(3) Summary of Open Seminar

1) Salt Accumulation Mechanism in Root Zone - Movement of Water, Salt, and Heat Transport - (July 21, 1998)

Simultaneous Measurement of Water Flow and Salt Transport in unsaturated Large Weighing Lysimeters

Mitsuhiro INOUE

Arid Land Research Center, Tottori University

A monitoring system for water flow and solute transport has been set up inside a glasshouse of the Arid Land Dome which is 15 meters high and 36 meters in diameter. This new experimental facility allows experiments in which the movement of water and salt can be monitored in large soil columns with 798 mm in diameter. Soil matric potential head, soil temperature, bulk soil electric conductivity and volumetric water content in the large soil columns can be determined using underground suction gauges (UNSUC), thermocouple sensors, four-electrode salinity sensors, and amplitude domain refrectometry sensors (ADR), respectively. In this seminar, the characteristic of the measuring system was described. The measuring accuracy of various sensors and electric balance was discussed. The validity of a monitoring system for water flow and solute transport was also discussed. Variations of bulk soil electric conductivity at depths of 10, 20, 30, 50, 70 cm for 6 months were measured and discussed under constant ground water level of 30cm and different NaCl solution concentrations of 1000, 3000, 5000 mg/L.

Mechanism of Salinization as Water Movement in Soil-Plant-Atmosphere System, and its Preventive Measures

Sho SHIOZAWA

Institute of Agricultural and Forest Engineering, University of Tsukuba

Most serious and difficult problem in irrigated agriculture in arid area may be rising groundwater table (waterlogging) by irrigation and soil degradation that result from high condensation of soil water due to high evaporation rate from wet soil surface. Evaporation from soil surface accumulates salt at or near the soil surface and water uptake by root accompanied with transpiration also deposits salt around roots. Evaporation is the process in which water vapor concentration on surface tends to equilibrate with that of air. Transpiration is evaporation from stomata. Noting the difference of the effects of salt accumulation due to evaporation and transpiration is important to choose preventive measure for salt accumulation and soil deterioration.

When groundwater table is low enough, dry soil layer would develop on surface, during evaporation process, which reduces evaporation rate. However, if groundwater table is high and soil surface is wet over the drying period, high evaporation rate is hold, and the salt concentration at surface can be as high as saturated solution, by condensation of soil water, resulting soil degradation. In contrast, transpiration is remarkably reduced by close of stomata when water potential in the plant becomes low, thus plant water potential never exceeds a certain value (about -20 bar). Moreover, water potential of soil around root is always higher than that of plant. Therefore the concentration condensed by plant water uptake is limited.

It can be concluded that covering wet soil surface with any plant canopy, preferably with salt, tolerant plants, can prevent high evaporation and condensation of soil solution to such high concentration that occurs on bare soil when groundwater table is near the surface.

Temperature Dependence of Thermal Conductivity of Soil

Tatsuaki KASUBUCHI

Faculty of Agriculture, Yamagata University

One of the ways to analyze the phenomena of linked heat and mass transfer in the soil is to examine the temperature dependence of thermal conductivity. But as Cass et al. has pointed out, more detailed experimental data are needed to investigate the phenomena.

Twin heat probe method has been developed to measure the thermal conductivity of soil accurately and quickly. By this method thermal conductivity of two kinds of soils (Ando soil and Red yellow soil) were measured as a function of temperature (5-75 °C) and water content in detail.

From our results it can be concluded that the thermal conductivity resulting from the latent heat transfer could be separated from the apparent thermal conductivity by subtracting the thermal conductivity in low temperature near 0 °C from those in higher temperature. The relation between the phenomenological enhancement factor (b) and the air filled porosity was divided into two parts, that is, b increases linearly with the air filled porosity for more than -3.2×10^2 J kg^{-1} of water potential and decreases exponentially or is proportional to reciprocal of the water potentials for below the water potential. The relations of both soils are coincided each other though the physical properties of both soils are different. The general feature of the relation is similar to that of Cass et al.'s results. But the water potentials at the inflection point is much higher than that of their's. These results are available to estimate not only the temperature dependence of thermal conductivity but also the vapor transfer under the temperature gradients.

2) Conservation of Agricultural Watersheds (Oct. 27, 1998)

Mechanism of Selective Soil Erosion Process for Controlling Soil Loss

Tatsuro KUSAKA

Faculty of Agriculture, Yamaguchi University

Eroded particles from clay loam and sandy loam using two surface flows were investigated in the present study. In particle analysis, sieves were used to separate the sand particles and paper filters were used to separate silt and clay particles. Clay particles were eroded in higher amount in the primary intervals in both soils. Sand was highest with highest erosion whereas silt did not show any remarkable effect. In clay loam soil, ratio of eroded silt and clay to the original was higher. Eroded sand ratio was only higher to the original in case of sandy loam soil with greater surface flow. Rills were developed when the ratio of the eroded sand to the original was with in the range of 0.64～0.72. Selective erosion process of the mentioned soils and the unknown condition for rill formation during soil erosion concerned to the eroded particles was being clear from the study.

Characteristics of Suspended Sediment Loads at the Agricultural Watersheds

Tetuaki NAGASAWA

Graduate School of Agriculture, Hokkaido University

There are two viewpoints concerning conservation problems related to the agricultural land use of watershed. One is soil erosion at the hill slope including arable land, such as surface soil loss and destruction of the agricultural land. Another problem is that the eroded soil on the slope is transported to the lower reaches of watershed by the river. The importance of the latter is greater because the river influences a wide area. It is necessary to explain the sedimentation mechanism through the river to lower reaches to understand various problems. And it is indispensable to understand the realities of sedimentation load by the river. So far, many studies have been performed on sedimentation of the river. Many of these studies have sampled water at fixed time intervals. The sampling requires much labor and is not safe at high water. Therefore, it is difficult to take samples for a range of time. Especially, the data for flood conditions is not obtained easily. It is possible to understand the behavior of sediment transport in a large river even if the measurement interval is long because the change is gradual. However, the response is sensitive to the weather change in a small watershed river. It is difficult to understand the actual conditions based on measurements of once in several hours or days.

The agricultural land in the watershed exerts various influences on the entire regional ecosystem. For instance, it is working as a buffer to the undesirable factors in the watershed. However, it is possible that it become a pollutant load source depending on the conditions. At any rate, to maintain sustaining agricultural production in the region, the agricultural land watershed system should harmonize stable.

The actual conditions of suspended sediment transportation were examined by turbidity. As for turbidity, continuous self-recording is possible and handling is comparatively easy. As for the suspended sediment that flows into the river, many factors are involved. Disaster prevention facilities, as settling basins are set up around the sloping field. But, a complete obstruction of suspended solids is very difficult. The relation between various conditions and suspended sediment loads was examined to devise effective conservation methods. The suspended sediment transportation in snowmelt period was characterized by corresponding to the change of temperature-snowmelt-discharge. The amount of suspended sediment load in snowmelt is less than in rainfall, but the amount increases suddenly when there is rainfall in snow melting. The process also depends on the soil properties, land use, and the weather conditions. Therefore, it is necessary to understand the actual conditions of each watershed for implementing conservation practices.

3) Irrigated Agriculture and Land Degradation in the Aral Sea Basin of Central Asia (Nov. 6, 1998)

Hydrological Circumstances and Agricultural Land Use in the Delta of Amudarya River in Aral Sea Basin

Hiroki OUE

College of Agriculture, Ehime University

"The drainage system can drain saline water smoothly or vice versa" feeds back not only to the hydrological circumstances, i.e. the salinization of the agricultural land, ground water level and its salinity but also to the irrigation system and the agricultural land use that the region should adopt. In a region in Karakalpak ASSR that we have researched, the drainage system seems to work so better that the leaching, surface irrigation in the cotton field and flood irrigation in the rice field can avoid the salinization of the field. In another region, the drainage system seems to work not so well that the region cannot adopt rice rotation system and has no way but adopt cotton rotation system suffering severe salinization.

Estimation of Evapotranspiration of both Irrigated and Non-Irrigated Lands in Arid District of Central Asia

Ken'ichirou KOSUGI

Graduate School of Agriculture, Kyoto University

In the central Asian arid districts, many irrigated farms have been sited along the big rivers such as Amu-Dar'ya, Syr-Dar'ya and Ili. This has brought large changes in land surface vegetation, and the amount of evapotranspiration has increased. Estimating the evapotranspiration at the various land surfaces is important for the appropriate management of water resources especially in arid districts. In the summer of 1992 and 1993, atmospheric variables and energy balances were measured at both irrigated and non-irrigated lands along the Ili River in the southern Balkhashi region in Kazakhstan. In the summer season, monthly evapotranspiration at the no-vegetation land was estimated to be only 6 mm. At the barley field and the alfalfa field sites, estimated evapotranspiration was 140 and 136 mm/month, respectively, both of which were about the same as the estimated evapotranspiration at the paddy field (143 mm/month). A large amount of evapotranspiration at the barley field and the alfalfa field sites was attributable to the high ground water level and large soil moisture content at these fields. Estimated monthly evapotranspiration was 70 mm at the woodland of the Haloxylon, which is one of the typical trees in this region.

4) Solute transport in vadose zone (Dec. 10, 1998)

Solute Dispersion in a unsaturated Soil

Nobuo TORIDE

Department of Agricultural Sciences, Saga University

Solute transport in laboratory soil columns was observed for unsaturated flow conditions using four-electrode salinity probes inserted horizontally at several depths. Repacked columns of a Tottori dune sand and an aggregated loamy alluvial soil were used in this study. Transport parameters based on the convection-dispersion equation (CDE) and the mobile-immobile model (MIM) for various unsaturated water contents were determined from breakthrough curves (BTCs) under unit, gradient unsaturated flow conditions. The dispersivity for the CDE was smaller for the saturated soil than for the unsaturated soil. While the CDE described better for higher water contents in case of dune sand, the agreement between measured and predicted BTCs base on the CDE was better as the water content decreased for an aggregated soil. The validity of the convection-dispersion equation (CDE) was discussed based on the parameter values for the MIM.

5) People of the Sahel (Jan. 22, 1999)

People of the Sahel

---Fulani Herders in Sub-Saharan Africa---

Shuji MATSUSHITA

Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo Gaikokugo Daigaku

Along the Sahel zone of Africa, which is a wide east-west belt demarked by the Sahara in the north and coastal Savannah and forest in the south, a peculiar cattle herders find their sphere of activity. They are Fulani people whose cattle herds stretch from Senegambia to Read Sea coast, a true pan-african ethnic group.

Fula, the language of Fulani people, belong to West Atlantic group of Niger-Kordofanian family, closely related to Wolof and Serer, the dominant Senegalese languages. The origin of Fulani people is a mystery. But their secondary diffusion clearly started from the middle Senegal valley.

Fulani herders practice transhumance. In the rainy season, they travel north. But in the dry season, they come down to south for the better pasture, avoiding the dense vegetation where tse-tse flies are endemic vermin. Fulani dry season camps are welcome to the local farmers because cattle droppings are the best manure in the area.

Fulani herders have had cattle-less settler brethren in West Africa. These "Town Fulanis" had supplied the Islamic intelligentsia to Sahel states. Later around 13 to 14 century, Fulanies themselves established their theocratic regimes like Futa Toro, Bondu and Futa Jallo in western part of West Africa.

The zenith of Fulani theocratic state building culminated in the enormous Jihadist Empire of Sokkota founded by a Fulani preacher, Uthman Dan Fodiyo. Following Uthman's footsteps, another Jihadist, Al-Hajji Umar, carved another of Jihad state in middle Niger area.

6) Desertification Mechanism and Micrometeorology at Semi-arid Grassland in Inner Mongolia, China (Jan. 25, 1999)

Desertification Mechanism and Micrometeorology at Semi-arid Grassland in Inner Mongolia, China

Yoshinobu HARAZONO

National Institute of Agro-Environmental Sciences

Field observational study had been carried out to reveal the mechanism of desertification at grassland and dune in Inner Mongolia, China from 1990 to 1994 under international study program by STA with the Desert Institute of China.

Micrometeorological measurements such as heat budget, and water budget, were carried out at Naiman. Then artificial grazing experiments using the different sheep grazing number (2,4,6 sheep per ha, namely the light, middle and heavy grazing section, respectively) was done to reveal the differences in micrometeorology among test sections and to examine the mechanism.

Desertification that is the degradation of biomass of the grassland was occurred at convex area of heavy grazing section, and there remained about 1/3 of biomass compared to those at no and light grazing sections. Biomass at each section changed according to yearly weather. The biomass increased at no and light grazing sections but decreased at heavy grazing section within the three grazing test period.

The heat budget and evapotranspiration had little change just after rainfall at the non-disturbed grassland that suggested the utilization of rainfall at the vegetation was kept by effective penetration into the ground. The grassland managed reasonably has ability to keeping the heat budget for long period resulted by a balance of evapotranspiration and energy budget. The over grazing destroys the vegetation that encouraged the desertification by changing of albedo, wind profile and evapotranspiration. The recommended sheep grazing number is 2-3 sheep per ha at Naiman area.

7) Present State of Desertification in Gobi / Mongolia (Jan. 29, 1999)

To Succeed with Greening in the Mongolian Steppe

Hisashi KOJIMA

Medicinal Plant Garden, School of Pharmaceutical Sciences, Kitasato University

Greening in the Mongolian steppe situated in an eastan edge of Gobi (desert) is our charming and attractive theme and task. It grows very cold (-20℃) and dry in winter. The considerable medicinal plants are perenial herbs, so they must pass the severe winter. One side is without difficulties of weed control, the other side is indispensable to the supply of water. Therefore, it is impossible to realize the goal, if the Mongolian people themselves don’t hope to do so.

First, the woody plants to serve as a partition wall will be planted, becoause sand flow and autotraffic must be stopped. Annual herbs and crops together with the hardy biennial and/or perennial herbs will then be cultivated. They are the following examples; *Vaccinium* spp. (*Ericaceae*), Cow berry, Small carn berry, Bil berry, and Blue berry. *Glyzyrrhiza* spp. (*Leguminosae*) Liquorices. *Astragalus* spp. (*Leguminosae*) Milk vetch. *Humulus lupulus*. L. (Moraceae) Common hop. *Forsythia suspensa* Vahl (*Oleaceae*) Forsythia fruit. Morus alba L. (*Moraceae*) White mulberry. *Prunus* Spp. (*Rosaceae*) Apricot, Peach, Prune. *Rheum* spp. (*Polygonaceae*) Rhubarb. *Scutellaria* spp. (*Labiatae*) Skullcap, etc.

Public herb gardens offer great potential benefit for local communities, because the plants from the

neighboring countries and areas can be introduced to grow side by side with indigenous plants. They can be bred under the best conditions in public plant research stations run by professionals and introduced successfully to local fields.

Transplanting Mechanization for Afforestatin in Mongolia

Masami IWASAKI

Faculty of Agriculture, Tottori University

The afforestation working to make the hole to transplant nursery stock such as the poplar in desert area of developing countries generally depends on the human power. In this seminar I would like to introduce some of the labor saving machines including the newly developed full automatic transplanting machine to assist the hard transplanting hole work for forest industry in Japan.

Firstly, it will be possible to use the earth-auger of the screw type as one of the digging machine to transplant nursery stock. The performance of the earthauger will obtain the high accuracy same as the human power, but the effciency will be low.

Secondly, the hydraulic shovel excavator widely used for the civil or construction industry will have also high potential to make the planting hole. The utilization of the hydraulic shovel excavator will get higher efficiency and lower accuracy than the earth-auger. In case of use of these high performance machine, we must consider not only making the planting hole but also total transplanting work including the soil covering attacheed with blade to the hydraulic shovel excavator.

Finally, the transplanting machine has been just developed to assist the serious labor shortage of the forest industry in Japan. The full automatic transplanting machine consists of the air conveying system of nursery stock and the earth-auger having long arm with crawler tractor.

It is important to educate the people living there to accomplish the afforestation in desert area such as China and Mongolia to prevent the desertification as well as to think about mechanization of afforestation working.

Utilization of Peat

Nobuo TAKAMIYA

Research Institute for Science and Engineering, Waseda University
(Japan Peat society)

(1) B field is situated in the south edge of Gurbantunggut Shamo and north outside of Hukan station.

Hukan station is 70km northeast of Urumqi, Capital of Xinjiang Uygur Autonomous Region of China. And Hukan is located 87 degrees 50 minutes of east longitude, in latitude 44 degrees 20 minutes north. Hukan station is 900 meters above sea level, precipitation is about 150 mm, highest temperature is 42.6℃ in the summer, lowest temperature is –41.6℃ in the winter, year average temperature is 6℃.

Soil of B field: pH＝8.0～9.5, EC＝0.12～0.38 ms/cm

(2) Using peat for B field, Alfalfa, maize, peanut, grape, safflower, rape, plant, some kinds of shrub etc. were planted experimentary.

Growth of these plants is better than control. Over 4 fold of the alfalfa harvest was gained compared

with control. Better harvest were recorded with corn is 6 fold, with Safflower is 2 fold, than control.

Cultivation of Plant in Inner Monglia of China
- Study on Greening of the Gobi by Rice Plant

Kazuhisa HASEGAWA

Ishikawa Agricultural College

The experimental paddy field was arranged in the Gobi not far off from Huang-Ho. Soil pH was 9.4. Several species of Japonica-type rice were grown at this field since 1994. The best yield of rice was taken about 500 Kg per 10a. Greening of rice plant in desert is useful to avoid erosion of soil and to produce food, while retaining water.

Present Conditions and Protection Policies of the Desertification in the Great Grassland in Mongolia

Masao TOYAMA

Arid Land Research Center, Tottori University

There is the area facing a serious desertification in Mongolia. That is Zamyn Uud Village in East Gobi Prefecture on the border of China. The desertification in Zamyn Uud Village is caused by the rapid increase of the traffic, but not by overgrazing. After the traffic increases, the grass is all gone and only two brownish wheel tracks remain. Then, the brown color gradually spreads out over the grassland.

The grassland in Zamyn Uud has a coarse sandy soil. In May, during the change of season from winter to summer, strong wind blows. After a cold winter is over, land surface is suddenly warmed up and ascending currents are generated, and then, strong side wind blows in. Around at 10:00 AM the violent wind begins to blow and continues till evening spreading about a large amount of sand.

Sand covers not only houses, but also more seriously, railroads and makes the switches out of order. To avoid such situations, we are planting poplar seedlings imported from China with volunteers' cooperation under the plan to cover the village with the poplar forest. The important thing is to act, rather than to think. Desertification is coming near to our life. There is not a moment to lose.

8) Caatinga vegetation of northeast Brazil (Feb. 2, 1999)

Vegetation structure of Caatinga in northeast Brazil

Norikazu YAMANAKA

Arid Land Research Center, Tottori University

Inner areas of northeast Brazil belong to semi-arid regions and “Caatinga”, which is one kind of savanna, is widely distributed. In these areas, desertification caused by deforestation and overgrazing etc. is proceeding. To control desertification, “The Mini-Project-Type Cooperation for the Conservation of Sand Dunes and Desertification Control in Rio Grande do Norte” conducted by the Brazilian Cooperation agency and JICA is now working. In this project, structure of Caatinga vegetation was investigated at Equador(alt.ca 530m, S.06° 54’04”, W.36° 43’41”). Around Eqador is the driest area in Rio Grande do Norte and mean annual rainfall is about 300mm. In May 1998, 2 plots of 20mx20m in size and 2 plots of 30m x 50m were demarcated. In these 4 plots, all trees above 1.3m in height were identified and diameter at breast height was measured. Floristic composition of understory was also investigated.

As the result, 23 species of woody plants, including succulent plants, were identified in 4 plots. *Caesalpinia bracteosa*, *Jatropha mollissima*, *Croton sonderianus* and *Aspidsperma pirifolium* were dominant species in plots. *Pilocereus gouneli* (Cactaceae) was also dominant in basal area. Stem density was 1400 – 5124/ha and basal area was 0.46 – 0.95m^2/ha.

Leguminosae was the most dominant family of floristic composition in this area, and most of which were trees and shrubs species with thorns. Succulent plants such as Cactaceae were also important component of the flora.

Biomass of Caatinga vegetation in northeast Brazil

Takuo YAMAKURA
Faculty of Science, Osaka City University

Primary production studies in the Caatinga vegetation were made at Equador of Rio Grande do Norte, northeast Brazil. Study plot of 5mx15m in size was demarcated near small valley in June 1998. All trees above 1.0cm in D.B.H (stem diameter at 1.3m height above ground) were identified and D.B.H was measured. *Croton sonderianus*, *Ziziphus joazeiro*, and *Mimosa* sp. were dominant species in the study plot.

Plants in one-thirds of study plot (5mx4.5m in size) were harvested for direct measurement of biomass and all the plants, included undergrowth plants, were treated with the stratified clip technique. Fresh weight of leaves, branches and stem were measured separately for each layer.

The profile structure of the destructive plot showed that the maximum tree height was 5.35m and leaf biomass density was maximum at 4.3-4.8m above the ground. Stem, branch and leaf biomass of destructive plot were 36.76, 24.38 and 3.26ton/ha respectively. Estimated root biomass of destructive plot was 19.85t/ha, and the total biomass was 84.25ton/ha.

9) Examples of Inhibitive Method Against Summer Heat and Heat Island by Using Phase Change in Water (Feb. 26, 1999)

Examples of Inhibitive Method Against Summer Heat and Heat Island by Using Phase Change in Water

Yoshinori SUZUKI

Faculty of Agriculture, Kyushu University

In the coming global warming, summer heat becomes much serious problem for biological production and urban ecosystem. The air temperatures in the heart of Tokyo and Fukuoka City show more than 2C increasing throughout the nearest 100 years. This is caused by the changes in structures and increasing of amount of energy usage. To inhibit such heat, we should not use another energy, and we should make the most use of mechanism in the nature.

There are various mechanisms in the nature. One of them is the phase change in water, which is deeply related to heat and has quite opposite action. That is, vaporization help cooling but condensation bring latent heat to protect plant against frost damage. Here, I want to talk about the former action in improvement of heat island in the urban environment or summer heat for domestic animals using water retain ceramic tiles made from industrial wastes. From the fundamental point of view, the relationships among surface temperature and water content, and evaporation rate from the ceramic tiles placed horizontally on the ground. From the application point of view, the effect of decreasing heat radiant from roof against human or daily cow are also discussed.

10) Perspective of Root Research (Mar. 16, 1999)

Perspective of Root Research

Shigenori MORITA

Graduate School of Agricultural and Life Sciences, The University of Tokyo

Roots anchorage the plant body as well as absorb both water and nutrients that are necessary for growth and development. Besides, roots are effective sensors for environmental stimuli and stresses, and interact with microorganisms in soil. Those are the reasons why many physiological studies on roots have been done from the end of the nineteenth century. Also there have been intensive and extensive ecological researches of crop root system in field for improving agricultural production. Recently root research is focused much more to solve serious environmental issues, for example drought, acid rain, salt accumulation and desertification, which are characterized at the interface between soil and plant roots. Japan also has long history of unique research on crop roots and root researchers are interacting very actively after Japanese Society for Root Research was established in 1992.

There are three important aspects of roots and root system which have to be focused on in the near future, namely subjects on whole root system, individual root which consists of root system, and interactions between root system and environmental factors. Examples of research subjects are as follows, (1) whole root system: to clarify of signals in shoot-root relationships, to understand root system as a system based on individual roots which are different each other in from and function, (2) individual root: to study root apical meristem, root elongation, root hair development and lateral root formation with methodology of molecular and cell biology, developmental genetics and morphogenesis, to examine root anatomy with reference to its function, (3) interactions between root system and environmental factors: to establish stress biology of roots growing under unfavorate conditions, to study role of plant roots in rhizosphere ecology.

When root research on above subjects will be proceeding on, new methodology should be developed based on the existing ones. Field works are also necessary to find research subjects must be studied as well as to feedback research results. Moreover, root researchers with different interests must be cooperated each other to succeed research projects.