently it was cleared that this effect could not be ignored in the humid case. The process is governed by the non-dimensional Rayleigh number. To analyze this phenomenon, the experiment was performed in a column with a 5cm diameter-and a 10cm height. The column was filled with Tottori dune sand. The soil which was saturated by a NaCl solution in the upper

half of the column and fresh water in the lower half of the column is the initial condition. The experimental results were agreed with the theory of Rayleigh number.

**A-7) Comprehensive Studies of Indicators and Traditional Knowledge
related to Desertification**

Control of Noxious Plants to Plant Production in Semi-arid Regions

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Lotus japonicus roots, cultured in a modified B5 medium, produced and secreted germination stimulants that induced *Striga hermonthica* seed germination. The germination-inducing activity was detected both in the roots and the culture filtrate. Following bioassay-guided purification procedures, an active compound was isolated from hexane extracts of the roots and the culture filtrate. Based on chromatographic behaviour on HPLC, and ¹H NMR, UV, MS and CD spectra, the germination stimulant was identified as (+)-5-deoxystrigol.

Rethinking Desertification from the Human Life Desertification Point of View

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So called desertification is rather human 'desertification', that is, a kind of degradation of human life in dry regions. The cause and the mode of manifestation are essentially various as the natural and human conditions are extremely different according to different dry lands. In this project the hot sub-saharaan dryland (savanne) without solid economic development nor administrative infrastructure is compared to the cold inner Mongolia dryland where economic development is big and administrative infrastructure is strong. One of the results is presented at the International Symposium held at Huhhot in July 2007 about the theme of 'Environment Protection and Sustainable Development in Chinese Dry Regions'.

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

Studies on Land Use Change in the Loess Plateau (China) by Remote Sensing/GIS Analysis and Field Survey

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The purpose of this study is to clarify changing land-cover and land-use in the Loess Plateau since 1980s (especially 1999-present, during which the 'Grain for Green' project is under operation in this area), using remote sensing/GIS, statistical data analysis and field survey.

In a preliminary study which was conducted in the previous year, Landsat data were used for diachronic analysis, and rural districts around Yen-an were selected for ground truth operation and intensive socio-economic research. In this year, research was conducted mainly from two dimensions: (1) evaluation of 'Grain for Green' project using albedo value which is an effective index for a measurement of vegetation recovery, (2) households' economic survey with special reference to peasants' coping strategy against income decrease accompanied with afforestation. As a result, albedo values clearly showed forest recovery in this area. In a micro level observation, this forest recovery are mainly found in the afforested area of the Grain for Green project (namely abandoned agricultural fields or grazing lands). Survey on peasants' economic strategy, on the other hand, showed several problems in terms of economic sustainability. It is necessary to conduct more detailed research in this dimension.

Results of the research was reported in several meetings and symposiums, including the 36th Conference of COSPAR in Beijing, 15th-23rd August.

Standardization of the Indicators for the Long Term Monitoring of Desertification

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The development of Benchmarks and Indicators in order to monitor and assess desertification and the establishment of operational and cost-effective Early Warning Systems (EWS) for drought and desertification are among the principal items on the agenda drawn up by the Committee on Science & Technology (CST) under the UN Convention to Combat Desertification. In this study, to understand the desertification process actualized in the order of several years, apply the Revised Universal Soil Loss Equation (RUSLE) developed by the University of Michigan estimated the amount of the soil erosion

(Water erosion) thought to be one of the most important Indicators of desertification.

RUSLE estimates erosion rate by climate, topography, soil and vegetation. Because RUSLE is a kind of empirical equation, it is necessary to tune and validate using field observation data. By correlating with field survey, experiment sites were established in Inner Mongolia, and the observation data was used to examine the accuracy of RUSLE. Then, 11-year water erosion data was estimated by RUSLE.

Results, water erosion increased around Khangai Mountains and a belt of steppe region in Mongolia. Then, from the benchmark grazing pressure from field survey, the corresponding benchmark soil erosion rate was calculated. Then, we counted how many years the erosion rate was greater than the benchmark, and the number of counts was mapped as desertification status (Figures 1 and 2). A small number of counts mean that the erosion rate is over the benchmark only in the humid years. A large number of counts mean that the erosion rate is always over the benchmark, which means more desertification risk.

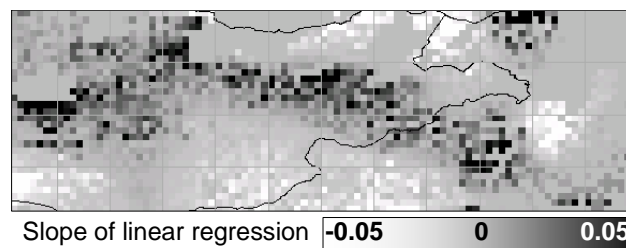


Figure 1 Trend of water erosion (1988 ~ 1999)

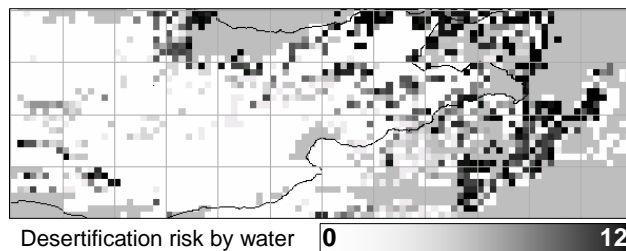


Figure 2 Desertification risk by water

Basic Investigation for Constructing the Humanities and Social Network about the Loess Plateau Desertification Measures

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(1) Field research (September, 2006)

We surveyed in Chinese Ocher Plateau was. We visited Yulin, Dadog, Ansai and Shenmu. Moreover,

we visited the Center for history geography research of Fudan University in Shanghai.

(2) Report by the joint research symposium (December 9, 2006)

It reported on this research in the joint research symposium of the Arid Land Research Center, Tottori University.

(3) Symposium "The future of China, Ocher Plateau, and Japan" (February 17, 2007)

Was held Symposium "The future of China, Ocher Plateau, and Japan". Reporters were 16 people and the participant exceeded 100 peoples. The NPO Green Earth Network's Kunio Takami lectured. the Arid Land Research Center, Tottori University and The University of Tokyo and Gakushuin University's scholars reported. And Ocher Plateau ecology culture recovery activity related Fukao Yoko reported.

C) Free Subject on Arid Land Studies

A Study on Water Making System to Improve the Life of People Living in Arid Land

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The Purpose of this study is development of a water making system that can produce good quality water for drinking, medical treatment and irrigation useful for the life of people living in the arid region, using electric power generated by renewable energy (especially, wind energy). In this study, 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. The experiments for the water maker using the Pertier device were performed in a controlled chamber. The effects of the electric power supplied to the Pertier device, the equipment configurations and the air-flow direction in the radiating channel on water production rate were investigated in the experiments. The water production rate increased due to keep the cooling fin at the lower temperature with the promotion of radiating from the Pertier device in the case of passing the air in the radiating channel in the opposite direction to the flow of the air in the cooling channel and attaching the duct at the each channel of the top surface of the device for preventing mixing of the cooled air and heated 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. From the experimental results in the case of the temperature and relative humidity from autumn to spring season, it was found that the cooling channel was occluded by the frosting on the cooling fins in the cooling channel.

Development of a Desalination System of Seawater or Brackish-groundwater with Refrigerant Process applying for Environmental Restoration Techniques in Arid Land

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In order to obtain irrigation water by desalination of seawater in the coast area of arid land, the experiments of ice making from brackish water and sea water were performed by using a jet-spray type ice machine. The characteristics of the demineralization in ice making process were shown from the results of the experiments.

The cubed ices were made from 1 - 5 wt% NaCl aqueous solution and seawater in the icing process of the experiment. The mass of the ice in the ice making process was measured. The ices put in a bowl were melted naturally in the atmospheric temperature, and then the concentration of the solution obtained by melting the ice was measured.

It was shown that the concentration of the solution from the ice were lower than that of NaCl aqueous solution from the experimental results. The ices made from the salt water were milky and the surface of the ice was rough in comparison with the ice made from distilled water. Furthermore, the concentration of the solution obtained in the early stages by melting the ice was higher than that of the solution in the later stages.

It was finally confirmed the concentration of the solution obtained by melting the ices was approximately halved. It is shown that the desalination of brackish water and seawater by ice making process was possible.

Satellite Based Land Aridity Monitoring

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1. The satellite derived day/night temperature difference (DNTD) correction method is established. The DNTD derived from the polar orbit satellite sensor such as NOAA/AVHRR is affected by the atmosphere and the observation angle. To compensate these effect the the split window based estimation scheme which uses the brightness temperature at 10.8 and 12.0 μ m. Compensation error is defined from the numerical simulation, the result is up to 1.8 [K] in the error standard deviation.
2. For the estimation of the heat capacity and the related thermal parameters of the various land cover, the solution of the bulk formula from the continuous land cover temperature measurement is derived. The derived heat capacity of vegetation and concrete is separated, but under some weather conditions, the solution could not be converged.

Mechanisms of Salt Tolerance among Several Miscellaneous Crops

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High salinity decreases crop growth and yield, but its severity can be mitigated by a large amount of precipitation, and good drainage to streams, rivers, the sea and deep water table. There is a short-term reduction in salinity after precipitation in saline desert sites and arid regions. Buckwheat may be suitable for cultivation in saline conditions because its growing period is very short. However, Mechanisms of salt tolerance of buckwheat is not clear. Metabolic injury caused by sodium ion mainly affects crop growth and yield and this may be reduced by application of small amount of calcium. Our objective was to investigate the differences among three buckwheats in the response to salinity with or without calcium based on dry-matter production and yield.

Common buckwheat (*Fagopyrum esculentum* L. cv. Tsushima and Shinano), Tartary buckwheat (*F. tataricum* (L.) Gaertn. cv. Pontivy and Phapal) and perennial buckwheat (*Fagopyrum cymosum* Meisn.) were used. Salt treatment was initiated by adding NaCl at 50 mM and increasing the concentration to 100 mM with or without 1mM or 10mM CaCl₂ two weeks later. As a control, some seedlings were cultured in half-strength Hoagland and Arnon's nutrient solution without NaCl and CaCl₂. To investigate the role of roots in salt tolerance, we cut off the roots including the basal stem below the cotyledonary node of several plants on 8 days after the start of treatment, and cultured the rootless plants in 100 mM NaCl solution for 2 days. Leaf area and dry weights of whole plant were measured one day before and 8 days after the start of treatment, also at the harvest. The shoots were dried at 65 °C for 48 hours after exposure to 110 °C for 30 minutes. Plant growth rate (PGR) was estimated. About 0.5 g each of the oven-dried leaves, stems (including petiole) and roots of control and salt-treated plants harvested days after the start of treatment were digested with sulfuric acid and hydrogen peroxide. Leaves and stems of the rootless plants harvested 10 days after the start of treatment were also digested in the same way. The contents of Na⁺ and K⁺ were determined by atomic absorption spectrophotometry. Atomic intensity of sodium ion on the surface of xylem vessel in the stem was investigated by ion micro analyzer attached SEM.

The treatment with 50 mM NaCl significantly lowered the plant growth rate (PGR) in all buckwheat species. The PGR decreased to 24% and 4% of the control in perennial species and Pontivy, respectively. This plant growth recovered with application of CaCl₂ in all buckwheat species. PGR of all buckwheat species significantly correlated with Na⁺ of leaf at 1% level. Pontivy accumulated a larger amount of Na⁺ in the leaves than Tsushima. The difference in Na⁺ accumulation in the leaves thus seemed to be related to the difference in salt tolerance among the three species. Na⁺ accumulated in the leaves rapidly in salt susceptible species during the two days after roots were removed. The Na⁺ content of the leaves in the plants after removal of roots to that in the plants with roots remaining was 2.5 and 6.0 times increased in Shinano and Phapal, respectively. The treatment with 100 mM NaCl significantly lowered the plant growth rate (PGR) in all buckwheat species. The PGR decreased to 20% of the control in perennial species and Tshushima and 2% in Pontivy. The plant was died in Shinano. This plant growth recovered with

application of CaCl_2 in all buckwheat species. There is no grain in perennial species, Shinano and Tartary buckwheat, however, there is some grain in Tsushima. Grain yield recovered by addition of CaCl_2 in all buckweats. Grain weight correlated with total plant weight and with harvest index significantly. Pontivy accumulated a larger amount of Na^+ in the leaves than Tsushima. The difference in Na^+ accumulation in the leaves thus seemed to be related to the difference in salt tolerance among the three species. Na^+ accumulated in the leaves rapidly in salt susceptible species during the two days after roots were removed. The Na^+ content of the leaves in the plants after removal of roots to that in the plants with roots remaining was 2.5 and 6.0 times increased in Shinano and Phapal, respectively. Sodium ion increased two times by salt stress at xylem vessels of the stem in Tsushima and more than 16 times in Shinano and Tartary buckwheat. In conclusion, Tsushima show the strongest of salt tolerance because maintenance of photosynthesis and leaf growth by decreasing and isolating Na^+ . Calcium may decrease the injury of Na^+ in all growth stage. Optimal concentration of calcium depends on the variety or species.

Eutrophication at a Pine Stand Devastated by Pine Wilt, and its Effects on Regeneration of Pine Seedlings

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In this study, we examined the effect of ectomycorrhizal fungi on the soil-borne disease in *Pinus thunbergii* seedlings. We used 3 ectomycorrhizal fungi dominated in *P. thunbergii* forests (healthy forests), 3 ectomycorrhizal fungi dominated in *Robinia pseudoacacia* forests (unhealthy forests) and 1 ectomycorrhizal fungus common to both forests. Under low-intensity light condition, the survival rates were higher in the pine seedlings inoculated with ectomycorrhizal fungi originated from healthy forests than in the seedlings inoculated with those originated from unhealthy forests. In addition, *Suillus granulatus* (ectomycorrhizal fungi dominated in healthy forests) significantly inhibited the mycelial growth of pathogenic fungi.

We concluded that the ectomycorrhizal fungi dominated in healthy forests facilitate the resistances of pine seedlings to soil-borne disease and play important roles in disease resistances of pine seedlings.

Assessment of Climate Change Impacts on Irrigated Agriculture in Arid Region Using the Irrigation Management Performance Assessment Model (IMPAM)

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For assessing performance of irrigation management, an integrated water movement model: Irrigation Management Performance Assessment Model (IMPAM) was developed. Recently, irrigated agriculture has a public pressure to reduce water use for conservation water resources and preservation of hydrological regime of river basin. Moreover, future global climate change can provide modified climatological and hydrological conditions, resulting in another challenge or constraint to the agricultural production and irrigation system.

The developed model IMPAM can simulate water balance and crop yields of an irrigation scheme as assessment indicators. It also evaluates the possibility of changes in water use and balance with alternative water management practices and adaptation to climate change impacts. IMPAM include the factors concerned with irrigation management such as rotation pattern of irrigation, seasonal and spatial pattern of cropping, physical structure and arrangement of irrigation and drainage facilities, and water resource (river and ground water). In addition, meteorological data, landuse pattern, geological and soil characteristics are given as forcing data. Since the model should be able to assess the management practices and policies on water balance of scheme level as well as on-farm level, and it is necessary to deal with spatial information such as landuse and facility arrangement, IMPAM was developed as a grid-based quasi-three-dimensional model. Crop-root water absorption module, irrigation water distribution module drainage module and groundwater irrigation module are assembled on a quasi-three dimensional soil water movement module.

IMPAM was applied to the Lower Seyhan Irrigation Project (LSIP) in the eastern Mediterranean coast of Turkey, to diagnose the present irrigation system and project future possible changes with global warming in irrigation management and crop productivity. Four scenarios were set for the simulations: a) present management under the present climate, b) present management under projected climate in the 2070s, c) reduced irrigation water supply under the projected climate in the 2070s, and d) extensive adoption of drip irrigation under the present climate. The results of the simulation prove that current irrigation management with the present irrigation system and water supply may adapt to the impacts of future climate changes that are likely to occur in the 2070s. Extension of groundwater drip irrigation system may affect irrigation management system and water balance and of the LSIP considerably rather than by climate changes.

Water Use of Wheat in Semiarid Zone

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In the Mediterranean zone such as Adana in Turkey wheat sometime suffers from drought during terminal stage. Furthermore the effect of elevated temperature by global warming in this area is concerned. A curve liner relationship between relative transpiration (T/T_0 , T is transpiration rate under desiccated condition and T_0 under irrigated condition) and FTSW in vegetative or early reproductive stage has been observed regardless of ambient or elevated CO_2 conditions. When watering for spring wheat cv. Adana99 was withheld from pots at flowering under ambient condition, T/T_0 decreased with a decrease of FTSW

and the response at the grain filling and vegetative or early reproductive stage were similar. Therefore the response curve should be available for sub-model to estimate the suppression of estimated biomass production through the effect of transpiration rate by soil desiccation in diverse stages. The result did not include the effect of elevated temperature and CO₂ on the response of T/T₀ to FTSW but the similar response in elevated conditions could be expected.

Effects of Drought Stress on Eco-physiological Characteristics of *Sabina Vulgaris*

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and *Shigenobu TAMAI***

In order to clarify the physiological mechanisms that allow establishment of *Sabina vulgaris* in different light conditions under a *Salix cheilophila* canopy in the frost-prone Mu Us Sandy Land of northern China, the photochemical efficiency of photosystem II at predawn (F_v/F_m) and the pigment composition of the needles of *S. vulgaris* seedlings in various light conditions were examined in late summer and winter. In the summer season, the F_v/F_m values of all seedlings were around 0.80. The ratio of chlorophyll (Chl)-a to Chl-b (Chl-a/Chl-b ratio) increased with growth light conditions. In the winter season, the F_v/F_m decreased considerably depending on growth light conditions. Although the Chl-a/Chl-b ratio remained the same in the summer season, changes in carotenoids such as lutein, the xanthophyll cycle pigments, and b-carotene were detected, particularly under high light conditions. These results suggest that changes in pigment composition against high light and/or low temperature may alleviate photodamage and contribute to establishment of the seedlings in a frostprone semi-arid land.

Studies on Transpiration from Pine Forest

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Relationship between the sap flow and meteorological condition was demonstrated over the pine forest in Tottori sand dune. Sap flow increased linearly with increased solar radiation and PAR, and while increased linearly with increased VPD (<0.2kPa). Over 0.2kPa of VPD, such a tendency was not found. This suggests that there was a limitation for sap flow even if the meteorological condition was better for the transpiration.

Nitrogen Cycling in Semi-arid Area

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Litterfall production, the amount of organic matter on the forest floor, and litter decomposition rates were studied in an exotic nitrogen (N)-fixing black locust plantation and an indigenous non-N-fixing oak forest on the Loess Plateau. The C and N concentration of litterfall and soil was also examined. Litterfall production was similar in the two forests. However, the amount of N in litterfall was greater in the black locust plantation than in the oak forest because of the high N concentration of black locust leaves. The decomposition rate of black locust leaves was higher than that of oak leaves. These results suggested that N cycling was greater and faster in the black locust plantation than in the oak forest, however faster decomposition caused the disappearance of the organic layer from the forest floor in the black locust plantation. The soil N content was lower than in the oak forest, indicating that the black locust plantation might be more susceptible to soil erosion than the oak forest.

Mechanism of the Change of the Tottori Sand Dune into Grass Land: How Plants Use Nitrogen in Sand Dune?

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Recently, the Tottori sand dune has been invaded by many plant species, but the mechanism of the plant invasion into such a nutrient poor condition is still unclear. We hypothesized that N-fixing plants species has an advantage in the nutrient poor sand dune, and that N-fixing species provide nitrogen to the sand associated with themselves in the nutrient poor sand dune. Nitrogen use of N-fixing plants and non-N-fixing plants and the effects of their distribution on N condition in sand were investigated in the Tottori sand dune.

Nitrate is one of available forms of nitrogen for plants, and plant nitrate use can be estimated by measuring nitrate reductase activity (NRA) without disturbing N condition in soil by isotope tracer. Therefore, we measured NRA of two N-fixing species (*Robinia pseudoacacia* L. and *Elaeagnus umbellata* Thunb.) and two non-N-fixing species (*Vitex rotundifolia* and *Racomitrium japonicum*), in addition to plant nitrogen concentration and carbon concentration. Sands associated with sample plants were also collected, and ammonium, nitrate, nitrogen and carbon pool sizes were investigated.

Nitrate reductase activity was detected in all four species, and *Racomitrium japonicum* showed the highest NRA. It indicated that all four species had capacities to use nitrate as nitrogen source. Nitrogen

concentration was higher in the N-fixing species than in the non-N-fixing species, while total nitrogen pool size and nitrate pool size were highest in the sands associated with *Vitex rotundifolia*. Ammonium pool size in sand showed no significant difference among species. Therefore, it is concluded that N-fixing species had no higher effect on nitrogen condition in sand than N-fixing species in the Tottori sand dune.

On the Water Transport Characteristics in Relation to the Xylem Structure

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Water transport capacity through the xylem depends on the anatomy of conduits. The larger diameter vessels produce higher hydraulic conductance of xylem, however, they also have higher xylem vulnerability to cavitation. How tree species construct the xylem structure and maintain the water transport capacity in a dilemma that they can not maximize both the hydraulic conductivity and the tolerance to cavitation? In this analysis, we analyze the hydraulic conductivity in relation to the xylem structure using a tree species with different xylem porosity. For our analysis, we used two ringporous wood species, *Quercus serrata*, *Zelkova serrata* and one diffuseporous wood species, *Betula platyphylla* var. *japonica*. The measurement was conducted before and after leaf flushing (April and August to September), and after leaf shedding (December). Through ringporous wood species, *Quercus serrata*, showed the high percentage loss of conductivity because of the large diameter vessels, it secured the high water transport capacity before leaf flushing due to the formation of newly vessels. While, diffuseporous wood species, *Betula platyphylla* var. *japonica* tended to have the low hydraulic conductivity before leaf expanding; however, it had the low percentage loss of conductivity because of the small diameter vessels. Ringporous wood species, *Zelkova serrata* showed the intermediate properties.

Change of Groundwater Quality in the Upland Field at Byobusan Sand Dune Area

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Groundwater quality in Byobusan sand dune area of northwest Honshu island is of concern, not only in agricultural aspects but also for conservation of surrounding water bodies such as Japan sea. Therefore this study was conducted in two fields (1.4km and 2.1km away from Japan sea) to evaluate the groundwater quality in the sand dune area. Plastic tubes were installed to collect groundwater of 2.0 m, 2.5 m, 3.0 m and 3.5 m depth. The sampling was performed every month from April 2004 to November 2005. Assessment of groundwater quality was performed on the basis of pH, electric conductivity (EC), dissolved

oxygen (DO), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe) nitrate nitrogen (NO₃-N) and phosphate phosphorus (PO₄-P).

The results showed that EC, pH, DO, Na, K, Ca, Mg, and NO₃-N concentration in groundwater were decreased with increasing depth whereas the opposite trend was observed for Fe. Iron concentration in groundwater of the study area was found always >5 mg L⁻¹ which may cause injury in cultivated crops if groundwater is used for overhead sprinkler irrigation. Since groundwater of the study area contained low concentration of Na and SAR values, there would not be any possibility of sodium hazards from irrigation. Potassium concentration was about ten as high as the average value of Japan rivers. Therefore we worry about the effect to the sea by the fertilizer.

Amelioration of the Environment of the Water and Soil by Artificial Zeolite or Aeration

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Amelioration of the environment soil by artificial zeolite showed the increased yield of marsh grass in Tottori Prefecture. And the aeration in closed water area in Aichi Prefecture, and experimental results as COD condition and etc. showed the effects of amelioration of water quality, and the micro bubble (air) should be ensured the oxygen condition in the water tank. These are presented in next JRCSA conference.

Sandy Soil Conservation by Recycled Non-wood Fiber Trays Application

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Soil erosion is one of the factors that can destroy soil physiochemical characteristics and affect plant productivity. Using some amendments such as recycled non-woody fiber trays (eco-trays) could help in stabilizing soil particles and reducing soil erosion effects. The experiment of this study was carried out at Arid Land Research Center of Tottori University Japan. The eco-trays were mixed with sand dune soil.

The objective of the study was to evaluate the effect of eco-trays in soil physiochemical properties including soil erosion, organic decomposing and their effect on plant growth. Sweet potato plant was planted in treated and non-treated soil and finally the soil was covered with black plastic sheet. The plant was irrigated frequently with small amount of water.

The experiment started in May 21st, 2006 and until July 1st, the growth of sweet potato was good without any side-effect of eco-trays application. The mixed paper started to decompose forming organic

matter. The decomposition process improved physiochemical properties of the soil by increasing water holding capacity and providing much water and nutrients to the plant. In July 2nd, the field was probably attacked by wild pigs and unfortunately it destroyed all grown crops. Due to this condition, the experiment was stopped and further care should be taken in any future work. Finally, it can be concluded that eco-trays system was helpful by improving physiochemical properties of the soil and supporting plant growth.

Salt Adsorption Effect of Artificial Zeolite while Applying to Arid Land Soil

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Effective use of artificial zeolite (henceforth, zeolite) in saline soil of arid land was examined in present research. At the first stage of the research, saline soil (sandy soil) was prepared artificially, and Ca-type zeolite was placed in the form of sheet (henceforth, adsorption sheet) on the saline soil to investigate its (zeolite's) salt-adsorption capacity. The experiment-result showed a decrease of the exchangeable Ca-ion and an increase of the exchangeable Na-ion in the saline soil. The analyses indicated that such a phenomenon was observed because of the ion-exchange reaction occurred between the soil and the zeolite as Ca-type zeolite contained a lot of exchangeable Na-ions too in it. Moreover, the EC also showed a decreasing tendency with the increase of clay ratio of soil in each part (top, middle and bottom layers) of the experimental pots. On the other hand, the pH value showed an increasing tendency after the placement of the adsorption sheet. The overall results indicated inability of salt adsorption of zeolite while applying to sandy saline soil.

Based on the results of the first stage, we changed the application method of zeolite to saline soil. The zeolite to be applied was pre-treated by acidification and the acidic-zeolite was mixed with the saline soil (second stage of the research). The experiments and analyses are ongoing and will be reported in future.

Importance of Surface Soil in Arid Area on Fertility Conservation - Germination and Growth Characteristics of Pioneer Plant and Soil Properties

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Wheat bran, that is outer shell of wheat grain and is produced in the milling process, is tested as soil additives in order to moderate salinity problem. Barley was cultivated on a cropping field located on semi-arid region in Western Australia and determined soil chemical properties after the cultivation. Soil Electric Conductivity, exchangeable sodium, and C/N ratio was approved by adding wheat bran. The results were obtained from the recovery effect of wheat bran on soil characteristics and crop health. Continuous application of bran was expected further effect.

Research on the Mechanism of Soil Surface Evaporation and Salt Accumulation

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As a remedial measure to prevent waterlogging, biological drainage is noteworthy due to low-cost as compared with physical drainage. We conducted a basic research to make clear the water-absorbing ability of a plant and its transpiration features using two units of “desertification mechanism analysis systems” which consists of a weighing lysimeter covered with a chamber. This system demonstrates properties at controlled temperature, relative humidity and wind. We selected a two-year old alba (*Populus alba* L.) as an experimental plant. Under several initial groundwater levels in each column, we monitored groundwater level, soil moisture contents, evapotranspiration (ET), air temperature, humidity, and so on using respective sensors. The results are summarized as follows: 1) Groundwater level lowered with increasing cumulative ET, however, the lowering of groundwater level stopped at around 90 cm below the soil surface. This depth is likely to be the lowest limit of groundwater level that can be lowered by both the evaporation from the soil surface and the transpiration from the plant. 2) The volumetric soil moisture content showed decreasing trend, on the other hand, soil water tension showed increasing trend throughout the monitoring period. Daytime variation of both soil moisture content and soil water tension surpasses as compared with that of night-time. During daytime, soil moisture content decreases due to active photosynthesis, and this causes the increase of soil water tension.

Water Flow and Solute Transport in Undisturbed Soils

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Water flow and solute transport are heterogeneous due to the inherent nature of undisturbed soils. Water flow and solute transport through undisturbed Andisols in Kumamoto, Japan, having aggregated soil structure were investigated on the basis of solute dispersivity for saturated and unsaturated flow conditions. The dispersivities for the saturated undisturbed soil were significantly greater than for the disturbed soil, ranging from approximately 3 cm for the surface soil column (25-55 cm depth) to 38 cm for the sublayer soil column (60-90 cm depth). The dispersivity increased with the travel distance from 2 cm to the maximum value for the sublayer column because of preferential bypass flow through narrow pore space. On the other hand, the scale dependency did not appear for the surface column. Since plant roots distributed uniformly in the surface soil, solutes mixed well laterally in the surface column, resulting in the relatively constant dispersivity with the travel distance. The dispersivity for unsaturated conditions was sufficiently

lower (< 1.4 cm) than for saturated conditions. Furthermore, the difference between the surface and sublayer columns became small. As water content decreased, macro pore flow could no longer be dominant and solute transport became uniform in the undisturbed column. Hence, the dispersivity for the undisturbed soil became close to those for the disturbed soil for unsaturated flow conditions.

Sampling Mechanism of a Wick Sampler for Percolating Water on a Sand Dune Field

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This study was conducted to determine the hydraulic properties and sampling ability of a wick sampler (WS) in a laboratory and a sand dune field. The steady state percolating experiment was conducted by using an artificial rain fall facility in a laboratory. In a bare sand dune field, WS was inserted at 0.55 m of depth. The micro-meteorology, soil moisture and matric potentials around the wick were measured for a year. Moreover, numerical experiments using HYDRUS-2D were conducted to analysis a sampling mechanism of WS.

The results were summarized as follows; 1) van Gunuchten's equation could be used as a water retention curve of a wick. 2) the saturated hydraulic conductivity was 1.44×10^{-2} cm/s. 3) the sampling rate for percolating water was estimated 375 % as a result of water balance analysis. 4) there was no time lag between the starting time of sampling and of discharge under the adequate interval of rain fall events, 5) there was time lag at the rain fall event after successive draught condition, 6) the lag caused that sampling water was used to recharge the dried wick in the WS.

Preferential Flow Effect on Solute Leaching

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Fingered flow rapidly moves water and pollutants from the root zone to the groundwater through a limited fraction of the unsaturated zone, limiting the possibilities for decay and adsorption. We developed a Green-Ampt based expression for the pressure head in a developing induction zone (from which fingers protrude) for the time before fingers developed. The equation excellently fits data from 2D fingered flow experiments if the dynamic water entry suction is treated as a fitting parameter, but we could not compare the fitted values to independent measurements of the water-entry suction. We therefore 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 tubes with different type of porous material; sand, glass beads, loam, volcanic soil and silt, and installed microtensiometers to measure pressures in these material.

It was examined that this equation could provide the dynamic water entry suction and the hydraulic conductivity at that value if the quantity of water flux supplied at soil surface and pressure values for at least one point close to the surface were measured.

Evaluation of Infiltration Capacity of Unsaturated Soil Considering Behavior of Pore-air

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Knowledge of the hydraulic properties of unsaturated soil is necessary to evaluate the seepage behavior of rainfall into the ground. It is especially important to understand the influence of the behavior of pore-air on the water seepage in an unsaturated soil. In this research, the experimental relationships between the air permeability coefficient and the degree of water saturation of unsaturated sandy and silty soils were considered in comparison with the water characteristic curve. The applicability of the air permeability coefficient models for expressing this relationship was examined. The following conclusions were obtained.

1)The relationship between air permeability coefficient and degree of water saturation shows hysteresis in the drying process and the wetting process when the uniformity coefficient of grain size distribution is nearly one. The values of air permeability coefficient during the drying process are smaller than that during the wetting process.

2)It is possible to conclude that the air permeability model based on the Burdine theory is more applicable than the one based on the Mualem theory for estimating air permeability coefficient from the water characteristic curve during the drying process.

3)The parameter ξ for pore tortuosity in the air permeability model are varied for each soil and drying and wetting process. Furthermore, it is suggested that the hysteresis mentioned above is caused by the difference in the pore tortuosity for air flow channel in both of drying and wetting processes.

Characterizing Hydrological Processes in Degraded Lands by Direct Infiltration Water Sampling

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Degradation of surface soil is a worldwide problem, which affects regional watershed and quality of

water resources. Because stream water includes time delay from load input and mixing process with other water resources, it is challenging task to estimate the cause of soil degradation. In this research, we developed an inexpensive and easy to use capillary glass fiber device with which we sampled and analyzed infiltration soil water quality. Precipitation, through fall, trunk flow, soil water and stream water were collected and analyzed by ion-chromatography, TOC and TN to see the effect of management induced soil degradation in a mountainside; one was well maintained with thinning operation and the other was roughly maintained. Sulfate ion was found in the well-maintained mountainside with heavy rainfall which it was not detected in the roughly maintained one, which showed the weakness of infiltration process in roughly maintained mountainside; moreover, buffering process had not sufficiently worked in that mountainside. Soil degradation processes in two mountainsides were effectively compared using soil infiltration water.

Study on Efficient Water Harvesting Using Capillary Barrier of Soil

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A capillary barrier consists of a fine layer of soil overlying a tilted coarse layer of soil under unsaturated conditions. It is well known that a grass cover growing over the soil surface affects on the amount of rainfall water infiltrating into the soil. The effect of the grass cover on the rainfall infiltration into soil should be clarified to obtain an effective development of the capillary barrier system of soil layers. In this year, this effect was investigated based on a measurement of moisture movement conducted in a sand soil slope.

The sand soil slope 4m long, 1.7m high was selected to monitor the moisture movements in soil. Two plots each 1.6 m in width, one with grass cover and another without grass cover, were prepared on the sand soil slope, and an amount of daily rainfall and moisture contents in soil were measured by using a rainfall gauge and a profile probe 40cm long, respectively, during 105 days from the beginning of June, 2006. Followings are observed:

(1) Grass covering the soil surface decreases the amount of rainwater infiltration into soil in the case of low intensity of rainfall. But this effect of grass cover on the infiltration of rainwater becomes small under the heavy rainfall whose intensity of daily rainfall is greater than some to 50 to 100mm..

(2) It is also observed that the soil under the grass cover becomes dry because of uptake of the plant roots. Thus it should be understood that, in the soil slope with grass cover, the change of moisture amount in the soil becomes lager than that in the bared soil.

Research on Field-scale Estimation of Near-surface Soil Water Content Using Ground-penetrating Radar in Arid Land

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A fast, simple and nondestructive procedure to measure near-surface soil water content profiles in unsaturated sandy soils is proposed. Surface ground-penetrating radar (GPR) system is employed to estimate the average soil water content in the survey region as a function of the soil dielectric constant measured by electromagnetic wave velocities. GPR has a couple of advantages over the intrusive soil moisture sensors. GPR system offers a simple approach for in-situ determination of soil water content and a completely non-intrusive measurement. GPR may be a suitable for low-cost mapping of soil water content profiles in large sample volume. The utility of our proposed method was demonstrated by using field infiltration experiments for Tottori dune sand.

Effect of Amount of Supplied Water on Yield and Quality of Cucumber Grown in Vinyl House

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** Arid Land Research Center, Tottori University

Fruits yield was examined with varying soil moisture tension in a vinyl house, and the maximum yield was obtained in driest treatment (495-500cmH₂O) at last year. However, there was a time-lag until irrigated water reached at a soil moisture sensor located 10 cm below the surface of soil, indicating a possibility of further reduction of supplied water. In this study, cucumber plant was cultivated in a vinyl house in faculty of Tottori University with 4 levels of total supplied water without using the soil moisture sensor. As a standard plot (100%), irrigation water was supplied so as to keep soil moisture to field capacity. And the amount of supplied water was reduced at 3 dried plots (60%, 30%, and 20%). Cultivative management except for irrigation was according to the common way. Results obtained were as follows;

1) Fruits yield were 1.29, 1.40, 1.50, and 1.26 kg plant⁻¹ at 100%, 60%, 30%, and 20%, respectively, and the maximum yield was obtained at 30% plot. 2) Total amount of supplied water was 5.7, 3.2, 1.9, and 1.2 m³ at 100%, 60%, 30%, and 20%. 3) Water use efficiency for fruits production was 31.6 g L⁻¹ at 30% plot.

These results indicated that supplied amount of water accounting for maintaining field capacity should be reduced to obtain higher fruits yield. Quality parameters, such as content of total vitamin C, nitrate, and calcium are under analyzing.

Prediction and Control of Salt Accumulation near the Soil Surface Wetted by Drip Irrigation

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We have developed a software for predicting two dimensional movement of water and solute considering the water vapor movement and effect of salt crust on evaporation. To test the validity of the model, laboratory experiments using soil tank under a wind tunnel were performed. Drip irrigation with 3,000 ppm NaCl solution was applied to an initially solute-free soil. The alternative direction implicit FDM (ADI) was used in the simulation. For water flow, Celia(1990)'s mass-conservative iteration scheme (for water) was applied. Independently measured hydraulic and solute transport properties were used in the numerical analysis. Results indicated that the evaporation rate was overestimated. It was likely due to inability in predicting salt crust at the soil surface proximity to the emitter. The reason why salt crust formed proximity to the emitter is still unknown and further basic study is needed.

Effects of Various Mulching Materials on the Growth and Quality of Vegetable Irrigated with Diluted Sea Water

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Drought and salinization are two limiting factors for agricultural production in many arid and semi-arid regions. Freshwater resources in these areas have been overexploited, so diluted sea water has some appeal. It was investigated that the effects of various mulching materials on salt accumulation and water use efficiency of Swiss chard irrigated with diluted sea water.

Mulching and diluted sea water tended to improve soil water content and reduce evapotranspiration, so mulching and diluted sea water irrigation improved yield and water use efficiency. Compared with non-mulching treatments, the EC1:5 for mulching treatments was effectively reduced, especially in 0-5 cm soil layer. Gravel mulching and pine leaf mulching were more effective than rice straw mulching in reducing salt accumulation. Gravel mulching had the best effect on preventing evapotranspiration and improving soil water content. The variation in water use efficiency for the various mulching treatments followed the order, gravel mulching > pine leaf mulching > rice straw mulching > non-mulching, which was the same trend observed for yield. Thus, gravel and pine leaf mulching may be good materials for sustainable agricultural production, especially under diluted sea water irrigation.

Poverty Reduction Programmes in Arid Regions in Africa

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1 . Eradication of Guinea Worm in Mauritania

In Mauritania, there were 8301 cases in 511 villages in 1990, which diminished to 3 cases in 3 villages in 2004. This project began in 1990 with identification of cases and sources of contamination, and their mapping. The eradication strategy includes sensitization of habitants, distribution of filters to the contaminated areas, treatment of “abate” at contaminated sources, and medical treatment of patients. The most important activities are:

- Training of Guinea worm agents selected among village people.
- Training of health workers
- Report/supervising tour system establishment
- Executing supervising tours every 3 months, analyzing reports, and adjusting strategies
- Mapping the contaminated areas, and following new cases

This project has established a system which was closely related to, and substitute in part, the public health systems which are very weak. It can be considered a sort of alternative and/or supporting system to the public health system. The Guinea worm project is characteristic for its Guinea worm agents and supervision/report system, which are considered as the major factors for its success.

However, this system requires constant financial input to maintain the supervising tours and Guinea worm agents. Now that the project is almost terminated, and so are the aids from foreign organizations, the fulfillment of the national health system (i.e. continuing the supervising and training system to be undertaken by the national authorities) is an urgent need.

2. Poverty in Africa and measures to be taken for its alleviation

Statistical data show acceleration of enlarging differentials in the world to the detriment of African countries. The reasons for this trend are numerous but sociologically speaking, major reasons are lack of education, desertification resulted in migration of nomads to cities, and increase of women-headed households.

There have been coping systems for survival. In Africa, these have been strong family/ community ties (which are jeopardized by desertification/ migration), traditional ways of living (which are jeopardized by market/ global economy), and diasporas support (which can be considered as the international version of traditional domestic support system.)

International Agencies have struggled for poverty alleviation through their various projects in the area of community development, WID (women in development), income-generating activities, micro-credit, e.t.c. The world trends in the international assistance have been shifted from individual projects to global programmes. And the majority of these programmes flag the poverty alleviation as the common objective. The collaboration between indebt and assisting countries as well as international organizations have been proved to be imperative: positive results of lessons learnt from the past.

3. Water Management and Waste Disposal in Urban Areas in Mauritania

In search to resolve problems due to the urbanization caused by the desertification, I studied water management and waste disposal projects in Nuakchott, capital of Mauritania. The hygienic situation is very bad there: one-third of the children among 0-5 years old who visit hospitals suffer from diarrhea, and more than half of school children have parasites.

It is imperative to improve the quality, price and access to the drinking water. The “Borne Fontaine Project” in Nouakchott has proved to be a successful drinking water project thanks to engagement of the

community authorities and habitants.

There are no public garbage collecting systems which are operating closely to the habitants in Nouakchott. Only exist small private companies. This situation is harmful both to the habitants and the workers (the majority of whom are very young: 13 to 25 years old.) According to a recent survey, gaarbage-workers are very vulnerable to diseases and wounds (for example, 82% of workers had back ache, and 80% had been injured during recent 2 weeks.) A project to improve this situation has recently started in Nuakchott. It organized jobless youngsters, providing them with training and equipment. The sensitization of the habitants in introducing new concepts of paying money for the garbage was also a crucial factor for the success of the project.

As a conclusion, the involvement of concerned local parties and the use of traditional local expertise are the key to poverty alleviation.

Resource Use and Resource Management in the Semi-arid Lands :the Case of Cattle Pastoralism

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*National Museum of Ethnology

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The aim of this study is to describe and analyze the migration pattern among the cattle herders in the semi-arid Africa. This is considered in the context of environment changes such as rainfalls and also changes in regional livestock economy. The results of this research are summarizes as follows.

The two types of migration rout like the linear and area was shown. Linear's pattern was found in the migration along the river, or that between along the river and on the hills. Area's pattern shows irregular migration. And the distances from camp to camp show 7-15 km per one time and about 110 km per year.

Study of the Material Culture on the Sinai Peninsula of Egypt

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*The Muddle Eastern Culture Center in Japan

**JSPS Fellow

*** Arid Land Research Center, Tottori University

The Sinai has been the principal maritime connection between the Mediterranean and the Indian Ocean worlds from ancient times. In order to clarify the history of East-West maritime relations and the transformation of material culture the Red Sea Area we conducted an archaeological survey in the Raya/al-Tur Area, including the excavations at the port city of Raya (about the 6th-12th centuries) in the southwest part of the peninsula, the Monastery of Wadi al-Tur (about the 6th-12th centuries) and the port city of al-Kilani (about the 13th century to the present). We also conducted multiple surveys of this area,

whose hinterland is the Monastery of Mt. Sinai (St. Catherine's Monastery). The surveys included excavations, surveys of rock inscriptions to clarify trade and pilgrimage routes, anthropological studies of the Bedouin and study of excavated objects from the sites, in collaboration with specialists in other fields such as philology, cultural anthropology, linguistics, epigraphy, architecture, urban engineering, physical anthropology, botany and analytic chemistry. Our comprehensive study of the material culture of this area revealed the organically-interrelated trilateral structure which is composed of 1. Monasteries and monks and Greek Orthodox Christians, 2. Port city and city and the Muslims and 3. Trade and pilgrimage routes and the Bedouins, and also it clarified the cultural exchanges with the Mediterranean world, Syria and Palestine, Arabian Peninsula and the Gulf region, Southeast Asia and China.

Also a meeting was held in February in Arid Land Research Center, Tottori University to discuss the result of this survey and the future surveys and studies.

Sand Drift Control by Surface Irrigation on Yumigahama Sandy Field

Makio KAMICHIKA, Takayuki KAWAI** and Tahei YAMAMOTO***

*Tottori University of Environmental Studies

** Arid Land Research Center, Tottori University

Study on Methods of Transplanting Improved Mulch and Green Manure Varieties, *Lippia* sp., for the Purpose of Land Reclamation in Arid and Semi-arid Areas

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*Weed Science Center, Utsunomiya University

**Idemitsu Kosan Co., Ltd.

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(3) Summary of Open Seminar

Topic of Open Seminar (Date)

Name of Speaker

Occupation of Speaker

Summary of Open Seminar

1) Working with IITA stations –How it's like and Way of apply- (Apr. 11, 2006)

Satoru MURANAKA

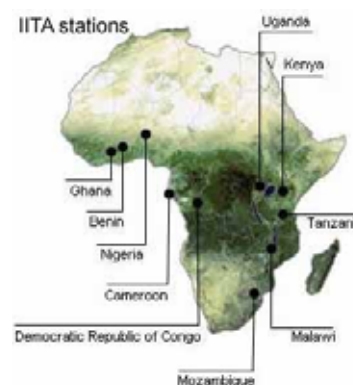
Post-doctoral fellow, International Institute of Tropical Agriculture

The seminar was held as follow-up activity of the “COE program for Arid Land Science” hosted by Arid Land Research Center (ALRC), Tottori University which accommodated the presenter (S. Muranaka) for on-the-job training during April – Dec, 2004. The seminar was intended to introduce the activities of International Institute of Tropical Agriculture (IITA) and job opportunities in IITA to young Japanese scientists and students willing to work on “Arid Land Science”.

IITA based on Sub-Saharan Africa is one of the International Agricultural Research Centers supported by CGIAR and intended to be Africa's leading research partner in finding solutions for hunger and poverty. More than 100 international scientists based in 12 IITA stations and several project sites across Africa are working on various agricultural problems in Sub-Saharan Africa.

Activities of IITA are grouped into several programs reflecting diverse environmental condition and agricultural practices across Sub-Saharan Africa. IITA Kano station where presenter belongs is located in northern Nigeria (annual precipitation: 800mm) and has good accessibility to several research sites of Nigeria and Niger with diverse annual precipitation (300 - 1200 mm). With this geographical advantage, Kano station is acting as a key research site for the Cereal and Legume Project of IITA and is hosting several projects (e.g. KKM pilot site of Sub-Saharan African Challenge Program, Gatsby Crop-livestock integration project). Kano station has also served as cowpea breeding center of IITA and releasing many varieties with various beneficial characteristics for farmers (e.g. extra early maturity, pest and disease resistance, high-yielding). And, to enhance the cowpea breeding activity, molecular biological and physiological approaches to support conventional breeding have been carried out on *Striga* resistance, drought resistance and intercropping adaptability in Kano station.

Recently, the needs of biochemical and physiological studies on various issues are become conscious among IITA scientists and IITA is eager to seek new collaboration with Advance Research Institutes (ARI) and Universities. Currently, on some challenges of IITA Kano station, Nagoya University, Kobe University and JIRCAS are contributing from plant physiological aspects. Under these circumstances, Japanese young scientists in these areas can have great opportunity to work with International Agriculture Research Institute, like IITA.



2) The present state of crop breeding in developing countries: the case of Pakistan (May 11, 2006)

Malic Ashiq RABBANI

Plant Genetic Resources Institute, National Agricultural Research Center, Pakistan

Pakistan is basically an agrarian country, earning about 35-40% of the national income from agriculture. Agriculture contributes 24% to the GDP, employs >46% of the country's total labor force and supports directly or indirectly 68% of population for their sustenance. It contributes about 60% to total export earnings derived from raw and processed agricultural commodities. Agriculture provides food, feed and raw materials for major industries, such as textile, sugar and to several other medium and small scale industries which account for about 50% of total value of industrial production. Pakistan has a total area of 80 million hectares, 27% of which is cultivated, while 8% of in under forests. Geographically, Pakistan has diverse climate ranging from sub-tropical to temperate and alpine forests. The wide variation in geography, altitude, soil, climate and culture have created a rich floristic diversity comprising of approximately 6000 species of higher plants. Systematic efforts to collect crop germplasm started in the early 1970s. In 1993, Plant Genetic Resources Institute (PGRI) was established and a decent facility for germplasm storage and associated research was established at NARC, Islamabad with the financial and technical assistance from JICA. PGRI has a mandate to explore, conserve, evaluate and document the plant biodiversity of Pakistan for the benefit of our future generation. The institute not only provides vital support to national crop improvement programs in the form of required germplasm but also act as a trustee of genetic resources of cultivated plants and their wild relatives. It has linkages with national crop coordinators, research institutes/universities and other NGOs working for biodiversity conservation. It also works in close collaboration with international research and development organizations to implement work plan. Currently around 22,000 accessions of more than 150 crop plant species are being conserved for distribution to research institutes and public. The indigenous material is also tested for various biotic and abiotic stresses. The other priority areas are maintenance of vegetatively propagated crops, keeping the germplasm free of pathogens and pests, and documentation of genetic resources for access through electronic media.

3) Dynamics of salt after forest clearing for grazing and the potential for salinity development in a semi-arid catchment in Australia (Jun. 13, 2006)

Dr. Velupillai RASIAH

Department of Natural Resources and Mines, Queensland, Australia

In general, salinity is one of the major issues in arid and semi-arid environment. It has implications in agricultural productivity, water quality, ecology and health of streams, terrestrial biodiversity, soil erosion, flood risk, and infrastructures and fixtures. Approximately 5.7 mil ha of farmland in Australia are currently under salinity risk and is projected to increase to 17 mil ha by 2050. The current economic cost of salinity is \$3.5 bil/yr. Most of Australia's landscape is salt (**hazard**) and sources of the salt is usually that deposited by rain over millions of years and/or derived from parent rocks. In undisturbed systems the salts are held deep in the profile. The deep rooted vegetations in undisturbed systems kept the water-table down and controlled the groundwater hydrology. After European settlement during the last 100 yrs the deep rooted vegetation has been removed for several purposes, primarily for agriculture, and replaced by annual shallow rooted crops. This practice decreased the total annual evapotranspiration and led to increases in

recharge and gradually rising groundwater table, which brought the salt to depths < 2m (**risk**).

In the Queensland state in Australia, approximately 107,000 of agricultural land are under serious salinity risk and this is expected to rise to 3.5 mil ha by 2050. We conducted a study in a near semi-arid catchment to investigate the link between the hazard and risk using the changes in chloride distributions in profiles, as signature indicator, after deforestation and subsequent use of the land for grazing and/or cropping. Using a hydraulic rig, soil cores were taken from 6 sites, across the catchment, representing different cropping systems and soil types that are approximately 30-40 years after deforestation and from the nearby undisturbed forest to 6-m depth as background. The cores were segmented at 50-cm depth increment and sub-samples from each depth increment were analysed for chloride, pH, EC, and selected cations.

Across the 6 sites, the narrowest Cl distribution under forest ranged from 0 to 541 mg kg⁻¹ compared with 57 to 747 mg kg⁻¹ for pasture and the widest under forest from 61 to 4761 mg kg⁻¹ and 341 to 3422 mg kg⁻¹ under pasture. Similar trends were observed for the EC and pH distributions. Regardless of the landuse, the Cl and EC increased with increasing profile depth, whereas no such consistent trend was found for pH. The comparison of paired Cl distribution curves indicated that most of the changes after deforestation occurred in the top 2 m. Compared with the native forest Cl accumulation occurred, in the top 2 m, in 3 out of the 6 downslope pasture sites and Cl leaking from one downslope pasture. Compared with the native forest no changes in Cl distributions were observed in 5 out of the 6 upslope pasture sites and an accumulation at the remaining one site. The stepwise multiple regression analysis for the data pooled across the 6 sites indicated that Cl distribution depended on the systems variables; soil depth, EC, and landscape position and the management variable the landuse practices (forest vs. pasture/cropping) ($R^2 = 0.66$). The Cl distributions in the undisturbed forest indicated conditions were favorable for accelerated lateralflow at < 2 m and limited vertical flow at depths > 2 m. The results show the forest profiles are inherently sodic (hazard) and may become saline in the top 2 m (risk) at downslopes after deforestation.

4) Genetic variation of soybean germplasms in Asia (Jun. 21, 2006)

Donghe XU

Japan International Research Center for Agricultural Sciences

Soybean (*Glycine max* (L.) Merr.) was domesticated in East Asia, where various kinds of landraces have been established as a result of adaptation to different environments and the diversification of food cultures. Wild soybean (*Glycine soja* Sieb. & Zucc.), which has been thought to be the wild progenitor of the domesticated soybean, is densely distributed in China, Korea, Japan, and Far East region of Russia. These two species can be crossed to produce easily fertile offspring. Asia is thus an important germplasm pool of soybean. To get a better understanding of the genetic relationships among soybean populations of different geographical regions or ecological types in Asia, kinds of DNA markers (RFLP, SSR, RAPD, DNA sequencing etc.) were used to analyze the genetic variation of the soybean germplasms in this region. DNA marker analyses revealed that the wild soybean has a considerably higher genetic diversity than the cultivated soybean, indicating that wild soybean is a potential genetic resource for improvement of the cultivated soybean. As to the cultivated soybean in Asia, The Japanese and Chinese soybeans formed different germplasm pools and the Korean accessions were involved in both germplasm pools. On the other hand, most of the accessions from southeast and south/central Asia were derived Chinese germplasm pool. This suggested that Chinese and Japanese soybean germplasms can be used as exotic genetic resources to

enlarge the genetic bases of the respective Asia soybean populations. Regarding the different ecological types, soybean varieties with different ecological types in a region might have been developed from the local genotypes. The results obtained by the DNA markers analyses provided valuable information for efficiently using the soybean germplasms grown in Asia.

5) Development and molecular cytogenetic identification of wheat-alien hetero –chromosome lines (Jun. 21, 2006)

Zhiguo WANG

Center for Agricultural Resources Research,
Institute of Genetics and Development Biology, CAS, China

Wild relatives of wheat had abundant and valuable genes for wheat improvement. Rye (*Secale cereale* L.), an important wild relative of wheat, contained good traits such as resistance to diseases, tolerance to abiotic stresses, and high yield potential. It has played a remarkable role in wheat improvement.

In order to introduce the favorable genes into wheat, a rye landrace “German White” and a winter wheat variety “Xiaoyan No.6” were crossed. The hybrids were selected based on the diseases response, the qualities of seed sets, and wheat-like plant type. Fifty-one lines of BC₂F₄ with good agronomic appearance and high resistant to diseases were analyzed by the methods of chromosome counting, genomic *in situ* hybridization, and two-color fluorescent *in situ* hybridization. The results were as follows:

1. The chromosome numbers of the 51 lines were 41-44 and the genetic composition of these lines was relatively stable.
2. The genomic *in situ* hybridization results revealed that 23 of the 51 lines harbored the rye chromosomes or segments and different patterns of rye chromosomes were present in wheat background.
3. The genomic composition of six lines was confirmed by the two-color fluorescent *in situ* hybridization with pSc119 and pAs1 that were labeled with fluorogreen and fluorored, respectively.

The results showed the genomic composition of BC97-2 was $2n=40W+DS$ (2D/2R), BC-122 was $2n=41W+6R+6BS$, BC-116 was $2n=40W+DT$ (1RS/1BL), BC-152 was $2n=41W+MT$ (1RS/1BL), BC-16 was $2n=42W+1RS$, BC-133 was $2n=40W+2t(6BS)+2t(6RL)$.

Finally, the status and perspective about application of wheat-rye 1RS/1BL translocation and multiple identification approaches of alien chromatin in wheat background were discussed.

6) Progress in photoautotrophic micro-propagation technology (Jun. 21, 2006)

Wenke LIU

Institute of Environmental and Sustainable Development in Agriculture,
Chinese Academy of Agricultural Sciences, China

The report gives a brief introduction of photoautotrophic micropropagation (also called sugar-free tissue culture) method and a newly developed environmental control system, and also explains the reason why we need to develop control system for culture room or culture vessel. Using this control system, the environmental factors (temperature, relative humidity and CO₂ concentration) can be controlled in the

range suitable for plantlet rooting and growth. The control precision of temperature, relative humidity and CO₂ concentration are control value \pm 0.1 , control value \pm 5%, and control value \pm 50 ppm, respectively. For control system developed for culture vessel (180 L in volume), only CO₂ concentration is controlled. Its control precision is control value \pm 50 ppm.

7) Dynamics of the environmental contaminant nitrate in fluctuating groundwater in a wet tropical catchment in Australia (Jul. 4, 2006)

Dr. Velupillai RASIAH

Department of Natural Resources and Mines, Queensland, Australia

Large quantities of mineral nutrients, particularly nitrate, are being transported to the Great Barrier Reef (GBR) lagoon, which is a UN listed World Heritage Area, from the northeast Queensland agricultural catchments of Australia. An in-situ study on the impact of applied soluble N on GBR coral health indicated coral processes were affected by high N levels. Dissolved nitrate concentrations in near-shore monitoring stations receiving runoff from intensively cultivated sites are much higher than the less intensively cultivated. It is therefore suggested that nitrate loading to GBR is a major issue affecting its health. The loadings were estimated from major flow events that occurred during the summer rainy or wet season. Less emphasis has been placed on N-flux from lateral and/or base-flow discharges, which occur between major rain events and immediately following the wet season and this account for more than 60% of total annual flow in the streams. In this presentation the impact of selected factors controlling the dynamics of groundwater and the nitrate in it during the rainy season, at catchment scale, are explored.

The depth to groundwater (GW) and the nitrate in it were measured from 32 bore wells, at least at 10-15 day intervals during 1-5 consecutive rainy seasons. The GW in the 32 wells rose, after a short lag-time, from depths > 10 m and fluctuated between < 1 m to > 4m throughout a given rainy season, and receded to depths approximately similar to that existed before the rains set in. The depths to GW were shallower (i) as the season progressed, (ii) high seasonal rainfall, (iii) in sandy soils than in clay, (iv) when closer to surface water bodies, (iv) on downslope than on upslope, and (v) in shallow wells than in deep aquifers. Nitrate concentrations in the GW were (i) higher when the GW rose initially (ii) higher when the rainfall was high, (ii) no consistent existed with the rise and fall of the fluctuating GW, (iii) decreased as the season progressed, (iv) higher in sandy soils than in clay (v) less when closer to surface water bodies, (vi) less on downslope than upslope, and (vii) less in deep aquifers than in shallow. The results indicate that nitrate dynamics was controlled primarily by that of GW. The rapid decrease in GW after the rains ceased suggests potential exists for the nitrate to be discharged as lateral-flow into creeks/rivers. This may contribute to the deterioration in the health of down-stream aquatic ecosystems, including the GBR.

8) A low-tech and low-cost soil physical property as a holistic soil physical health indicator (Aug. 1, 2006)

Dr. Velupillai RASIAH

Department of Natural Resources and Mines, Queensland, Australia

In the wet tropical high-risk agricultural catchments in Australia soil erosion and the associated sediment transport to off-site aquatic ecosystems have been identified as serious production, sustainability, and environmental issues. To reverse this situation, several agencies have been encouraging growers,

particularly sugarcane and banana, to switch to management practices that will reduce/minimise soil erosion and sediment transport to off-sites. Growers are, however, seeking reliable low-cost low-tech indicators to self-assess the effectiveness of the changed management practices. The responses of soils to changes in management practices are defined by indicators, which reflect soil health. Several soil properties have been proposed as indicators to characterise the health of soils and in general they are broadly grouped in three categories: physical, chemical, and biological. Soil physical health is characterised by indicators such as bulk density (BD), water retention, conductivity, infiltration, least limiting water range, soil strength, dispersible clay, and stability and distribution of water stable aggregates. However, a most appropriate indicator would be the one that integrates the impact of several processes/functions in soil. In this presentation we will assess whether the low-tech total porosity (TP) possesses the ability to (i) discriminate the changes in land use practices from forest to cropping and land management practices under cropping and (ii) characterise the changes in other soil physical processes/functions, thus allowing consideration of TP as a holistic soil physical health indicator. The depth incremented (10-cm) TP in the rows and interrows (clean bare) of banana from 4 sites and the corresponding forest sites were computed from bulk density measurements. Similar measurements were also taken from three interrow grass-cover treatments from a field plot experiment. The compacted depth in banana rows, compared to forest sites, ranged from 35 - 45 cm and from 35 - 100 cm in the interrows. The TP in 10 cm depth increments in the forest > rows > interrows. The soil structural parameter term [(clay+silt)*soil organic C] and soil disturbance parameter term accounted for approximately 70% of the variability in the changes in TP in the compacted depths. Out of the three interrow grass-covers assessed for their ability to decrease the compaction-induced reduction in TP, only the indigenous grass was found to be significantly effective about 18 months after establishment. The sorptivity parameter for the forest soils ranged from 0.50 to 0.89 cm sec^{-0.5} compared with 0.17 to 0.49 cm sec^{-0.5} for banana the soils, indicating that infiltration was significantly reduced under cropping and this could lead to increased surface run-off and sediment transport, particularly from interrows. The ability of TP to discriminate forest vs. cropped soil, rows vs. interrows, soil types, interrow grass-cover management options, soil structural term, infiltration and the run-off and sediment transport processes inferred from infiltration indicate that TP can be used as a low-tech holistic soil physical health indicator.

9) Fifty years of research experience on Foggara Oases in Syria, Algeria and China

(Aug. 28, 2006)

Iwao KOBORI

Senior Programme Advisor, the United Nations University

A *Qanat* is an underground subterranean water channel in dry regions that serves as a source of drinking water. Almost all researchers on *Qanat* have focused on its origins, diffusion and dispersal; only a few studies have been conducted for its rehabilitation. As *Qanat* systems are globally distributed, even at the present time, re-evaluation of such systems with appropriate case studies are highly recommended. The system is known by different names in different regions: it is called *Foggara* in Algeria; *Falaj* in Oman; *Karez* in Iran, Afghanistan, Pakistan and China; and *Khattara* in Morocco.

I started my research on *Qanat* and *Karez* Oases in 1956, when I extensively observed *Qanat* in Iran and in West Asia, at first as a member of the Tokyo University Iraq-Iran archaeological mission. Since that time, I have extended my field work to other parts of the world, to confirm *Qanat* systems *in situ* as a

geographer. As it is difficult to conduct global research alone, I have concentrated on carrying out intensive research on the evolution of *Qanat* oases in three regions: Tidikelt (Algeria), Palmyra Basin (Syria), and Turpan Basin (China). I also have visited Iran several times to refresh my knowledge on Iranian *Qanat*, and have collected first-hand information on *Falaj* in Oman, the Arabian peninsula in general, *Khattara* in Morocco, *Karez* in Turkmenistan, and small, similar systems in Latin America and elsewhere.

Through my research and observations, I have found that this unique and indigenous technology (probably invented in the Iranian plateau) is now in danger of fading away if we do not give serious consideration to the future of the *Qanat* system. The two main reasons for the decline of the *Qanat* system are 1) changes in the socio-economic backgrounds concerning *Qanat* construction, and 2) technical problems. Under this situation, we need precise and detailed information on each region. Besides the present and future of *Qanat* systems, we still need to carry out international research projects on the origin and diffusion of *Qanat*. For this purpose, increased cooperation among developed and developing countries is extremely important. For international networking, it will be necessary to prepare lists of researchers and bibliographies on *Qanat* in each region, and to translate precious information on *Qanat* written in several languages into other languages.

Finally, we must think about the role of future generations who will continue our efforts to preserve the unique *Qanat* system. While there is some information on *Qanat* in university texts, I think that public interest in the *Qanat* system may not be sufficient. For the conservation of this excellent cultural heritage, some teaching programmes on *Qanat* should be established for school children.

10) Traditional Knowledge World Bank for safeguarding ecosystems (Aug. 28, 2006)

Pietro LAUREANO

President, IPOGEO Italian Research Center on Local Traditional Knowledge, Italy

Traditional Knowledge are ancient techniques and practices of a territory passed on through the generations and used for water harvesting, soil management, use and protection of natural areas, rural architecture and for organising urban centres. They are the historical knowledge of humanity that allowed building architecture and landscapes with a universal value protected by UNESCO in the category of cultural landscapes. An appropriate use of natural resources such as water, soil and energy is made possible by using traditional knowledge that establishes the harmony of architecture with the environment, the symbiosis of the techniques of organisation of space with the traditions, the social habits, the spiritual values and the fusion between practical aspects and beauty.

Today, traditional knowledge is in danger and its disappearance would not only cause the loss of people's capability to keep and pass on the artistic and natural heritage, but also of an extraordinary source of knowledge and cultural diversity from which appropriate innovative solutions can be derived today and in the future. UNESCO launched a global programme for an inventory assigned to IPOGEO – Research Centre on Traditional and Local Knowledge. The project gathers and protects historical knowledge and promotes and certifies innovative practices based on the modern re-proposal of tradition as well. The main targets are the firms, the natural areas and the historical centres which will be assigned quality trademarks and acknowledgements of international excellence in production or use of good practices and innovative solutions. Each technology, proposition and experience achieved will provide a spin-off on an international scale and each good practice will contribute to safeguarding the whole planet.

11) Camel pastoralism, water use and traditional knowledge on the Sudanese Red Sea coast

(Aug. 29, 2006)

Hiroshi NAWATA

Assist. Professor, Arid Land Research Center, Tottori University

The purpose of this presentation is to show a framework of local development to combat livelihood degradation, based on a case study of pastoralism, water use and traditional knowledge on the Sudanese Red Sea coast.

Camel pastoralism on the Sudanese Red Sea coast has been local people's practices with traditional knowledge. Camels not only show broad feeding range for every family of plants, but also show high-level palatability on almost all species of halophytes. Camels rely on half-shrub halophytes, mainly Chenopodiaceae plants, and the foliage of the evergreen mangrove, *Avicennia marina*. This helps in maintaining a regular supply of forage for the camels. Quantity and quality of the water are irregular, because water source of rain, surface runoff and groundwater are very flexible. Purposes of utilization of water points can be roughly divided into for human and for livestock in terms of equipment and water quality. Availability of water for each species of livestock is limited by water quality, especially salt contents. The most remarkable point can be what pastoralists may have utilized poor quality water resources efficiently through intermediary camels. It also makes possible to recapture camel pastoralism in the sense that camels need to take highly salined water regularly. The physical environments, especially coral reef topography, tidal conditions and existence of water points, determine human and camels' accessibility to coral reef islands and resource patch availability.

As far as the people use camels for accessing coastal resources, the camels can restrain an overexploitation of these biological resources. In such a sense, I suggest that resource patch accessibility and availability are determined by camels' intervention so that its overexploitation in the coastal zones of the arid tropics has been limited consequently. Therefore, it can be interpreted that a restraint of overexploitation is inclusively in the mechanism or process of human resource utilization under natural conditions.

On the other hands, in recent years, outsiders' inappropriate technologies with shallow scientific understanding made a big impact on local ecosystems and their livelihoods. That is a plantation of exotic species *Prosopis* spp. (mesquite) at inappropriate places. *Prosopis* spp. are ever green leguminous trees or shrubs. In Sudan, these are introduced and planted to fix sand dune movement and to protect residential and cultivated areas from wind and sand encroachment. These seedlings failed to establish on sand dunes, but were well established within oases leading to lowering of water tables and suppression of native vegetation. The water table of dried river beds went down drastically because of *Prosopis*. Useful water is taken by exotic species *Prosopis* spp. As a result, wise use of flexible water resources was forced to be strengthening water use at only particular wells. Beyond control of *Prosopis* is destroying local ecosystems, and multi-livestock pastoralism is in danger now.

This presentation calls on to do paradigm change in combating desertification to combat livelihood degradation in local communities of the people. Scientists need to reflect mistakes in development projects of past twenty-years and urge an application of local people's practices and traditional knowledge for development, and appropriate technologies with deeper understanding of human & nature in drylands.

12) Floodplain agriculture in the Tokar Delta of the Red Sea coast, Sudan (Aug. 29, 2006)

Nobuyuki HORI

Professor, Tokyo Metropolitan University

This presentation is intended to represent the annual change of seasonal floodings in the delta of the arid region and its human response on the agricultural land utilization to the limited area of floodings based on the geographical field research in the Red Sea area of Sudan.

The Red Sea coastal plain area in Sudan is fed by the few winter rainfalls. However, the Tokar delta formed by the Baraka River from the Ethiopian Plateau and the Eritrean Highlands is characterized by the seasonal floodings during summer season. The possibility of the agricultural land use in this delta has been controlled by the magnitude of the seasonal floodings, especially since land allotment of the fields during the British colonial period. Annual flooding area from 1900 to 1990 rather fluctuate from year to year. The magnitude of fluctuation and duration of flooded area are also quite changeable, especially after 1950's. The annual life of farmers is completely controlled by the occurrence of flooding in the own field within the year. If there is no occurrence of floodings in his field, the farmer will look for seeking the possibility of cultivation within the field owned by the same ethnic group.

13) Water and waste disposal in urban areas in Mauritania (Aug. 29, 2006)

Fumiko HAKOYAMA

Professor, Fuji Women's University

In search to resolve problems due to the urbanization caused by the desertification, I studied water management and waste disposal projects in Nuakchott, capital of Mauritania. The hygienic situation is very bad there: one-third of the children among 0-5 years old who visit hospitals suffer from diarrhea, and more than half of school children have parasites.

It is imperative to improve the quality, price and access to the drinking water. The "Borne Fontaine Project" in Nouakchott has proved to be a successful drinking water project thanks to engagement of the community authorities and habitants.

There are no public garbage collecting systems which are operating closely to the habitants in Nouakchott. Only exist small private companies. This situation is harmful both to the habitants and the workers (the majority of whom are very young: 13 to 25 years old.) According to a recent survey, garbage-workers are very vulnerable to diseases and wounds (for example, 82% of workers had back ache, and 80% had been injured during recent 2 weeks.) A project to improve this situation has recently started in Nuakchott. It organized jobless youngsters, providing them with training and equipment. The sensitization of the habitants in introducing new concepts of paying money for the garbage was also a crucial factor for the success of the project.

As a conclusion, the involvement of concerned local parties and the use of traditional local expertise are the key to poverty alleviation.

14) Understanding the environmental knowledge of West African Fulani (Aug. 29, 2006)

Julia KROHMER

Botanical Institute, Goethe-University

Traditional knowledge has been for a long time elided or even disregarded by scientific and governmental institution in all parts of the world. Only recently this “climate” changed, and we now observe a continuously rising appreciation of local environmental knowledge, which is brought into the centre of scientific attention. First this implied a mere preservation of this knowledge, which is threatened by the rapidly changing living conditions, by writing it down. Today, in addition to this, researchers increasingly aim for integrated and sustainable environmental management. Against this background, investigations about the environmental knowledge and perception of Fulani in Burkina Faso and Benin were carried out. The Fulani, traditionally nomadic or semi-nomadic cattle breeders, possess a very broad knowledge of their natural environment. This ranges from a detailed environmental classification to the knowledge of species’ site requirements, ecological processes and degradation features up to a detailed botanical knowledge and immense medical plant knowledge.

Using concrete examples of the Fulani’s environmental knowledge, potentials and limits of involving TEK (traditional ecological knowledge) into management approaches are discussed, particularly in view of the changing ecological and social conditions. The question about the flexibility of this knowledge respectively its capacity to adapt to changing environmental conditions is also posed. Obviously, TEK must not to be ignored when developing new measures to solve the current environmental problems of West-Africa, since still today, it determines to a great extent the people’s way of thinking and the course of action of the people. But on the other hand, traditional knowledge is, especially today, no magical formula to resolve all problems.

15) Date palm culture and its traditional ways of utilization in Tunisia (Aug. 29, 2006)

Keiko TAKAKI

Professor, Obirin University

This presentation focuses on traditional ways of utilization of date palm in Djerid Oases of Tunisia, and its application for local development and against desertification. Djerid oases are one of two major date palm oases locates in the south of Tunisia. The date has more than 400 kinds, in Djerid, about 100 kinds are scientifically known, and around 20 sorts are named and recognized by ordinary people. Three groups of dates by quality and harvest time are 1) *Deglat*, 2) *Alig* or *Futimi*, 3) *Tamr Abyad*.

The value and the various ways of utilization of the date palm are such as dates as nutrition, date palm as nutrition, palm tree trunks as wood, utilization of palm leave stalks, fence made of palm stalks against sand and desertification, commodities made of dried leaves, baskets for agricultural work, many kinds of baskets and sacs, many kinds of containers (*tabaq*), many commodities made of palm leaves and its fiber, palm leaves as fuel, palm stalks toys (*sigs*) and trap, door and furniture made of old palm trunk, some handicrafts made of old palm trunks.

Reevaluation and training of the traditional skills to utilize date palm tree and to produce handicrafts can be income generating work. Recycling of old palm trunks to fabricate new merchandise, for example JICA’s OVOP project, will help local development. Regeneration of the old palm oases is cost-effectively.

New palm oases can mitigate the desertification.

16) Arid land civilization, traditional knowledge and desertification in Africa (Aug. 29, 2006)

Yoshihito SHIMADA

Professor, Graduate School of Letters, Nagoya University

So called desertification is rather human ‘desertification’, that is, a kind of degradation of human life in dry regions. The cause and the mode of manifestation are essentially various in the natural and human conditions, and extremely different according to different dry lands. In this presentation, the hot sub-saharan dryland (savanne) without solide economic development nor administrative infrastructure is compared to the cold inner Mongolia dryland where economic development is big and administrative infrastructure is strong.

17) Global Forum on Agricultural Research (Sep. 14, 2006)

Adel EL-BELTAGY

Chair, Global Forum on Agricultural Research

The general information of the Global Forum on Agricultural Research (GFAR) was introduced. The GFAR’s mission is to alleviate poverty, to increase food security and to promote sustainable natural resource utilization, which are critical issues for the agricultural sector in the world. GRAR are pursues this mission in partnerships with national agricultural research systems, advanced research institutes, international agricultural research centers, non-governmental organizations, farmer’s organizations, private sectors and donors. To provide technical, socio-economic and policy solutions on the issues, GRAR has carried out various projects and programs for sharing information and exchanging knowledge, and for working together to generate new and relevant knowledge.

18) Soil moisture memory related to evapotranspiration in the Kazakhstan steppe during the growing season (Oct. 11, 2006)

Yoshihiro IJIMA

Institute of Observational Research for Global Change, JAMSTEC

Water deficit is the primary factor limiting plant growth in semiarid grasslands in Central Asia. In the present study, continuous measurements of the surface energy balance and plant growth (above- and belowground biomass) were made during the growing season of 2002 at the natural grassland in northern part of Kazakhstan. Although this year had above normal rainfall in total during the growing season from May to November (244 mm within 183 days), a dry period occurred during July and August. Evaporative water was effectively supplied by precipitation and surface soil moisture during the wet season (May and June) in conjunction with increasing aboveground biomass. During the early stage of the dry period, the mature plant was likely to tap deeper sources of soil moisture that stored by snow melt water. As the soil moisture was attenuated due to the water balance of large evapotranspiration and deficit in precipitation

during the summer dry period, evaporative fraction and aboveground biomass rapidly decreased, while below ground biomass increased. The results suggest that the summer soil moisture functions as water storage and it is essential for plant growth as a direct source of water during the dry period at natural grassland in the Kazakhstan steppe.

19) Adaptation to Saline Soils ---Learning from halophytes (Nov. 15, 2006)

Xiaojing LIU

Center for Agricultural Resources Research,
Institute of Genetics and Development Biology, CAS, China

Soil salinization and water shortage are the major constrains for crop production in the world. The shortage of freshwater is limiting the reclamation of saline soils through leaching and drainage methods, the most efficient technologies on saline soil reclamation. Recently the utilization of halophytes, the native flora of saline environments, has been paying more attention due to their salt tolerant characteristics and potential economic values.

The studies on mechanisms of salt tolerance in halophytes indicated that the seed germination of halophytes needs low salinity environment, nitrogen and phosphorous deficiency are the major constrains for the biomass production in halophytes, and sodium chloride may alleviate the detrimental effects of water stress in halophytes due to the osmotic adjustment etc. Therefore, to improve the biomass production of halophytes in saline soils, it is important to create a relatively low soil salt level during seeds germination and then manage soil water and nutrient during growth. These conditions are linked with the local climate, dynamics of soil salt and water, and soil fertilities etc. Considering the dynamics of soil salt and water in monsoon climatic conditions of North China, practically, plowing the soils in early spring, mulching the soil by plastic film, nursing seedling and transplanting in rainy season, applying fertilizers etc. were adopted to grow cash crop halophytes. In addition, a new method of freezing saline water irrigation in winter was invented to create the low salinity environment in spring.

20) Managing irrigation for sustainable agricultural development in the North China Plain

(Jan. 9, 2007)

Xiyang ZHANG

Professor, Center for Agricultural Resources Research,
Institute of Genetics and Development Biology, CAS, China

The double cropping of winter wheat (*Triticum aestivum* L.) and summer maize (*Zea mays* L.) in the North China Plain (NCP) requires intensive irrigation that results in rapidly depleting aquifers and threatens the sustainable agricultural development in the region. Long-term field experimental results showed that reducing the present number of seasonal wheat irrigations to either 3, 2 or 1 depending on seasonal rainfall would benefit both grain production and water use efficiency of winter wheat. The study further investigated the possibility of growing winter wheat and maize with minimum irrigation application (MI): replenishing soil moisture in the top root zone profile to field capacity before sowing with no further irrigation afterwards. 8-yr results (1997-2005) showed that grain yield of winter wheat was over 5000 kg

ha⁻¹ and maize was over 6000 kg ha⁻¹ in most of the seasons under MI. Averagely yield was decreased by 13.9% for winter wheat and 13.3% for maize compared with the full irrigation treatments (FI). Water use efficiency under MI was increased by 15% for winter wheat and 10% for maize compared with that under FI. Average seasonal evapotranspiration (ET) was 334.7 mm under MI and 446.7 mm under FI for winter wheat, and 319.3 mm and 403.3 mm for maize, respectively. The annual supplemental irrigation requirement of MI was only half of the FI. Approximately 200 mm irrigation water use could be reduced annually under MI. The results showed that in this serious water shortage area the limited irrigation strategy might be possible and the saved water could be used for other more profitable productions.

21) The effect of phosphorous deficiency on root system formation in peanut (*Arachis hypogaea* L.)
(Jan. 9, 2007)

Shigenori MORITA

Professor, Field Production Science Center,
Graduate School of Agricultural and Life Sciences, the University of Tokyo

Peanut is one of the important legumes in arid and semi-arid areas, but the information on root system development has been limited. Development of root system, namely, size and shape of rooting zone as well as the total length and weight of roots in soil may play important roles for absorbing water and nutrients in soil. Root system development, therefore, was examined using both monolith method and pin-board method with reference to genetic background, and there found significant differences in root depth index as a criteria of root distribution in soil based on the length and weight of roots among different cultivars. At that time there was an intimate interrelationship between root depth index and growing habit of the first-order lateral roots downward to 20cm in soil. This finding suggests that the number, length and growing direction of the first-order lateral roots might influence strongly the distribution of roots in soil. This hypothesis was examined in the pot experiment. The distribution of roots in peanut grown under P-deficiency condition was shallower than that under normal condition with reference to both length and weight of roots. The growing direction of the first-order lateral roots was measured quite precisely using plastic mesh in the pots and it was found quite clear that they elongate shallower significantly than in the control plot. This result strongly support the above hypothesis and this can be used to improve peanut cultivation in arid and semi-arid areas.

22) People and Nature in Burkina Faso, Africa (Jan. 23, 2007)

Norikazu ISHII

23) Global environment issues and irrigation and drainage (Feb. 6, 2007)

Teitaro KITAMURA

Director, Research Institute of Global Environment

Now our earth is facing Global Environment Issues (below GEI) which damage the various aspects of the earth. The lecture gives first the historical introduction of GEI. And secondary it explains what global

environment is. The GEI are thirdly explained. Finally lecture touches the measures for the solution methods of GEI.

1. Appearance of GEI

In 1962, Rachel L. Carson published a book 'Silent Spring' which appeals the dangerous crop spraying. Moreover the book warns to world people that human being is destroying our natural environment and compromising our existence basis. This message impulses to all human being. Thus human being recognizes serious mistake by human being. After her message, GEI succeed the international subjects and so many international activities moves and many treaties are concluded internationally.

2. The Earth Environment

Secondary the earth environment explained. Our living condition on the earth is how it is a thin globe and how it is vulnerable like soap bubble. It is a mystery that human being lives on the earth. However the lecture points out the possibility of human being existence, because we have a lot of land where we could produce many demands.

3. Global Environment Issues

In the lecture, GEI are classified into three categories, namely the followings,

- a) Urban Type GEI: Global warming, Ozone layer destruction and Acid rain
- b) Rural Type GEI: Destruction of farm land, Desertification and Disappearance of forest
- c) Common Type GEI: Ocean pollution, Decreasing ecosystem diversity and Crossing the border of hazardous waste

and in this section these various issues are explained.

4. For the Pursuit of Solution of GEI

First the solution method by each type is explained. Finally the role of irrigation and drainage for the solution of GEI is discussed.

24) Interaction between soil and plant for soil water consumption in semi-arid land

(Feb. 6, 2007)

Toru MITSUNO

Graduate School of Agriculture, Kyoto University

I tried to compare between two famous agricultures in semi-arid and arid region based on traditional agriculture, one is the runoff agriculture in Israel that is revive from Navatian Traditional Agriculture, another is the Grilisidia Integral in Bali, Indonesia that is reform the Pekalangan, traditional agroforestry with the modern science and technology. Then, It can be found out that both agriculture systems are interested based on the interactions between the plant root system and soil water behavior depending on climate, soil and crop conditions.

As water becomes critical condition in these agricultures based on traditions, the agriculture is singular system depending on the climate condition, especially rainfall distribution and quantity, soil characteristics and crops water consumption. And these depend on investment potential for irrigation facilities and farmers technical abilities as well.

Because these irrigated agriculture systems in semi-arid and arid region are selected adaptively through the long history, these became special system depending on special combinations of conditions on the just site. But we compare two cases, Runoff Agriculture and Grilisidia Integral and then it is very

interesting that these cases are based on the interaction between plant root system and soil water characteristics.

25) Improvement and Utilization of the Salt-Affected Soils by Salt Tolerance Plants

(Feb. 13, 2007)

PinFang LI

Dept. of Soil and Water Sciences, College of Resources and Environment,
China Agricultural University

About half of Chinese regions have less than 380mm precipitation, which belong to arid areas. Therefore, drought is leading to desertification, salinization areas increasing year by year. Fresh water and arable land resources are just about 1/4 of world average level per person in China. Soil and fresh water resource shortages have become very serious. We must domesticate and introduce halophytes to saline and salinized areas so that most of the salinized areas can be reused. Improvement and utilization of the salt-affected soils by salt tolerance plants is one of the most economical and effective approaches. The most important thing is to breed salt-tolerance plants. Salt tolerance of plants depends on a great extent, alleviating ion imbalance and hyperosmotic stress, so plants must have the ability of keeping homeostasis and resuming growth in stressful environment. In that case, to study on mechanisms of salt tolerance and its development and utilization is very important.

There are over 502 kinds of halophytes in China. My research is about the wild perennial grass, *Iris lactea* Pall. var. *chinensis* (Fisch) Koidz., is a prevalent plant species in desert steppe and saline meadow. I have studied the mechanisms of ionic and osmotic adjustment about it under salt stress. The salt threshold of seed germination of it is 0.64% and its seedlings salt durability is relatively more powerful to some degree. When soil contents over 0.8% of salt, it will obviously damage plants. Wild adult cultivars can still maintain normal growth at 0 ~ 10cm topsoil which salt content is 2.16%. It is generally of great sodic-salt, drought and cold tolerance. Its bouquet and green stage is much longer as well. Besides, this plant is used in medical field. It is considered a better plant in developing salt-affected soil. Meanwhile, it can be used in city greening and saline water using.

26) Impacts of Recent Human Activities on the Hydrological Cycle and the Environment in the Heihe River Basin, Western China

(Feb. 19, 2007)

Jumpei KUBOTA

Research Institute for Humanity and Nature

The seminar focused on changes in the hydrological cycle and the environment during the past fifty years caused by the agricultural development in the Heihe River basin, an inland river of the arid region in the western China. The Heihe River basin consists of three parts, namely the upper mountainous area which is the source of the Heihe River by big amount of precipitation and glaciers, the middle oasis area like Zhangye and Jiuquan, and the lower terminal arid area like Ejina. Each area has independent hydrological condition and ecosystem. Surface runoff from the upper mountain area by rain and melt water of snow and glaciers is the only source of water available in the middle oases area and the lower arid area. In the middle

oasis area, most of surface water has been diverted from main river courses to many irrigation canals, resulting in the serious decrease of discharges in the lower deserted area. The increasing groundwater consumption in the middle reaches has caused the rapid decline of groundwater resources. Analyzing changes in water balance components during the past fifty years, human impacts on the hydrological cycle in the Heihe River basin has been evaluated.

27) Silicon transporters in rice (Feb. 27, 2007)

JianFeng MA

Research Institute for Bioresources, Okayama University

Silicon (Si) is an important nutrient for rice growth and production by helping rice overcome abiotic and biotic stresses. Rice is able to accumulate high Si in the shoots, but the mechanism of Si uptake by the roots is poorly understood. Physiological studies have shown that Si uptake by rice roots is actively mediated by a kind of transporter. To clone the genes encoding Si transporter, we isolated two mutants (*lsi1* and *lsi2*), which are defective in Si uptake, by using Ge tolerance as an index. Physiological studies showed that both *lsi1* and *lsi2* are mutants which was defective in Si uptake. Rough mapping showed that *Lsi1* was located in chromosome 2. Fine mapping resulted in the isolation of this gene. The cDNA was 1409 bp long and the deduced protein consisted of 298 residues, and the program PSORT predicts that the *Lsi1* encodes a membrane protein. Real-time PCR analysis showed that this gene was not induced by Si and constitutively expressed mainly in the roots. To investigate cellular localization of *Lsi1*, *Lsi1* with its promoter was fused with GFP and introduced into rice. Microscopic observation showed that *Lsi1* was localized in endodermis and exodermis, where Casparian strips exist. Furthermore, staining with anti-LSI1 polyclonal antibody revealed *Lsi1* is localized at the distal side of the endodermis and exodermis cells. On the other hand, *Lsi2* was mapped to the chromosome 3. Experiment with GFP fusion shows that the protein is localized at the plasma membrane of onion epidermal cells. *In situ* hybridization and immunostaining revealed that *Lsi2* was also localized at both exodermis and endodermis where Casparian strips are located. However, in contrast to *Lsi1*, *Lsi2* was localized at proximal side of plasma membrane. All evidence indicates that *Lsi1* is a transporter responsible for influx of Si into the cell, while *Lsi2* is a transporter for efflux of Si from the cells.

**28) The effect of N fertilizer on forage quality of perennial ryegrass in Tenpoku region, Hokkaido
(Feb. 27, 2007)**

Hideki OKAMOTO

Tenpoku Branch, Hokkaido Kamikawa Agricultural Experiment Station

We conducted a study to evaluate the effect of different level of fertilizer nitrogen (90, 160, 180, 210, and 240 kg/ha) for perennial ryegrass (*Lolium perenne* L.), cv. 'Pokoro' swards three times per year in Tenpoku region of Hokkaido. Dry matter (DM) yields increased with the increase in N level from 90 to 210 kg, however, there was no significant difference between 210 and 240 kgN/ha. It was also shown that N recovery increased with the increase in N level; while, DM increase per unit nitrogen reached the maximum values in the 160-210 kg N/ha range. Based on yield and N-use efficiency, a nitrogen application

rate of 210 kg/ha is recommended.

As for forage quality of ryegrass, increased N-fertilizer application reduced *in vitro* dry matter digestibility (IVDMD) and water soluble carbohydrates (WSC) contents; on the other hand, fibre and crude protein (CP) contents were increased.

Furthermore, we studied to test the effect of nitrogen fertilizer on sugar composition and silage fermentation. Perennial ryegrass usually contains glucose, fructose and sucrose. Under the condition of frequent cut like grazing, it might exhibit the existence of maltose. Among these sugars it was shown that increased N-fertilizer application reduced fructan (it is calculated as fructan = WSC – monosaccharide – oligosaccharide) content in every cutting and sucrose in 2nd cutting. The silage was made from each cut at each level of N application. All the treatments, except one, gave silage of good fermentation quality. The meadow from the 2nd cutting at 240 kgN/ha gave poor quality silage because the WSC content was not sufficient for silage fermentation. WSC, fructan and fermentation quality were very much interrelated. It is concluded that high rates of fertilizer N application (i.e., 240 kgN/ha/year) to ryegrass meadow reduced the WSC content, and especially fructan which affected the silage fermentation quality of the meadow.

Keywords: Perennial ryegrass, Cutting use, Nitrogen fertilizer, WSC, Sugar composition

29) Numerical Modeling of Nitrogen Transport in Soils (Mar. 12, 2007)

Kimihito NAKAMURA

Graduate School of Agriculture, Kyoto University

Groundwater nitrate contamination and eutrophication of water body are common problems in the world. Quantitative, technical information related to nitrogen is needed to help farmers make management decisions that support profitable yields while avoiding environmental degradation. Nitrogen transport in soils is modeled numerically incorporating solute transport equation with water movement and nitrogen transformations. Various forms of nitrogen exists in soils and soil microbes convert nitrogen forms intricately by mineralization, immobilization, nitrification, denitrification, and nitrogen fixation. In this seminar, numerical modeling of nitrogen transport in soils using convection-dispersion equation and the first-order reaction rate constants of nitrogen transformations is described in the cases of upland and paddy soils. Because upland soil is unsaturated and oxidized, mineralization and nitrification processes are dominant and denitrification process does not occur except the reduced interior portion of aggregates. Meanwhile, the upper zone of paddy soil, which is a few centimeters thick, is saturated and oxidized and the lower zone is saturated and reduced. Denitrification process is dominant in the reduced zone. Mineralization and nitrification processes occur in the oxidized layer. If we can set the first-order reaction rates of nitrogen transformations based on redox characteristics of soil profiles, it is possible to analyze nitrogen transport in soils numerically, estimate the amount of nitrogen transformations, and suggest the best water and nitrogen management practices to reduce nitrogen loads to environment. Furthermore, this seminar shows two case studies in California and Kyoto in which the adequate organic nitrogen management originated from dairy manure should be performed in order to conserve groundwater and soil qualities.

30) Understanding exchanges of greenhouse gases between farmland and the atmosphere

(Mar. 23, 2007)

Dr. Kosuke NOBORIO

School of Agriculture, Meiji University

The emission of anthropogenic greenhouse gases (GHG) is a big concern in the global society. The GHG, e.g. N₂O and CO₂, is supposed to exchange between the atmosphere and farmland where nitrogen fertilizers and composts are applied. The closed chamber method and the relaxed eddy accumulation (REA) method were used to measure gas flux at a wheat field in Alberta, Canada and a grass field in Iwate, Japan. The flux of N₂O into the atmosphere in the wheat field increased a little with increases in a N-fertilizer application rate until the rate reached the recommended application rate. The N₂O flux into the atmosphere increased dramatically when the N-application rate was greater than that of recommendation. The flux of N₂O into the atmosphere in the grass field had a spike at about a week after a dairy cattle manure application. The spike was observed with both the closed chamber method and the REA method. The N₂O flux decreased with time passed on with small spikes after rainfall events. Under accumulated snow conditions, N₂O gas exchanges between the atmosphere and the grass field were evident. Further research is needed for exchanges of GHG between farmland and the atmosphere.

(4) Summary of Open Seminar for 21st Century COE Program

Topic of Open Seminar (Date)

Name of Speaker

Occupation of Speaker

Summary of Open Seminar

1) Groundwater recharge and flow system in sand dune (May 17, 2006)

Takayuki KAWAI

Arid Land Research Center, Tottori University

From the long-term observation, it was clarified that the percolation system at Tottori sand dune is controlled by the sand lamination construction. And also cleared that the groundwater spreading model was able to explain the characteristics of groundwater level change.

2) Variation in compensation for defoliation between determinate and indeterminate soybean cultivars and the effects of some soil environmental factors on their compensation

(May 17, 2006)

XiangJun LI

Arid Land Research Center, Tottori University

Artificial defoliation methods were used to estimate the compensation of determinate (Enrei) and

indeterminate (Touzan 69) soybean cultivars for defoliation and the significance of environmental factors (soil moisture and soil salinity) in the soybean compensation. The indeterminate soybean cultivars had less yield loss and better compensation after defoliation than determinate ones. This was due to higher leaf area recovery and higher photosynthetic rate after defoliation. The environmental factors significantly influence the ability of soybean to compensate for defoliation primarily through changing the leaf regrowth potential. Drought stress and salinity stress negatively affected soybean compensatory ability for defoliation, and the effect was more pronounced in indeterminate soybean cultivars than determinate ones. These results indicated that it is necessary to consider the growth habit of soybean cultivar and the soil environmental condition for better conducting pest management in soybean production.

3) Socio-economic Modelling and Application Example - Verification Analysis with Applied General Equilibrium Model - (May 17, 2006)

Atsushi KOIKE

Faculty of Engineering, Tottori University

4) Challenge to Creation of Independent and Sustainable Industry in Developing countries

- Non-electric Refrigerator for Mongolian Nomads- (Jul. 28, 2006)

Yasuyuki FUJIMURA

Atelier Non-Electric

5) Research on Aeolian Dust Production Process –Observation in Desert by ADEC & JADE-

(Jul. 19, 2006)

Masao MIKAMI

Meteorological Research Institute

6) Environmental Variation and Desertification in Sahara – Sahel Region, and Recent Topics on Natural Resource Management (Sep. 29, 2006)

Hiroshi KADOMURA

Professor, Faculty of Geo-environmental Science, Rissho University