

## 1.3 Joint Research

### (1) List of Joint Research

Title of Joint Research Project

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

#### A-1) Land-atmosphere Interaction in Arid Regions

Research on the atmosphere - ground surface interaction in arid region

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

A development of a method for estimating surface soil moisture using a heat budget model incorporated with a radiometric temperature

*Dai MATSUSHIMA\*, Tomokazu KATO and Reiji KIMURA*

Thermal characteristics estimation for the various land cover

*Masao MORIYAMA and Reiji KIMURA*

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

Studies on the development of flow meter using pipe bend

*Soichi NISHIYAMA\*, Man Chi Trung, Satoshi NAGATA and Hisao ANYOJI*

Developing a water-saving irrigation system using a vertically-installed TDR probe and a simulation model

*Kosuke NOBORIO\*, Hiroyuki OCHIAI and Hisao ANYOJI*

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

Physiological, biochemical and mechanical responses of plant roots against environmental stresses

*Eiichi TANIMOTO\* and Atsushi TSUNEKAWA*

Silica accumulation in crop and greening plants under stress conditions

*Jun ABE\*, Shigenori MORITA and Atsushi TSUNEKAWA*

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

*Hideyuki SHIMIZU\*, Yasumi YAGASAKI, Shoko KOBAYASHI and Atsushi TSUNEKAWA*

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

Evaluation of drought and salinity tolerance in wheat with alien chromosomes

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

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

Specific characteristics for salt tolerance mechanism of halophilous plants

*Tsuneo NAKASUGA\**, *Shingo TANIGUCHI* and *Shigenobu TAMAI*

Studies on the salt tolerant characteristics of plant and the desalting of saline soil

*Katsuhiko YABE\**, *Torahiko TANIGAWA*, *Koji KOBAYASHI* and *Shigenobu TAMAI*

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

*Fukuju YAMAMOTO\**, *Mao Hui-ping* and *Norikazu YAMANAKA*

**A-6) Soil Degradation in Arid Areas**

Prediction of soil loss and evaluation of soil conservation practices by process based model

*Taku NISHIMURA\**, *Taisuke ONISHI* and *Takei YAMAMOTO*

Unstable wetting front effect on solute leaching for a sandy soil in arid region

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

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

*Haruyuki FUJIMAKI\** and *Mitsuhiro INOUE*

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

Rethinking desertification from the human life desertification point of view

*Yoshihito SHIMADA\**, *Kanako KODAMA*, *Shun ISHIYAMA*, *Ryou NAKAMURA* and *Hiroshi NAWATA*

Control of noxious plants to plant production in semi-arid regions

*Yukihiro SUGIMOTO\**, *Rieko HORI* and *Hiroshi NAWATA*

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

Studies on land cover change and its socio-economic factors in the Loess Plateau under the 'Grain for Green' project

*Renya SATO\**, *Ryota NAGASAWA*, *Aosier BUHE*, *Zuishin KA*, *Hiromu ITOU* and *Hiroshi NAWATA*

Basic research for regional environmental history in loess plateau

*Koichi MURAMATSU\**, *Hiroshi ICHIKI*, *Megumi FUKUSHIMA* and *Hiroshi NAWATA*

### C) Free Subject

Reconstruction of precipitation and evaporation rates during these 10,000 years using lake sediments in arid regions

*Kaoru KASHIMA\**, and *Masato SHINODA*

Experimental study on environmental controls of carbon dioxide exchange in grassland ecosystem

*Tomoko NAKANO\** and *Masato SHINODA*

Studies on snowmelt, strong wind, and dust outbreak in spring over the dryland of Asia

*Manabu NEMOTO\** and *Masato SHINODA*

A study on water making system using renewable energy for environmental restoration in arid land

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

Improvement of measurement technique of sensible and latent heat flux with fine thermocouple and sonic anemometer

*Nobuhiro MATSUOKA* and *Reiji KIMURA*

Growth experiment of crops with remote sensing technique

*Etsuji ISHIGURO\**, *Susumu HAKOYAMA*, *Daitaro ISHIKAWA*, *Shinichi SEKIOKA*, *Sumitaka KASHIWAGI* and *Reiji KIMURA*

Estimation of reference evapotranspiration in slanting surfaces using GIS technique

*Masahiro TASUMI\** and *Reiji KIMURA*

Activity of landscape conservation and changes of topography and vegetation in Tottori sand dune

*Naru TAKAYAMA\**, *Haruhiko YAMAMOTO* and *Reiji KIMURA*

Reduction of vaporization at ground-surface considering hydraulic discontinuity (2)

*Tadao AODA\** and *Hisao ANYOJI*

Comparative study on soil factor affected to biological production at desert

*Kazuhisa HASEGAWA\** and *Atushi TSUNEKAWA*

Dynamics of soil organic carbon in the steppe region, Mongolia

*Kenji TAMURA\**, *Maki ASANO Takashi KANDA and Atsushi TSUNEKAWA*

Mechanisms of salt tolerance in miscellaneous crops

*Asana MATSUURA\* and Atsushi TSUNEKAWA*

Questioning effects of deep rooting in crop: from a comparative study on water uptake of upland rice and soybean

*Hideki ARAKI\**, *Wataru TSUJI, Taiichiro HATTORI and Atsushi TSUNEKAWA*

Effects of drought stress on physiological characteristics of two *Artemisia* growing in semi-arid land in China

*Ken YOSHIKAWA\**, *Norikazu YAMANAKA, Yoshiro ISHII,REE, Rika SASAKI, and Shigenobu TAMAI*

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

*Kazuyoshi FUTAI\**, *Norikazu YAMANAKA, Fukuju YAMAMOTO, Takeshi TANIGUCHI, Ryouta KATAOKA, Hiromasa OONISHI and Shigenobu TAMAI*

Study on the relation between decomposer diversity and functioning in arid ecosystems

*Nobuhiro KANEKO\**, *Reiji FUJIMAKI and Shigenobu TAMAI*

Production and water use of crops in semi arid areas

*Toru KOBATA\**, *Fumihiko ADACHI and Shigenobu TAMAI*

Irrigation management and related material dynamics in large irrigation scheme

*Tsugihiro WATANABE\**, *Takanori NAGANO, Keisuke HOSHIKAWA, Youichi FUJIWARA, Takashi KUME and Shigenobu TAMAI*

Studies on transpiration from pine forest

*Kyoichi OTSUKI\**, *Tomoomi KUMAGAI, Yasuhiro UTSUMI, Reiji KIMURA and Norikazu YAMANAKA*

Stream water chemistry in semi-arid area

*Ryunosuke TATENO\* and Norikazu YAMANAKA*

Plant ecophysiology concerning the plant invasion in the Tottori Sand Dune: plant N use and water use characteristics

*Rina KOYAMA\**, *Naoko MATSUO, Nobuto OTE, Kenichi OSAKA, Tetsuya SHIMAMURA, Naoko TOKUJI, Shinpei KOYAMA and Norikazu YAMANAKA*

Hydraulic and transpirational properties of trees growing under different light conditions

*Naoko MIKI\**, *Mayumi OGASA, Miyuki HORI, Lin Li YANG and Norikazu YAMANAKA*

Studies on sand drift control at sandy field

*Makio KAMICHIKA\* and Tahei YAMAMOTO*

Change of water quality at Byoubusann sand dune area

*Choichi SASAKI\*, Miyoshi KADONO, Koh KATO and Tahei YAMAMOTO*

Amelioration of the environment of the water and soil by artificial zeolite or aeration

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

The examination on water saving and soil moisture environmental preservation by the minute continuous irrigation

*Torahiko TANIGAWA\*, Takashi KIMATA and Tahei YAMAMOTO*

Salt adsorption effect of artificial zeolite while applying to arid land soil (II)

*Kingshuk ROY\* and Tahei YAMAMOTO*

Importance of surface soil in arid area on fertility conservation - heavy metal absorption characteristics of pioneer plants -

*Yuichi ISHIKAWA\* and Tahei YAMAMOTO*

Research on groundwater management using plant transpiration and water uptake

*Yoshinobu KITAMURA\*, Katsuyuki SHIMIZU, ABOU, Jun SHIROTO and Mitsuhiro INOUE*

Study on efficient water harvesting using capillary barrier of soil

*Toshihiro MORII\* and Mitsuhiro INOUE*

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

*Kouji KAMIYA\* and Mitsuhiro INOUE*

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

*Yuuji TAKESHITA\*, Shinya MORIKAMI, Ryou SAKONO, Shuzo MORITA, Tatsuaki AWANO, Seiichiro KURODA and Mitsuhiro INOUE*

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

*Satoshi YAMADA, Kouji INOSAKO\* and Mitsuhiro INOUE*

Characterization of soil degradation process by direct infiltration water sampling method

*Yasushi MORI\*, Tahei MORISAWA, Naokazu EGUSA, Yuuya HIRAI and Mitsuhiro INOUE*

Quantification of fertilizer dissolved in percolating water using a multi-point direct sampling method

*Kouji INOSAKO \* and Mitsuhiro INOUE*

Mechanism of transfer of water, solute and heat in soil

*Yasutaka KIHARA \* and Mitsuhiro INOUE*

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

*Kimihito NAKAMURA \*, Kotaro FUKADA and Mitsuhiro INOUE*

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

*Kensuke KONDO \*, Zhen Qingtao and Mitsuhiro INOUE*

Poverty reduction programmes in arid regions in Africa

*Fumiko HAKOYAMA \* and Hiroshi NAWATA*

Study of the material culture on the Sinai Peninsula of Egypt

*Youko SHINDO \*, Mutsuo KAWATOKO, Risa TOKUNAGA and Hiroshi NAWATA*

## **(2) Summary of Joint Research**

### **A-1) Land-atmosphere interaction in arid regions**

#### **Research on the atmosphere - ground surface interaction in arid region**

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

\* Meteorological Research Institute, Japan Meteorological Agency

\*\* Faculty of Engineering, Kagawa University

\*\*\* The Institute of Physical and Chemical Research (RIKEN)

\*\*\*\* Arid Land Research Center, Tottori University

#### **A development of a method for estimating surface soil moisture using a heat budget model incorporated with a radiometric temperature**

*Dai MATSUSHIMA \*, Tomokazu KATO and Reiji KIMURA \*\**

\* Faculty of Engineering, Chiba Institute of Technology

\*\* Arid Land Research Center, Tottori University

## I. Background and Objectives

In arid and semi-arid regions, it is concerned that water resources deficit and growing amount of yellow dust will be occurred in near future because of variation of precipitation, population growth, and increasing amount of agricultural products. For the purpose of understanding such problems and investigating solution of them, it is necessary to understand surface layer soil moisture. In terms of estimating surface layer soil moisture using satellite remote sensing technique, methods using satellite-borne microwave radiometer has been practical, however, it is difficult to estimate precise distribution of the soil moisture, because the spatial resolution of them is generally as rough as about 40km and more. On the other hand, satellite remote sensing using visible, near infrared, and thermal infrared bands has much more spatial resolution than that using microwave, however, it is not able to estimate soil moisture as the primary products. But they can be estimated in principle as the secondary products when the satellite data are incorporated in the heat budget equation of the earth surface. This study aims to clarify quantitative relation of the soil moisture and the thermal inertia of sand of Tottori sand dune, using experimental data and a surface heat budget model.

## II. Methods

### (1) Field experiment

A field experiment in terms of the thermal inertia was carried out on a ground of sand dune in the Arid Land Research Center of Tottori University from 5 July to 22 October 2007. Data analysed in this study were obtained between 10 July and 18 October. The following equipments were set in the experimental area (7m by 7m), such as a ADR-type soil moisture sensor, soil temperature sensors, heat flux plates, four-components radiometer (80cm AGL), a cup anemometer (174cm AGL), air temperature and humidity sensors (91cm AGL), and a rain gauge.

### (2) Comparison of the thermal inertia retrieved from the surface heat budget model and the soil moisture

The experimental data were incorporated into the heat budget model, then the thermal inertia was retrieved. The heat budget model is a differential equation of the surface temperature, which is composed of the heat budget equation and the bulk parameterizations. The model can calculate daily variation of the surface temperature and fluxes when time series of input variables (solar radiation, etc.) are given. This daily variation depends on parameters as the thermal inertia and so on, values of the parameters can be retrieved if the calculated surface temperatures are optimized to the measured temperatures. The simplex method was employed as the optimizing algorithm in this study. The optimized values of parameters are representation of diurnal values because the surface temperatures measured from 900h to 1700h were used in optimization in this study.

## III Results and Discussion

Estimated values of the thermal inertia were positively correlated with the volumetric soil moisture between 0 and 5cm deep, and the correlation coefficient was 0.65. The daily values of the thermal inertia tended to be smaller when the solar radiation was small in some cases, which suggested the estimation was not so precise when the solar radiation was smaller than a certain

criterion. Difference of the thermal inertia was between 150 and 200 for 1% difference of the volumetric soil moisture, and the standard deviation was between 200 and 350 (the unit of the thermal inertia is  $J m^{-2} s^{-1/2} m^{-1/2}$ ). This is consistent with that the 3-4% difference of the volumetric soil moisture can be distinguished using estimated thermal inertia in 30% level of significance, and 6% of that can be distinguished using estimated thermal inertia in 5% level of significance. In other words, the volumetric soil moisture can be distinguished by 'large', 'moderate', and 'small' in 30% level, and 'large' and 'small' in 5% level of significance. The correlation coefficients between the thermal inertia and the volumetric soil moisture decreased as the depth increased as 0.59, 0.54, and 0.34 for the depths of 10, 20, and 50cm. This indicated estimated thermal inertia reflected the characteristics of the soil moisture in the most upper level.

### **Thermal characteristics estimation for the various land cover**

*Masao MORIYAMA\* and Reiji KIMURA\*\**

\* Faculty of Engineering, Nagasaki University

\*\* Arid Land Research Center, Tottori University

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

### **Studies on the development of flow meter using pipe bend**

*Soichi NISHIYAMA\*, Man Chi Trung\*\*, Satoshi NAGATA and Hisao ANYOJI*

\* Faculty of Agriculture, Yamaguchi University

\*\* The United Graduate School of Agricultural Sciences, Tottori University

\*\*\* The Graduate School of Agricultural Sciences, Yamaguchi University

\*\*\*\* Arid Land Research Center, Tottori University

The results are as follows.

#### **1 Hydraulic design method of irrigation system by the unsteady flow approach**

In irrigation system, the purpose of hydraulic design is to uniform application of water in the field. The discharge from each emitter is the function of the operating pressure head. So, hydraulic design is the pursuit of the pressure head distribution along the lateral line. The new method of analysis is proposed by using unsteady flow method.

For each type of pipes and form of emitters in drip irrigation systems, the relationship between pressure head and discharge in each emitter or a unit of pipe length is expressed by a constant coefficient. Based on this coefficient and obtained data, by means of smallest square



method, the relationship between lateral discharge and lateral inlet pressure head is determined by an equation called lateral pressure head equation. Therefore, the calculation and design of irrigation systems is very much simplified when we suppose to replace all irrigating laterals with those valves which have their coefficient like that of the lateral pressure head equation.

## 2 Application of 45° Bend Pipe Using a Bypass Flow Meter Without Changing the Flow Direction and the System Construction

Sprinkler systems are largely applied in agricultural production. Rapid and accurate determination of flow discharges is required in order to optimally control and manage sprinkler systems. There have been a number of studies on measuring methods and instruments, but these options were very expensive. With the aim of finding techniques that are low-cost and require low energy consumption, the use of 90° bend pipe flow meters has been examined, but the equipment was difficult to install. This study found that 45° bend pipes can be installed on any main straight pipe section without influencing the flow direction or pipeline system construction. The main flow discharge can then be defined by the proportion of the bypass flow discharge. The procedure of designing bypass flow meters was accomplished by introducing orifices with different diameters into a bypass route based on the obtained experiment results. Since the bypass flow discharge is very small in comparison with the main pipe flow discharge, a small flow meter can be installed on the bypass route with considerable reduction in cost. Moreover, a float-type flow meter can also be installed on the bypass route in order to rapidly and accurately determine the flow discharge. Consequently, the control and management of the quantity of irrigated water become easier and more convenient. Accurate and timely water measurement is important for large-scale irrigation systems in agriculture.

### **Developing a water-saving irrigation system using a vertically-installed TDR probe and a simulation model**

*Kosuke NOBORIO\**, *Hiroyuki OCHIAI\** and *Hisao ANYOJI\*\**

\* Faculty of Agriculture, Meiji University

\*\* Arid Land Research Center, Tottori University

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

#### **Physiological, biochemical and mechanical responses of plant roots against environmental stresses**

*Eiichi TANIMOTO\** and *Atsushi TSUNEKAWA \*\**

\* Graduate School of Natural Sciences, Nagoya City University

\*\* Arid Land Research Center, Tottori University

Adventitious roots (AdR) support the growth of cuttings-propagated tea plants in the farm. For basic characterization of tea AdR, we investigated mechanical property and polysaccharides of cell walls. By comparing soil-, hydroponics- and aeroponics-cultured AdR, and gibberellin(GA)-starved AdR, we obtained new evidence for the basic regulatory process of cell wall rigidity and root growth. The most apical part of the roots (0-2 mm behind root tip) responded most remarkably. Aeroponics-cultured roots, under the least mechanical stress, had the highest content of pectic polysaccharides and the lowest content of cellulose. GA-starved roots were similar to soil-grown roots with the lowest pectin and the highest cellulose contents. Two balanced regulatory processes were suggested in the root tip. 1) Regulation of vesicle-transport system to excrete pectic polysaccharides. 2) Regulation of membrane-located cellulose synthase system. These information provide new insights into the regulation of woody root growth and development in the soil and in the hydroponics with deifferent mechanical stress.

### **Silica accumulation in crop and greening plants under stress conditions**

*Jun ABE\*, Shigenori MORITA\* and Atsushi TSUNEKAWA \*\**

\* Graduate School of Agricultural and Life Sciences, the University of Tokyo

\*\* Arid Land Research Center, Tottori University

Accumulation of silicon in plants was analyzed by X-ray micro-analyzer in ALRC. While some species of *Artemisia* that distribute in Russian arid lands are known for the high contents of silicon in the mucilage from the seeds, no significant accumulation of silicon was detected in the seeds of several *Artemisia* species collected in arid lands and deserts in western China. Investigations on forage grasses indicated silicon deposition in both root endodermal cell walls and leaf surface with remarkable variation in the distribution patterns and contents among the species. Sudan grass, a drought tolerant grass, showed high content silicon deposition than other species.

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

*Hideyuki SHIMIZU\*, Yasumi YAGASAKI\*, Shoko KOBAYASHI\* and Atsushi TSUNEKAWA \*\**

\* National Institute for Environmental Studies

\*\* Arid Land Research Center, Tottori University

Effects of water stress on the growth of *Artemisia halodendron*, *Caragana microphylla* (as

shrub species) and *Cleistogenes squarrosa* (as a grass specie) were investigated in the present study. The dry matter production was inhibited by water stress in order of *A. halodendron*, *C. squarrosa* and *C. microphylla*. Water stress induced a significant decrease in S/R ratio in *A. halodendron* and *C. squarrosa*. LAR of *C. squarrosa* decreased with increasing water stress. However, the S/R ratio of *C. microphylla* was not affected, and its LAR and SLA was increased with increasing water stress. These results suggested the several adaptation mechanisms in different plant species to water stress.

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

##### **Evaluation of drought and salinity tolerance in wheat with alien chromosomes**

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

\* Faculty of Agriculture, Tottori University

\*\* Arid Land Research Center, Tottori University

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

##### **Specific Characteristics for Salt Tolerance Mechanism of Halophilous Plants**

*Tsuneo NAKASUGA\**, *Shingo TANIGUCHI \** and *Shigenobu TAMAI\*\**

\* Faculty of Agriculture, Ryukyu University

\*\* Arid Land Research Center, Tottori University

Soil contains the most diverse biological community in terrestrial ecosystems. Soil biota has important ecosystem functions such as nutrient cycling which supports plant growth. Studies on soil biodiversity is rapidly progressed due to development of molecular and physiological methods and also manipulation of biodiversity in a field condition.

In this study we aimed to specify the most important soil biota responsible for organic matter decomposition in arid soil condition.

We used zeolite cotton cloth as target organic matter and buried it in soil using a litterbag method. Heterotrophic respiration of soils adjacent the litterbag (above and below the bag) was measured using a manometer. Soil suspension was inoculated to BIOLOG Ecoplate to see bacterial community activity.

## **Studies on the salt tolerant characteristics of plant and the desalting of saline soil**

*Katsuhiko YABE\**, *Torahiko TANIGAWA\*\**, *Koji KOBAYASHI\*\** and *Shigenobu TAMAI\*\*\**

\* School of Environmental Science, the University of Shiga Prefecture

\*\* Graduate School of Life & Environmental Sciences,  
Osaka Prefecture University

\*\*\* Environmental Graduate School, the University of Shiga Prefecture

\*\*\*\* Arid Land Research Center, Tottori University

The experiments were carried out to clarify the rate of the tree growth, the evapotranspiration, the extent of the saline absorption, and the limit of the salt tolerance by planting Tamarix under the four kinds of saline concentration, that is 0%, 1.0%, 4.0%, and 7%. The soils used are 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 40cm diameter and 50cm depth. The treatments were four regimes made from the NaCl solution diluted with water. The ground water level in the period of experiment was kept to about 40cm under the earth surface. Measurement items are the tree height, the tree diameter of base, water supplied to three replications, and the salt distribution. The results obtained are as follows.

Firstly, the larger evapotranspiration was observed from the 0% and 1.0% experiment pots. Secondly, the evapotranspiration in the 4.0% and 7.0% experiment plots was largely suppressed and not attained to about 3mm/d. Consequently, the largest amount of the salt absorption was judged to be obtained in the 1% experiment pot. On the other hand, the larger tree growth were observed in the 0% and 1.0% experiment pots, but the tree growth in the 4.0% experiment pot was largely suppressed and the trees in the 7.0% experiment pots. wilted. Judging from these results, the limit of the salt tolerance was considered to be about 7%.

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

*Fukuju YAMAMOTO\**, *Mao Hui-ping\*\** and *Norikazu YAMANAKA\*\*\**

\* Faculty of Agriculture, Tottori University

\*\* Graduate School of Agriculture, Tottori University

\*\*\* Arid Land Research Center, Tottori University

Growth, photosynthesis, and Na<sup>+</sup>, K<sup>+</sup>, and Ca<sup>2+</sup> distributions were investigated in 2-year-old hydroponically cultured *Populus alba* L. cuttings exposed to salt stresses (0, 0.85, 8.5, 17, and 85 mM NaCl in Exp. 1 and 0, 50, 100, 150 and 200 mM in Exp. 2) for 4 weeks in 2/5 Hoagland solution. Salt did not markedly inhibit height growth and diameter increment in 150 mM and 100 mM NaCl, respectively. The 85 mM NaCl treatment increased the dry weights of roots and total dry weight of plants, while 150 mM NaCl significantly reduced the dry weights of

leaves, stems, and total plant weight. The decline in the photosynthetic rate lagged 2 weeks than the decline of stomatal conductance in 50 mM and 100 mM salt solutions. Different ions exhibited different distributions in different parts of the plant. Most Na<sup>+</sup> ions were excluded and/or compartmentalized in roots at low and moderate salt stress ( $\leq 50$  mM). K<sup>+</sup> content in leaves increased with the increase in the salt concentration in the growth solutions.

#### **A-6) Soil Degradation in Arid Areas**

##### **Prediction of soil loss and evaluation of soil conservation practices by process based model**

*Taku NISHIMURA\**, *Taisuke ONISHI\*\** and *Tahei YAMAMOTO\*\*\**

\* Graduate School of Agricultural and Life Sciences, the University of Tokyo

\*\* United Graduate School of Agricultural Science, Tokyo University of Agriculture and  
Technology

\*\*\* Arid Land Research Center, Tottori University

##### **Unstable wetting front effect on solute leaching for a sandy soil in arid region**

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

\* Faculty of Agriculture, Saga University

\*\* Arid Land Research Center, Tottori University

The infiltration model presented in this study predicts a linear decrease of the pressure head within the induction zone prior to finger formation. Assuming the pressure head as the dynamic water entry suction at the wetting front and saturation at that suction, we calculated the pressure gradient with time ( $G_p$ ) for independently applied water flux ( $q_s$ ) at the soil surface less than saturated hydraulic conductivity. The relation between  $G_p$  and  $q_s$  derived from this calculation reasonably estimated experimental results.

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

*Haruyuki FUJIMAKI\** and *Mitsuhiro INOUE\*\**

\* School of Life and Environmental Sciences, Tsukuba University

\*\* Arid Land Research Center, Tottori University

We have conducted two experiment using soil tanks in each of which 16 TDR probes were inserted horizontally: one was in a greenhouse and the other was under an wind tunnel. After soybean plants were grown to have leaf area larger than about 300cm<sup>2</sup>, saline water was applied from a porous pipe inserted at a depth of 15 cm. We are analyzing root distribution for both. A numerical model for simulating two dimensional water and solute movement under such condition is under development.

We also performed soil samplings in two plantations under subsurface drip irrigation in Israel. By analyzing two dimensional distribution of electrical conductivity of soil solution, we found that the salinity of an almond orchard was severe condition for the tree. For the other jojoba plantation, the salinity may not so severe for the salt-tolerant plant, but more frequent and low intensity irrigation is recommended to keep the soil surface dry.

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

##### **Rethinking Desertification from the Human Life Desertification Point of View**

*Yoshihito SHIMADA\**, *Kanako KODAMA\*\** *Shun ISHIYAMA\*\*\**, *Ryou NAKAMURA\** and *Hiroshi NAWATA\*\*\*\**

\*Graduate School of Letters, Nagoya University

\*\*JSPS Fellow, National Museum of Ethnology

\*\*\*Fukui Prefectural University

\*\*\*\* Arid Land Research Center, Tottori University

Our study of desertification is done from human life desertification's point of view. Shimada tries to have a general view on the Afro-Eurasian Inner Dry land desertification from Sahara-sahel of Africa to Inner Mongol of China. Kodama studies particularly Inner Mongol Desertification. Ishiyama studies the desertification of Central Sudan of Africa, and Nakamura studies mangrove and coral sea environments of Swahili coast, especially those of Kilwa Island.

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

*Yukihiro SUGIMOTO\**, *Rieko HORI\** and *Hiroshi NAWATA\*\**

\* Kobe University

\*\* Arid Land Research Center, Tottori University

Sorghum genes responsive to *Striga hermonthica* parasitism were isolated and their expression was analyzed. Using the suppression subtractive hybridization strategy, 30genes,

up-regulated in response to *S. hermonthica* parasitism, were isolated from roots of susceptible sorghum cultivar Abu 70. Changes in expression of each of the genes were investigated in roots and leaves obtained from the *S. hermonthica*-parasitized sorghum cultivars Tabat and Wad Ahmed. Tabat is more susceptible while Wad Ahmed is less susceptible to *S. hermonthica* than cv. Abu 70. The changes were studied also in roots of the three sorghum cultivars treated with salicylic acid (SA) or methyl jasmonate (MeJA). *S. hermonthica* parasitism induced JA-responsive genes and suppressed SA-responsive genes in roots of cvs. Abu 70 and Tabat. In contrast, in the less susceptible cultivar Wad Ahmed, *S. hermonthica* parasitism induced SA-responsive genes but slightly induced JA-responsive genes.

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

### **Studies on land cover change and its socio-economic factors in the Loess Plateau under the 'Grain for Green' project**

*Renya SATO\**, *Ryota NAGASAWA\*\**, *Aosier BUHE\*\*\**, *Zuishn KA\*\*\*\**, *Hiromu Itou\*\*\*\*\** and *Hiroshi NAWATA \*\*\*\*\**

\*Graduate School of Social and Cultural Studies, Kyushu University

\*\*Faculty of Agriculture, Tottori University

\*\*\*Department of Biosphere and Environmental Sciences, Rakuno Gakuen University

\*\*\*\*Graduate School of Agriculture, Tottori University

\*\*\*\*\*Arid Land Research Center, Tottori University

The purpose of this study is to examine effects and problems of the 'Grain for Green' project of China, which progressed halfway through the onset, from the viewpoints both of ecological recovery and of changes in land use as well as rural subsistence economy.

The 'Grain for Green' project tries for ecological recovery of the upper reaches of the Huang-He and the Yangtze River, by prohibition of grazing and transformation of cultivated fields in steep slopes into afforested areas. This project aims at not only ecological recovery but also rural economic development, because improvement of peasant economy is regarded as a key for future sustainability of the forests.

The research members used remote sensing analysis to examine the extent of ecological recovery after the onset of the project on the one hand, and conducted intensive field research in Beisongta Village, Ansai Province, Shanxi to investigate the extent of change of traditional land use and subsistence economy on the other hand. The result of remote sensing analysis showed marked recovery of land cover, that indicates the effect of afforestation and the prohibition of grazing.

Though peasant subsistence economy were greatly affected by the prohibition of sheep and goats grazing and decrease of cultivated land, hothouse cultivation which started at the same time as the project, seems to make up for them so far.

**Basic research for regional environmental history in loess plateau**

*Koichi MURAMATSU\**, *Hiroshi ICHIKI*, *Megumi FUKUSHIMA\*\** and *Hiroshi NAWATA \*\*\**

\*Research Institute for Oriental Cultures, Gakushuin University

\*\*Graduate School of Humanites, Gakushuin University

\*\*\*Arid Land Research Center, Tottori University

C) Free Subject on Arid Land Studies

**Reconstruction of precipitation and evaporation rates during these 10,000 years using lake sediments in arid regions**

*Kaoru KASHIMA\** and *Masato SHINODA\*\**

\*Graduate School of Physical Science, Kyushu University

\*\*\*Arid Land Research Center, Tottori University

**Experimental study on environmental controls of carbon dioxide exchange in grassland ecosystem**

*Tomoko NAKANO\** and *Masato SHINODA\*\**

\*Faculty of Urban Environment, Tokyo Metropolitan University

\*\*Arid Land Research Center, Tottori University

Exchange of CO<sub>2</sub> between terrestrial ecosystems and the atmosphere is controlled by the balance between CO<sub>2</sub> uptake during photosynthesis and CO<sub>2</sub> emission via plant and soil respiration. The objective of this study was to evaluate the quantitative dependence of photosynthetic production and ecosystem respiration on temperature, moisture, radiation, and plant biomass in a semi-arid grassland. Toward this aim, we measured CO<sub>2</sub> fluxes using a closed-chamber technique in an environmental control equipment in ALRC, Tottori University and in a grassland of Mongolia. As a result, we found that (1) values of gross primary production (GPP) were linearly related to live aboveground biomass (AGB) enclosed by the chamber, (2) GPP/AGB fit well a rectangular hyperbolic light-response curve for all the study periods, but when the air and soil were dry, considerable reduction in GPP was observed, (3) the GPP/AGB ratio was also expressed as individual functions of air temperature, vapor pressure deficit, and volumetric soil water content, and (4) values of Reco were expressed well as a bivariate function of soil temperature and soil moisture near the soil surface.



**Studies on snowmelt, strong wind, and dust outbreak in spring over the dryland of Asia**

*Manabu NEMOTO\* and Masato SHINODA\*\**

\* National Agricultural Research Center for Hokkaido Region

\*\* Arid Land Research Center, Tottori University

In the present study, micrometeorological results on the ground throughout a year in a Mongolian grassland and upper-air condition extracted from reanalysis data were simultaneously analyzed. Just after snow disappeared, wind speed at the ground was boosted drastically. Upper air wind speed was the strongest around the time throughout a year. Therefore, the enhancement of wind speed at the ground was induced by entrainment of strong wind at the upper with development of boundary surface layer triggered by snow disappearing. As the results, it was clarified that the snow cover had effects not only to restrain to suspend soil particles, that is dust, but also to enhance strong wind required for the suspension of the dust.

**A study on water making system using renewable energy for environmental restoration in arid land**

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

\*Faculty of Engineering, Tottori University

\*\*Faculty of Regional Science, Tottori University

\*\*\* Arid Land Research Center, Tottori University

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 Peltier device has been developed. The water maker unit which the Peltier devices are placed is stacked vertically. The experiments for the water maker were performed in a controlled chamber of temperature and relative humidity set in Arid Land Reserch Center, Tottori University. The effects of the electric power supplied to the Peltier device, the equipment configurations and the amount of air-flow in the cooling channel on water production rate and temperature profile in the channel were investigated in the experiments.

When the electric power supplied to Peltier devices become larger, the temperature of cooling fins on one side of Peltier devices rises with the rise of the temperature of radiating fins on the other side of Peltier devices. This thing causes a decrease in water production rate. It is important that the control of the temperature of fins on both sides of Peltier device to keep the temperature of cooling fins lower than the dew point of air flowing in the cooling channel.

Water production rate increases because of the amount of moisture in the air flowing into the cooling channel, when the amount of air-flow becomes larger.

It was also found the water production rate decreased when the numbers of the stages of water maker become more. This thing shows the existence of the optimum numbers of the stages to maximize the water production rate.

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 in summer season, it was found that the amount of water production was 1 kg per day used by multi-stages water maker.

### **Improvement of measurement technique of sensible and latent heat flux with fine thermocouple and sonic anemometer**

*Nobuhiro MATSUOKA and Reiji KIMURA*

\*Graduate School of Agriculture, Kyoto University

\*\*Faculty of Agriculture, Tottori University

\*\*\*Graduate School of Agricultural and Life Sciences, the University of Tokyo

\*\*\*\*Arid Land Research Center, Tottori University

To measure latent heat flux, IRGA is indispensable but is not suitable under severe weather condition. Therefore, development of simple measurement technique is expected without maintenance. We proposed a new technique for the measurement of latent heat flux with fine-thermocouple and sonic anemometer. Spectrum of temperature by the fine-thermocouple shows this sensor has sufficient response for eddy measurement and comparable with that of Sonic anemometer. We compared fluxes from this method and conventional method. The result shows that 1) No difference in amount of sensible heat fluxes for the two methods and 2) amount of latent heat flux with the new method is larger than conventional method by  $8.4 \text{ W/m}^2$  and RMSE is  $190.6 \text{ W/m}^2$ .

### **Growth experiment of crops with remote sensing technique**

*Etsuji ISHIGURO\**, *Susumu HAKOYAMA\**, *Daitaro ISHIKAWA\*\**, *Shinichi SEKIOKA\*\**,  
*Sumitaka KASHIWAG\*I and Reiji KIMURA\*\*\**

\* Faculty of Agriculture, Kagoshima University

\*\* Graduate School of Agriculture, Kagoshima University

\*\*\* Arid Land Research Center, Tottori University

This study carried out to contribute to the rice cultivation management for the improvement of the grain grade by adaptation of non-destructive method using spectral reflectance from the canopy of rice fields. Those results were shown as following.

**Estimation of reference evapotranspiration in slanting surfaces using GIS technique**

*Masahiro TASUMI\* and Reiji KIMURA*

\*Faculty of Agriculture, Miyazaki University

\*\*Arid Land Research Center, Tottori University

**Activity of landscape conservation and changes of topography and vegetation in Tottori sand dune**

*Naru TAKAYAMA\*, Haruhiko YAMAMOTO\* and Reiji KIMURA\*\**

\*Faculty of Agriculture, Yamaguchi University

\*\*Arid Land Research Center, Tottori University

**Reduction of vaporization at ground-surface considering hydraulic discontinuity (2)**

*Tadao AODA\* and Hisao ANYOJI\*\**

\*Faculty of Agriculture, Niigata University

\*\*Arid Land Research Center, Tottori University

**Comparative study on soil factor affected to biological production at desert**

*Kazuhisa HASEGAWA\* and Atushi TSUNEKAWA\*\**

\*Ishikawa Prefectural University

\*\*Arid Land Research Center, Tottori University

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 (TypeC...FeO 5.7%、other) were useful in fertilizer response.

Further, these materials and aqua TypeC (FeO 2.6%) —0.01% water solution 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/m<sup>2</sup>.

**Dynamics of soil organic carbon in the steppe region, Mongolia**

*Kenji TAMURA\**, *Maki ASANO\*\**, *Takashi KANDA\** and *Atsushi TSUNEKAWA\*\*\**

\*Graduate School of Life and Environmental Science, Tsukuba University

\*\*Faculty of Law, Keio University

\*\*\*Arid Land Research Center, Tottori University

The plant species compositions showed differences in moisture conditions among the study sites. *Leymus chinensis*, and *Stipa krylovii* dominated in plant communities at forest steppe site, while *S. krylovii* and *Carex* sp. were dominant at steppe sites, While, *Peganum nigellastrum* characteristic for the vegetation in desert steppe. The organic carbon and total nitrogen contents decreased gradually from the forest steppe to the desert steppe site. Soil organic carbon content (OC) ranged from 0.6 to 21.4 g kg<sup>-1</sup>, showing high values in top soil horizons and rapid decreases with soil depth. Total nitrogen content (TN) showed a similar tendency. Organic carbon and total nitrogen contents were positively related to the vegetation coverage and the number of plant species. The  $\delta^{13}\text{C}$  values of soil organic matter ( $\delta^{13}\text{CSOM}$ ) vary from -23.2 ‰ to -20.2 ‰. The vertical distributions of  $\delta^{13}\text{CSOM}$  value show no correlation with soil depth. C3 and C4 plants exhibited distinctive  $\delta^{13}\text{C}$  ranges of -25.0 ‰ to -27.3 ‰ (with a average of -26.2 ‰) and -12.5 ‰ to -14.3 ‰ (with a average of -13.4 ‰), respectively. Present data for the range of  $\delta^{13}\text{C}$  values of soil organic matter fell between the reported value of C3 and C4 plants. These results suggested the soil organic matter of study sites were derived from the mixture grassland of C3 and C4 grass as that as in agreement with vegetation survey.

**Mechanisms of salt tolerance in miscellaneous crops**

*Asana MATSUURA\** and *Atsushi TSUNEKAWA\*\**

\*Faculty of Agriculture, Kyushu Tokai University

\*\*Arid Land Research Center, Tottori University

**Questioning effects of deep rooting in crop: from a comparative study on water uptake of upland rice and soybean**

*Hideki ARAKI\**, *Wataru TSUJI\*\**, *Taiichiro HATTORI\*\** and *Atsushi TSUNEKAWA\*\**

\*Faculty of Agriculture, Yamaguchi University

\*\*Arid Land Research Center, Tottori University

**Effects of drought stress on physiological characteristics of two *Artemisia* growing in semi-arid land in China**

*Ken YOSHIKAWA* \*, *Yoshiro ISHII* \*, *REE* \*, *Rika SASAKI* \*, *Norikazu YAMANAKA* \*\*, and *Shigenobu TAMAI* \*\*

\*Graduate School of Environmental Science, Okayama University

\*\*Arid Land Research Center, Tottori University

*Artemisia ordosica* and *A. sphaerocephala*, perennial shrub species, are growing in Mu Us sand land, one of the famous dry land confronting desertification in China. *A. ordosica* can grow on fixed and semi-fixed sand dunes and, on the other hand, *A. sphaerocephala* is restricted its distribution on shifting sand dune. To clarify such difference in growing site conditions, seedlings of these two species were grown under artificial drought stress for one growing season.

Both top and root growth rates of *A. ordosica* were significantly suppressed by drought stress. On the other hand, *A. sphaerocephala* was not affected for its growth by water shortage.

The volumetric modulus of elasticity of leaf cell of *A. ordosica* decreased by drought stress, indicating the cell walls readily distended in response to changes in cell volume, and therefore the turgor pressure rose slowly. Moreover, *A. ordosica* showed a sensitive response of stomata closure by water shortage and a rapid recovery of transpiration after irrigation. Such physiological properties for water conservation suggested high ability of *A. ordosica* to survive on fixed and semi-fixed sand dunes with large soil moisture fluctuation.

On the other hand, the size and function of stomata and the water relations of leaf cell of *A. sphaerocephala* did not show any changes by water stress. Both the rates of photosynthesis and transpiration were also showed no response on changes in soil moisture condition. Therefore, *A. sphaerocephala* can grow in arid condition by its high capacity to water absorption by low water potential in root system. However, a lack of water conservable characteristics restricted growing site of *A. sphaerocephala* on shifting sand dune with relatively constant soil water condition.

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

*Kazuyoshi FUTAI* \*, *Takeshi TANIGUCHI* \*, *Ryouta KATAOKA* \*, *Hiromasa OONISHI* \*, *Fukuju YAMAMOTO* \*\*, *Norikazu YAMANAKA* \*\*\*, and *Shigenobu TAMAI* \*\*\*

\*Graduate School of Agriculture, Kyoto University

\*\*Faculty of Agriculture, Tottori University

\*\*\*Arid Land Research Center, Tottori University

## **Study on the relation between decomposer diversity and functioning in arid ecosystems**

*Nobuhiro KANEKO\**, *Reiji FUJIMAKI* and *Shigenobu TAMAI*

\*Graduate School of Environment and Information Science, Yokohama National University

\*\*Arid Land Research Center, Tottori University

Soil contains the most diverse biological community in terrestrial ecosystems. Soil biota has important ecosystem functions such as nutrient cycling which supports plant growth. Studies on soil biodiversity is rapidly progressed due to development of molecular and physiological methods and also manipulation of biodiversity in a field condition.

In this study we aimed to specify the most important soil biota responsible for organic matter decomposition in arid soil condition.

We used zeolite cotton cloth as target organic matter and buried it in soil using a litterbag method. Heterotrophic respiration of soils adjacent the litterbag (above and below the bag) was measured using a manometer. Soil suspension was inoculated to BIOLOG Ecoplate to see bacterial community activity.

## **Production and water use of crops in semi arid areas**

*Toru KOBATA\**, *Fumihiko ADACHI\** and *Shigenobu TAMAI\*\**

\*Faculty of Life and Environmental Science, Shimane University

\*\*Arid Land Research Center, Tottori University

Cultivar differences in the maintenance capacity of green leaves under drought conditions is only partially known in rice. Our objective was to determine whether the capacity in seedling stage differs among rice cultivars particularly in drought-prone areas. Twenty-five rice cultivars including traditional cultivars in Japan and Vietnam were grown in shallow (diameter/depth=0.25/0.20 m) pots. At the five-leaf stage from the pots water was withheld. Every four days, the green leaf area (GLA), leaf green color with a chlorophyll meter (SPAD) and fraction of transpirable soil water (FTSW) were measured. GLA was determined by leaf area at the start of soil desiccation and visual scoring of senescence. FTSW was estimated from pot weight and soil moisture content at harvest. The relative SPAD, GLA and SPAD · GLA (observed values/value at heading) in each cultivar decreased with a decrease in FTSW. Maintenance capacity of the SPAD, GLA or SPAD · GLA under low FTSW differed among cultivars. These results suggested that the capacity to maintain green leaves under desiccated soil conditions differed among rice cultivars in seedling stage. Furthermore the contribution of the capacity to seedling growth should be assessed.

## **Irrigation management and related material dynamics in large irrigation scheme**

*Tsugihiko WATANABE\**, *Takanori NAGANO\**, *Keisuke HOSHIKAWA\**, *Youichi FUJIWARA\**,  
*Takashi KUME and Shigenobu TAMAI\*\**

\*Research Institute for Humanity and Nature

\*\*Arid Land Research Center, Tottori University

This research aims at developing the methodology of analyzing regional material dynamics in irrigated area and assessing impacts of irrigation management on it, for improving hydrological environment in arid area. The emphasis is on utilization of stable isotope analysis for identifying the origin and route of minerals that cause soil salinity problem and the route and dynamics of nutrients and other pollutants that cause water quality problem.

In the project, the hydrological models including irrigation management performance model, basin hydrology model and groundwater model, which have been developed in the previous research projects, are validated, and the proto-type combined model with material dynamics component is to be developed. The project selects the lower-plain of the Seyhan River Basin and the Harran Plain of Turkey as case study areas, because of higher availability of basic research information and resources.

The research activities and outcomes of the year 2007-2008 (H19th year of the Japanese fiscal year) are summarized as follows:

- 1) The research organization including establishing the team of local collaborators in Turkey.
- 2) With reviewing the past researches in the case study area, including of the universities and governmental agencies, the history and actual condition of irrigation management in the region was diagnosed.
- 3) With the available information and additional field observations, the current problems are defined and the target material and sampling points are defined.
- 4) As the results, all available references and data to be utilized for quantitative evaluation of water dynamics and water balance of the region.

## **Studies on transpiration from pine forest**

*Kyouichi OTSUKI\**, *Tomoomi KUMAGAI\**, *Yasuhiro UTSUMI\**, *Reiji KIMURA\*\** and *Norikazu YAMANAKA\*\**

\*Graduate School of Agriculture, Kyushu University

\*\*Arid Land Research Center, Tottori University

This research failed to find the features of transpiration of *pinus thunbergii*. However, we clarified the mechanism of transpirations of various tree species such as broad-leaved tree (*Quercus glauca* Thunb), conifers (*Cryptomeria japonica*, *Chamaecyparis obtusa*), and bamboo

(*Phyllostachys pubescens*), and found some new information on the transpiration from forests in Japan based on these results and previous research reports; 1) parameters of transpiration from broad-leaved forests could be expressed as constant, 2) parameters of transpiration from coniferous forests could be expressed as the function of tree height.

### **Stream water chemistry in semi-arid area**

*Ryunosuke TATENO\* and Norikazu YAMANAKA\*\**

\*Faculty of Agriculture, Kagoshima University

\*\*Arid Land Research Center, Tottori University

We collected river water from basin with area, precipitation and forest cover, and major ion concentrations of collected water were analyzed. As results, some ion concentrations were apparently changed with basin area and precipitation gradient. In future, we will analyze the effects of forest cover on river water chemistry and discuss the relationships between re-vegetation technique and water management.

### **Plant ecophysiology concerning the plant invasion in the Tottori Sand Dune: plant N use and water use characteristics**

*Rina KOYAMA\*, Naoko MATSUO\*, Nobuto OTE\*, Kenichi OSAKA\*, Tetsuya SHIMAMURA\*,  
Naoko TOKUJI\*, Shinpei KOYAMA\* and Norikazu YAMANAKA\*\**

\*Graduate School of Informational Science, Kyushu University

\*\*Graduate School of Bioresources, Tottori University

There have been extensive invasion by many plant species in the Tottori Sand Dune during past several decades. However, as the nutrient availability is very low and the soil moisture condition is spatiotemporally heterogeneous in a dune, the environment in the dune is not always favorable for plant invasion. The mechanisms behind the plant invasion into the dune have not been fully understood, especially from the viewpoint of ecophysiology of invasive species. Focusing on the physiological characteristics of dune species, especially on the plant nitrogen (N) use and water use, we investigated the nutrient condition in the dune, the N use of dune species, and the water use of dune species.

#### <Nutrient condition and plant nutrient>

Since the major N source for most plant species is soil inorganic N, total N pool size in the soil can not be a sufficient indicator of soil N availability. In this study, we investigated the spatial distribution of total N, extractable organic N, and inorganic N in the dune sand. The ratio



of inorganic N to total N in the dune sand was higher in comparison with other type of ecosystems. The spatial pattern of total N and that of inorganic N differed to each other, and the spatial changes in total N pool size was gradual on a scale of 15 – 20 m, while inorganic N pool size were highly heterogeneous on a smaller scale (within 1-m). Nitrogen pool sizes changed seasonally, while the spatial patterns of them retained in all seasons. The distributions of moisture condition, pH, EC and vegetation did not show clear correlation with those of N pool sizes. However, distribution of some plant species corresponded with that of total N pool size from summer to autumn, which suggests the influence of plants on soil N condition.

We also conducted the isotopic analysis on plant and soil to estimate the N use of N-fixing plant species and the contribution of N-fixing plants as a N source for soil. Nitrogen concentration and the  $\delta^{15}\text{N}$  natural abundance ( $\delta^{15}\text{N}$ ) of three woody shrub species (*Robinia pseudoacacia* L., *Elaeagnus umbellata* Thunb., and *Vitex rotundifolia*) were investigated in the dune. N-fixing *R. pseudoacacia* and *E. umbellata* showed higher N concentration, and  $\delta^{15}\text{N}$  of these species was closer to that of atmospheric  $\text{N}_2$  than *V. rotundifolia*. On the contrary, N pool size was largest in the sand associated with *V. rotundifolia*, and smallest in the sand associated with *R. pseudoacacia*. The  $\delta^{15}\text{N}$  of the sand associated with N-fixing *R. pseudoacacia* was closest to that of atmospheric  $\text{N}_2$  among species, while the sand associated with another N-fixing species, *E. umbellata* showed similar  $\delta^{15}\text{N}$  to the sand associated with non-N-fixing *V. rotundifolia*. The results showed that N-fixation was an important N source for the N-fixing plants in the dune; however, the N-fixing plants did not always play a role as a direct N source for the sand associated with them, and the influence of plants was not consistently found in the sand associated with them.

#### <Water use of plants>

We measured the oxygen and carbon isotope ratio ( $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ ) in leaf organic matter, which reflect transpiration and water-use efficiency, in three tree species (*Robinia pseudoacacia* L., *Elaeagnus umbellata* Thunb., and *Vitex rotundifolia*) grown on the dune. The positive relationship was found between the  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  in three species, and *E. umbellata* had the higher  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ . These results indicate that *E. umbellata* maintains higher water-use efficiency via stomatal control.

### **Hydraulic and transpirational properties of trees growing under different light conditions**

*Naoko MIKI\**, *Mayumi OGASA\**, *Miyuki HORI\**, *Lin Li YANG\** and *Norikazu YAMANAKA\*\**

\*Graduate School of Environmental Science, Okayama University

\*\*Arid Land Research Center, Tottori University

Hydraulic acclimation of *Quercus glauca* and *Eurya japonica* was analyzed in response to the differences of growing light conditions (relative light condition on each treatment was 100 %, 10 % and 3 %, respectively). Two years after starting treatments, hydraulic conductivity, xylem anatomy of stem and stomatal responsibility of leaf were compared among three growing light

conditions. Vulnerability to cavitation for stems taken from the 3 %-treatment (most dark condition) was high comparing with them in other treatments. There were no significant differences in size of xylem vessel among treatments. However, Trees of 100 % and 10 %-treatment tended to use more small vessels and decrease the risk in occurrence of cavitation than them in 3 %-treatment. Large vessels were used in trees of 3 %-treatment. *Q. glauca* tree in 100 %-treatment reduced stomatal conductance ( $g_s$ ) and transpiration rate ( $Tr$ ) around noon. *E. japonica* tree in 100 %-treatment also kept low  $g_s$  and  $Tr$  values over the entire day and tended to be small in total leaf area per a tree. It is suggested that *Q. glauca* tree maintain the hydraulic function with changing the size of used-vessel depend on growing light conditions, while *E. japonica* tree, in addition, tended to adjust the amount of leaf in a tree-scale.

### **Studies on sand drift control at sandy field**

*Makio KAMICHIKA\* and Tahei YAMAMOTO\*\**

\*Tottori University of Environmental Studies

\*\* Arid Land Research Center, Tottori University

### **Change of water quality at Byoubusann sand dune area**

*Choichi SASAKI\*, Miyoshi KADONO\*, Koh KATO\* and Tahei YAMAMOTO\*\**

\*Faculty of Agriculture and Life Science, Hirosaki University

\*\*Arid Land Research Center, Tottori University

### **Amelioration of the environment of the water and soil by artificial zeolite or aeration**

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

\*Faculty of Life and Environmental Science, Shimane University

\*\*Nikkokiden Inc.

\*\*\*Arid Land Research Center, Tottori University

### **The examination on water saving and soil moisture environmental preservation by the minute continuous irrigation**

*Torahiko TANIGAWA\*, Takashi KIMATA\* and Tahei YAMAMOTO\*\**

\*Graduate School of Life and Environmental Sciences, Osaka Prefecture University

\*\*Arid Land Research Center, Tottori University

Practical application test of the SIMERUS replanting system was carried out in this fiscal year.

First, the improvement in the practicability was achieved on the permeation type tube. In short, the following were examined : Improvement of the durability and adoption of the cheap material. Therefore, it can be said that the base of the enlargement was established.

Second, on the capillary water supply sheet, the application to the plane replanting was examined. As the result, the application to greenhouse culture, plant factory, roof replanting, etc. will become easy.

### **Salt adsorption effect of artificial zeolite while applying to arid land soil(II)**

*ROY Kingshuk\* and Tahei YAMAMOTO\*\**

\*College of Bioresource Science, Nihon University

\*\*Arid Land Research Center, Tottori University

Salt accumulation in topsoil is one of the main causes of desertification in many arid regions in the world. Many approaches are in practice related to the salinity mitigation of soils. This study was carried out to investigate the salt adsorption capacity of artificial zeolite (an alkali-treated form of the coal-ash) while adding it to sandy-soil. From the results of the experiments, because of the high CEC content of the artificial zeolite, the EC and the ESP in the experiment-soil were found to be decreased after the application. However, since zeolite is an alkaline material, while applying it to a farmland, the control of soil pH should be considered in advance.

### **Importance of surface soil in arid area on fertility conservation - heavy metal absorption characteristics of pioneer plants -**

*Yuichi ISHIKAWA\* and Tahei YAMAMOTO\*\**

\*Faculty of Bioresource Science, Akita Prefectural University

\*\*Arid Land Research Center, Tottori University

### **Research on groundwater management using plant transpiration and water uptake**

*Yoshinobu KITAMURA\*, Katsuyuki SHIMIZU\*, ABOU\*\*, Jun SHIROTO\*\*\* and Mitsuhiro INOUE\*\*\*\**

\*Faculty of Agriculture, Tottori University

\*\*JSPS Fellow

\*\*\*Graduate School of Agriculture, Tottori University

\*\*\*\* Arid Land Research Center, Tottori University

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 weighing lysimeter covered with chamber. We selected a two-year old abele (*populus alba* L). as an experimental plant. Under several initial groundwater levels in a column, we monitored groundwater level, soil moisture contents, evapotranspiration (ET), air temperature, humidity, and so on using respective sensors. As a result, we confirmed quantitatively that water-uptake by plants lower groundwater table. For the next step, monitoring system is improved by installing a device monitoring sap flow in plant in order to differentiate between transpiration and evaporation. Moreover, to identify the effects of water-uptake by plants on soil moisture, distribution of rhizome in a lysimeter is currently analyzed.

We also have conducted literature review on biological drainage. Through the review, the modeling work on salt and water movement and the design of biological drainage are quite few, while most of reports discuss on ability of water-uptake by different plants and monitoring results of water and salt movements in soil. Therefore, we are going to keep our monitoring and conduct designing of bio-drainage based on the current monitoring data.

### **Study on efficient water harvesting using capillary barrier of soil**

*Toshihiro MORII\* and Mitsuhiro INOUE\*\**

\*Faculty of Agriculture, Niigata University

\*\*Arid Land Research Center, Tottori University

A capillary barrier consists of a fine soil layer of soil overlying a tilted coarse layer of soil under unsaturated conditions. Rain water infiltrating from the surface of soil is retained just above the boundary between the fine soil and coarse soil layers. This is easily explained by the distinction of soil water characteristic curve of the fine soil from that of the coarse soil. The water accumulated above the boundary surface between the fine soil and the coarse soil layers will flow downward along the boundary surface. This prevents the rain water from infiltrating into the lower layer of the coarse soil. In the current year, the barrier characteristics of the fine soil layer overlying the coarse soil layer was investigated based on the in-situ measurement of soil moisture content during about four months from October 2007.

The fine soil layer overlying the coarse soil layer was constructed in the sand slope, 200 cm in horizontal length, 48cm in width, 20 degrees in angle of the soil layers, and 20 cm and 10 cm in

thickness of the fine soil and coarse soil layers, respectively. Soil moisture content and rain intensity were measured by using dielectric aquameters ECH2O and rain gauges ECRN-50, respectively, automatically every one minute. Two series of soil moisture content which were measured after the large and short-period rainfall and the large and long-period rainfall were selected and analyzed to show the distinctively small change of the moisture content in the lower coarse soil layer compared with the upper layer of fine soil.

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

*Kouji KAMIYA\* and Mitsuhiro INOUE\*\**

\*Faculty of Engineering, Gifu University

\*\*Arid Land Research Center, Tottori University

The hydraulic properties of unsaturated soil are necessary to evaluate the seepage behavior of rainfall into the ground. In this research, the next two points for unsaturated hydraulic properties were considered.

- (1)The applicability of the air permeability model on unsaturated soil
- (2)A simple method for predicting the water characteristic curve

For predicting the air permeability coefficient from the water characteristic curve of unsaturated sandy and silty soils, the applicability of the air permeability model based on the Burdine theory and Mualem theory for expressing the relationship between the air permeability coefficient and the degree of water saturation was examined. As a result, the model based on the Burdine theory is more applicable during the drying process. However, the optimized parameters for pore tortuosity in the models are varied for each soil and are related the shape of the water characteristic curve. And then, it is recognized that the both models are good agreement with each other, fitted to the measured air permeability coefficient.

The drying characteristic curve for expressing the relationship between the volumetric water content and the drying rate is obtained from the evaporation experiment of unsaturated soil sample under a temperature condition. The water characteristic curve was estimated from the inverse analysis of unsaturated seepage into soil in the evaporation process by using the drying characteristic curve. It was recognized that the estimated water characteristic curve was good agreement with the measured one.

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

*Yuuji TAKESHITA\*, Shinya MORIKAMI,,Ryou SAKONO, Shuzo MORITA, Tatsuaki AWANO, Seiichiro KURODA\*\*\* and Mitsuhiro INOUE\*\*\*\**

\*Graduate School of Environmental Science, Okayama University

\*\*Faculty of Environmental Science and Technology, Okayama University

\*\*\*National Institute for Rural Engineering

\*\*\*\*Arid Land Research Center, Tottori University

A fast, simple and nondestructive procedure to measure unsaturated seepage flow in unsaturated sandy soils is proposed. Surface ground-penetrating radar (GPR) system is employed to estimate wetting front of 2-D unsteady state seepage flow in the survey region as a function of the soil dielectric constant measured by electromagnetic wave velocities. GPR system offers a simple approach for in-situ determination of unsaturated seepage flow and a completely non-intrusive measurement. GPR may be a suitable for low-cost mapping of soil water content profiles in the field scale and trace the transient behavior of the unsaturated seepage flow in sandy soils. The utility of the proposed method was demonstrated by using field infiltration experiments for Tottori dune sands.

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

*Satoshi YAMADA\**, *Kouji INOSAKO\** and *Mitsuhiro INOUE\*\**

\*Faculty of Agriculture, Tottori University

\*\*Arid Land Research Center, Tottori University

In this study, the amount of supplied water was temporally saved by controlling soil moisture tension, and effect of temporal water saving during fruit harvesting period on fruits yield and qualities of cucumber plant was investigated. As water treatments, plot supplied with water constantly through fruits harvesting period (Continuous irrigated treatment; C plot) and plot whose irrigation was reduced in early or late fruits harvesting period (E plot or L plot, respectively) were examined. After final harvesting, total dry weight, fruit yield, harvest index (H.I.), total nitrogen accumulation, and fruits qualities (nitrate and total vitamin C) were measured. Soil moisture tension was maintained from -200 to -300 cm H<sub>2</sub>O and -800 cm H<sub>2</sub>O, in C plot and E or L plot, respectively. Data of tomato plant were not shown because of the inferior growth. Results obtained were as follows; 1) Total dry weight was in the order of L plot > E plot > C plot, and H.I. were 0.17, 0.22, and 0.22, in C, E, and L plots, respectively. 2) Total nitrogen accumulation was likely in total dry weight in the order of L plot > E plot > C plot. 3) Nitrate and total vitamin C contents of fruits were less affected by water treatments. These results indicated that a temporal water saving promoted especially fruits growth of cucumber, without affecting fruits qualities.

## Characterization of soil degradation process by direct infiltration water sampling method

*Yasushi MORI\**, *Tahei MORISAWA\*\**, *Naokazu EGUSA\*\*\**, *Yuuya HIRAI\*\*\** and *Mitsuhiro INOUE\*\*\*\**

\*Faculty of Life and Environmental Science, Shimane University

\*\* The United Graduate School of Agricultural Sciences, Tottori University

\*\*\* Graduate School of Life and Environmental Science, Shimane University

\*\*\*\* Arid Land Research Center, Tottori University

These days, planted forest mountainside was roughly maintained due to the population descent and small birth rate. Because thinning operation would be delayed, forest was always dark and floor weed was rare. Management induced non point source pollution like surface soil erosion was suspected, however, we could not approach to the source with the stream water analysis. Therefore, direct soil water sampling device using glass fiber capillary force was developed to examine hydrological processes in watershed. In our design, water was collected just by the capillary force and let the excess water down through so that infiltration water was truly sampled and solute concentration kept the same quality as in soil water. The experiment was conducted at two neighboring Japanese cedar planted forest under different management, i.e., south slope was roughly maintained and west slope was well maintained by thinning operation. Load discharges were higher in south slope and lower in west slope. Infiltration water analysis revealed that ion concentration was gradually decreased at west slope, however in south slope, it dropped to lower level in soil water and increased again in stream water. The trend showed that soil buffering function was poor in south slope. Actually, disk permeameter survey revealed that hydraulic conductivity was small in south slope; TOC and biological activity were lower. This entire soil environment explained the water environmental differences in stream water. Because changes in soil environment affects water environment in the future, monitoring or examination of soil environment was considered as preventive measure for environmentally sound water and solute circulation in watershed.

## Quantification of fertilizer dissolved in percolating water using a multi-point direct sampling method

*Kouji INOSAKO \** and *Mitsuhiro INOUE\*\**

\*Faculty of Agriculture, Tottori University

\*\* Arid Land Research Center, Tottori University

In this study, three type of container wick sampler (CWS) were made for quantification of fertilizer dissolved in percolating water. The different points are diameters of wick parts, that is, 30cm, 50cm and 70cm. These CWS is named as CWS30, CWS50 and CWS70, respectively.

Experiments were conducted at a sand dune field in arid land research center. Shallot was cultivated under the condition of ordinary crop management. CWSs were set at 50 cm depth in this field. Collected water was stored in the bottom of the sampler and sent to a tank through a plastic tube. The tank was brought back to our laboratory every week. EC and NO<sub>3</sub>-N were measured in the laboratory. There were two experimental periods. First period was from September 21st, 2006 to July 17th, 2007 and second has been started since September 10, 2007. In this time, the results of the first period were reported.

Accumulated amounts of collected water using CWSs were 1826.7, 1576.1 and 1577.8 mm, respectively. Moreover, relative errors of each sampler were 9.8 % of CWS50, 3.9 % of CWS30 and 2.8 % of CWS70 respectively. In the case of a sand dune field, it seemed that the ununiformity of amount of percolated water was small. EC of drained water was increased after additional fertilizer on November 22, 2006. However, it was not significant after it on October 24, 2006. It was seemed that the difference was occurred by amount of precipitation. The detail relationships between water balance and solute balance will be clarified from the results of our experiment conducted in the same field now.

### **Mechanism of transfer of water, solute and heat in soil**

*Yasutaka KIHARA\* and Mitsuhiro INOUE\*\**

\*Faculty of Life and Environmental Science, Shimane University

\*\* Arid Land Research Center, Tottori University

The salt accumulation driven by evaporation is a serious problem in the semi-arid and arid land agriculture. The solution density at the surface is higher than that in the lower zone. This state is called gravitational 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 by using a small size column experiment (5cm-diameter, 10cm-height). On the other hand, this phenomena using a large size column experiment (80cm-diameter, 120cm-height) was not confirmed. In this study, the evaporation experiment using a middle size column (20cm-diameter, 40cm-height) was conducted. It were cleared that there were difference between soil solution concentration and the high concentration solution retained in the bottom of the column.

### **Development of measurement method of continuous air content in soil using the principle of sound resonance**

*Kimihito NAKAMURA\*, Kotaro FUKADA\* and Mitsuhiro INOUE\*\**

\*Graduate School of Agriculture, Kyoto University

\*\*Arid Land Research Center, Tottori University



Soil air consists of the air connected to the atmosphere and the air isolated from the atmosphere. Each affects the gas exchange between soil air and atmosphere in a different way. However, there are no experimental methods to measure the continuous soil air content. Therefore, we introduced the method to measure the continuous soil air content based on the principle of acoustic waves. We conducted laboratory experiments to confirm the possibility for the measurement.

The experimental apparatus consists of the cylindrical sampler and the pipe. We used glass beads and sand, which were packed in samplers. We measured the frequency of acoustic standing wave generated in the pipe and investigated the relations between air content in sampler and the frequency.

As a result, the frequency changed as the air in sampler increased. The average particle diameter of the sample also affected the frequency. We explained the experimental results by considering the air in sampler as a spring and a dashpot. The results obtained using sand with several water contents showed the possibility for measuring the continuous soil air content. Additional investigation about the effects of attenuation of air oscillation on the frequency and the sound pressure is needed.

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

*Kensuke KONDO\*, Zhanq Qingtao and Mitsuhiro INOUE*

\*Faculty of Environmental and Symbiotic Sciences,  
Prefectural University of Kumamoto

\*\*United Graduate School of Agriculture, Tottori University

\*\*\*Arid Land Research Center, Tottori University

The objective of the efficient water management is to conserve soil water and maintain lower level of salts in the root zone. A pot experiment was conducted in a greenhouse to evaluate effects of mulching types on water use efficiency, evapotranspiration of Swiss chard (*Beta vulgaris* L.) and salts accumulation in clay soil irrigated with saline water. For this purpose seawater was diluted to achieve the electrical conductivity of water as 4.8 and 7.4 dS m<sup>-1</sup>. Pots were mulched in the form of gravel, pine-needles and rice-straw. These results showed that use of mulches significantly reduced evapotranspiration of Swiss chard and effectively reduced salt accumulation in the root zone of soil. Compared with rice-straw mulch, gravel and pine-needles lowered salt accumulation in the soil especially under high saline irrigation. The mulching material improved plant biomass as well as water use efficiency. Under high saline water, mulching were differed for dry matter production, water use efficiency and soil water content in the order of gravel > pine-needle > rice-straw > no-mulch. The experiment indicated that mulching practice affected favorably the movement of salts and water in the soil and mitigated the adverse effects of saline water on Swiss chard.

## **Poverty reduction programmes in arid regions in Africa**

*Fumiko HAKOYAMA\*and Hiroshi NAWATA*

\*\*Faculty of Human Life Sciences, Fuji Women's University

\*\*Arid Land Research Center, Tottori University

### 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.

### **Study of the material culture on the Sinai Peninsula of Egypt**

*Youko SHINDO\**, *Mutsuo KAWATOKO\**, *Risa TOKUNAGA\*\** and *Hiroshi NAWATA\*\*\**

\*The Middle Eastern Culture Center in Japan

\*\*Keio University

\*\*\*Arid Land Research Center, Tottori University

### **(3) Summary of Open Seminar**

#### **Topic of Open Seminar (Date)**

*Name of Speaker*

Occupation of Speaker

Summary of Open Seminar

#### **1. *Striga gesnerioides* in West Africa and Development of Marker Assisted Selection Method for *Striga* resistance in Cowpea (13 APR. 2007)**

*Satoru MURANAKA*

Post-doctoral fellow, International Institute of Tropical Agriculture, Nigeria

The seminar was held as a follow-up activity of the “COE Program for Arid Land Science”

hosted by the Arid Land Research Center (ALRC), Tottori University, Japan, which accommodated the presenter (S. Muranaka, in their on-the-job training program), between April 2003 and December 2004 as postdoctoral researcher. The seminar was to introduce the current research activities of IITA and the opportunity for further collaboration between ALRC and IITA.

IITA is based in sub-Saharan Africa. The Institute is one of the International Agricultural Research Centers supported by the Consultative Group on International Agricultural Research (CGIAR). The research for development (R4D) activities of IITA are currently categorized into seven projects—Agrobiodiversity, Agriculture and Health, Opportunities and Threats, Root and Tuber Systems, Banana and Plantain Systems, Cereal and Legume Systems, and High Value Agricultural Products. IITA scientists are working to enhance food security and improve livelihoods in Africa through research-for-development. The presenter is located in IITA-Kano, (the savanna region of IITA's research) and tackling with development of suitable cowpea varieties and cropping systems in the savanna region of Africa.

The Project “Marker Development and Marker-Assisted Selection for *Striga* Resistance in Cowpea” (coordinated by presenter) aims to develop molecular marker to identify *Striga gesnerioides* resistance in cowpea and establish marker-assisted selection (MAS) methodologies which can fasten the breeding process of cowpea. *Striga gesnerioides* is the parasitic weed that causes serious problem for cowpea production in Africa. Under *Striga* infested condition, it can cause up to 100% of yield loss of cowpea. Therefore *Striga* resistance has become more important to cowpea breeding programs since most of the local cowpea varieties are susceptible to *Striga gesnerioides*.

Under this project, two SCAR marker (61R and MahSe2) were already identified as effective markers (about 80% effective) in identifying *Striga* (Nigerian *Striga* races: SG3) resistance in cowpea. The development of MAS is ongoing in IITA-Kano with several F<sub>2</sub>-F<sub>4</sub> populations. Also, multilocation trial is ongoing to identify *Striga*-resistant parents for several *Striga* hot-spot in 9 different West African countries, where different *Striga* races exist. Through this activity, some multi-*Striga*-resistant materials and suitable *Striga*-resistant parents for specific region, such as IT98K-205-8 (resistant to *Striga* races in Nigeria, Niger, Cameroon, Burkina Faso, and Mali) and IT98K-216-44 (resistant to *Striga* race in Zákpotá, Bénin) have been identified respectively.

The project also trains African scientists/breeders in National Agriculture Research System (NARS) to develop human capacity to apply new technologies into their own breeding activities in home institutes. The developed molecular markers and MAS methodology will be transferred to the breeders for further breeding activities in each country.

## **2. Climate Change and Energy Technologies for Regional Development (14 MAY 2007)**

*Dong-ke ZHANG*

Professor, Centre for Fuels and Energy, Curtin University of Technology, Australia

Centre for Fuels and Energy at Curtin University of Technology is a significant energy research facility in Western Australia, covering a broad range of energy and environmental

issues and with strong links with the industry, especially in coal, natural gas, petroleum and biomass-based renewable energy options.

In this seminar the speaker analysis the ecological chaos and concludes that the world population may have become too large to sustain on the earth. Carbon capture and forest restoration are critically important in repair and sustain the ecological system.

He then goes on to examine the synergy between coal and biomass energy options as a meaningful solution to regional development challenges faced by the large number of small regional communities.

**3. Six key areas and 25 subjects for ecosystem observation and research in the Chinese Ecological Research Network (CERN) (29 MAY 2007)**

*Guobin LIU*

Professor, Institute of Soil and Water Conservation, CAS, China

Prof. Liu gave us a brief introduction of the Chinese ecological research network (CERN) and six key areas and 25 subjects for ecosystem observation and research in the network. The office of CERN summarized this strategy planning after integrated assessment to each station, sub-center and synthesis center of CERN in 2001-2005. The six key areas include the ecological process, structure and function as well management based on the development of ecological science and requirement of environmental management of China

**4. Activity Report on Village Development in Papua New Guinea (21 JUN. 2007)**

*Mikio MATSUDA*

Former Japan Overseas Cooperation Volunteers

**5. Land-Surface processes of monsoon ~Its formation, variability and warming~ (2 AUG. 2007)**

*Hiroaki UEDA*

Associate Professor, Tsukuba University

**6. Agricultural Research for Development Priorities and Achievements in the Dry Areas of the Central and West Asia and North Africa Region (14 SEP. 2007)**

*Mohan Chandra SAXENA*

Senior Advisor to the Director General of ICARDA,  
International Center for Agricultural Research in the Dry Areas (ICARDA), Syria

The Central and West Asia and North Africa (CWANA) region extends from Morocco and Mauritania in the West to Kazakhstan in the East and Turkey in the North to Ethiopia and Eritrea in the South. It represents the largest dry land area region in the developing world. Much of the area is characterized by a Mediterranean climate with cold wet winters and dry and hot summer season. Rainfed agriculture is therefore practiced only in winter season. Rainfall is low and highly variable both temporally as well as in magnitude. Drought is therefore of common occurrence in several parts, of the region. CWANA is one of the most water scarce regions in the world. Increasing use of groundwater to meet the demands for domestic and agricultural purposes, far in excess of the recharge, is causing serious environmental threat. Soils are poor in fertility and highly susceptible to water and wind erosion. The region has one of the highest rates of population growth, which is accentuating pressure on the natural resources of land, water and biodiversity. High per capita cereal consumption and low domestic production has made the region the largest importer of grains. Poverty is widespread and is a major cause of rural to urban and the South to the North migration. There is vicious cycle of poverty and natural resource degradation. Agriculture however continues to be the main economic activity on which the livelihood of the majority of the people in the region depends. Sustainable development of agriculture, particularly in the dry areas which were bypassed by the 'green revolution', is therefore a key to meeting several Millennium Development Goals (MDGs), particularly those related to poverty alleviation, food security, and improved nutrition and health of children and women.

The key natural resource limiting agricultural production in the dry areas is water. The West Asia and North Africa (WANA) sub-region of CWANA faces the most serious threat of water shortage, as the per capita renewable water supply here is less than 1500 m<sup>3</sup> and it is expected to fall to less than 700 m<sup>3</sup> by the year 2025, well below the water poverty threshold of 1000 m<sup>3</sup>. Even in the Central Asia and Caucasus (CAC) sub-region water scarcity is increasing and excessive water withdrawals from rivers have caused environmental disasters as typified by Aral Sea region. Global climate change is predicted to make the drier areas of CWANA more dry and hot with severe consequences for agriculture and animal husbandry there. With such serious situation regarding the renewable water supply in CWANA, the major priority for research for sustainable development of agriculture in the dry areas of CWANA is all aspects of enhancing water availability and its use-efficiency and productivity. CWANA is also the region for domestication of major food and feed crops and livestock, and therefore has the centers of their genetic mega-diversity. This biodiversity is threatened because of the increasing population pressure. Conservation and sustainable use of this biodiversity is essential not only for the present but also for the future, particularly in light of the more extreme weather conditions expected in the future because of climate change. Biodiversity collection, characterization, conservation and utilization research has therefore emerged as the next important priority area. Desertification and land degradation is another major threat to agriculture. Vast areas in CWANA are under rangelands that are being degraded because of overuse in response to increasing population pressure. Rehabilitation of degraded rangelands and preventing degradation of productive ones

through research on integrated crop-livestock systems and natural resource management is another priority in CWANA. The region has a rich heritage of indigenous knowledge, which had enabled the rural people to make sustainable use of the limited natural resources in the desert margins and degraded lands in the past. Unfortunately, increased population pressure, breakdown of traditional social institutions and inappropriate policy environment has capped the affectivity of such traditional knowledge, and it is under threat of extinction. Proper documentation of traditional knowledge and the adaptation of its elements in the context of modern agriculture are essential for sustainable agricultural development.

The national agricultural research systems (NARS) of CWANA, in partnership with regional agricultural research institutes, international agricultural research centers (IARCs), and advanced research institutes (ARIs) in the North and the South, and with financial support from donors, are devoting research efforts on these priority areas to achieve food and nutritional security, improved livelihoods for their people and to ensure sustainable use of natural resources and protect environment. The International Center for Agricultural Research in the Dry Areas (ICARDA) is the only Center operating under the Consultative Group on International Agricultural Research (CGIAR) that has its headquarters in this region. It is therefore playing a pivotal role in undertaking relevant research on priority research areas that are harmonized with the priorities identified by the NARS in collaboration with sub-regional agricultural forums (AARINENA in the WANA sub-region and CACARI in the CAC sub-region) and the priorities identified by the CGIAR System through its Science Council. These priorities excellently address the needs for meeting the major MDGs.

ICARDA seeks to improve the welfare of people in the dry areas of the developing world by increasing production and nutritional quality of food while preserving and enhancing natural resource base through research, training and dissemination of information, in partnership with NARS, national governments, other IARCs (e.g. CIMMYT, ICRISAT, IFPRI, ILRI, IPGRI, IWMI), ARIs (including JIRCAS and ALRC of Tottori University), civil society organizations (CSOs), and donor agencies (including JICA). ICARDA has global responsibility for improvement of three important food crops (barley, lentil, and faba bean), and the sustainable management of natural resources in the dry areas, especially enhancing the on-farm water-use efficiency. The regional responsibilities of the Center focus on improvement of wheat (with CIMMYT), Kabuli chickpea (with ICRISAT) and forage and pasture crops and rangeland management with small ruminants in CWANA. The Center's strategy is to engage NARS and CSOs in the region, sister IARCs, and the ARIs from all over the world into a research continuum that ensures that tools of cutting edge research are harnessed to meet the challenge of sustainable development of agriculture in the dry areas. This strategy has resulted in significant achievements and has positively affected the economic wellbeing of the people and the sustainable management and conservation of natural resources of land, water and biodiversity in CWANA and the dry areas in other developing countries. The spillover has also benefited the dry land agriculture in several industrialized countries.

ICARDA's gene bank holds the largest collection in the Mediterranean region, about 131,000 accessions of cultigens (landraces as well as elite material) and wild relatives of its mandate crops, most of which are geo-referenced, characterized and well documented. About 35,000 samples are distributed to collaborators for use in breeding programs. ICARDA scientists and their partners

have effectively used this biodiversity for improving adaptation of the mandate crops for yield and yield stability under moisture limited environment and responsiveness to improved moisture supply. Molecular tools and analytical physiological research have helped in making fast progress in identifying desirable genes for such adaptation and their incorporation in suitable phenotypes. Collaboration with ARIs, including JIRCAS, has been very rewarding in this research. Tolerance to common biotic stresses has been combined with adaptation to drought and improved water use efficiency. Participatory breeding involving farmers has helped in faster crop improvement for marginal environments. Crop management techniques to enhance productivity per unit amount of water under rain-fed and supplemental/deficit irrigation have been developed. Water harvesting techniques, using remote sensing and geographical information system, have been developed and disseminated. Work on use of marginal quality water for use in forestry, raising biomass for renewable energy and for feed production has been promising. People-centered participatory research on use of natural resources has helped in identification of promising options for interventions acceptable to local communities. Crop-livestock integration research and research on use of vetches for early weaning of lambs, reseeding degraded pastures with native vegetation and intercropping with saltbush and spineless cacti with barley has helped in improving the productivity of small ruminants and reducing degradation of rangelands. Policy and institutional research has helped identifying factors that could enhance the adoption of improved technologies by farmers and herders and increase the impact of research.

#### **KEYWORDS**

Biodiversity, Crop Improvement, CWANA, Drought Tolerance, Natural Resource Management, Research for Development

#### **7. (12 DEC. 2007)**

##### **(1) Habitat Analysis of Pelicans as an Indicator of Integrity of the Arid Ecosystems of Central Asia**

*Yukihiro MORIMOTO*

Graduate School of Global Environmental Studies, Kyoto University

Aral Sea crisis, one of the most sensational events in the 20<sup>th</sup> century is already reported widely as an environmental disaster caused by large-scale irrigation agriculture in arid region. Major interest of people is tend to set upon the water usage, however, we should pay attention not only to the water budget but to the integrity of the ecosystems of Central Asia, the arid region where wetlands and riverine forests exist. We should feel more sense of urgency that alteration of basic hydrology in arid region could degrades the primary production of the wetland ecosystems which had been the key resources of human life and wildlife of the territory. The pelican, a large aquatic bird species that reaches ten kilos or more in weight, needs a lot of fish, and it is considered as a top predator in the web of life at the coastal regions. Therefore, the sustainable populations of a pelican species could be one of the indicators of the integrity of the local ecosystems. The pelican species, a victim of the Aral crisis, still has major colonies in Ili river



delta, where the large-scale irrigated agriculture, same as the lower Syr-Darya river region, had been taking place. The difference between Ili river delta and the lower Syr-darya river may imply a key factor for the sustainability. The Kok-Aral dam project, which intends to restore limited areas of the northern part of the Aral, may be a solution of rehabilitation of the wetland ecosystems, as several observations of pelicans in the deltas has reported recently. Consideration of not only the water budget but also the restoration of pelican's habitat, which include wetland vegetation, would contribute to the sustainable land use planning of the arid and semi-arid region of the Central Asia.

## **(2) Creation of green shelter belts in the Aral Sea region**

*Tamaki MATUSMURA*

Graduate School of Agriculture, Kyoto University

The Aral Sea, which was once the fourth largest lake in the world, lost about 70 % of its water area. As a result of desertification of this sea, sand storms on the dried seabed have caused a lot of crop damage and human respiratory disease. A Japanese NPO, People's Institute of Environment, organized a planting project for creating green shelter belts against sand storms. They selected one of typical shrubs in this area, sexual (*Haloxylon aphyllum*), which is tolerant of dryness and soil salinity.

In October 2006, they started the first plantation activity in Karateren village near the Aral Sea in Kazakhstan. People in this village willingly participated in planting 1800 sexual seedlings in a plantation site of 2ha. With the good management by villagers for a year, the survival rate of these seedlings was 59.6%. In October 2007, as the second activity, Karateren site was expanded to 2.5ha and added 1700 seedlings. Besides, 1200 seedlings were planted in another site of 1ha on the dried seabed where the soil salinity was very high with dry air.

We need to obtain more information about the ecology of sexual and discuss the appropriate management to each plantation site for the experimental plantation success.

## **8. Development of a daily grid precipitation data set: Toward evaluation of climate changes on water resources in arid / semi-arid regions (26 DEC. 2007)**

*Akiyo YATAGAI*

Research Institute for Humanity and Nature

Recent development of high-resolution GCMs has allowed us to improve our understanding of the impacts of global warming on regional water resources. However, high-resolution observational datasets to validate such GCMs have not been developed. Current works on validating the GCMs against observational data focus on the extreme event analysis, not the climatology. For arid/semi-arid regions, it is crucially important to enhanced precipitation over the mountainous regions.

Asian Precipitation -- Highly-Resolved Observational Data Integration Towards Evaluation of the Water Resources (APHRODITE's Water Resources) supported by the Global Environmental Research Fund by the Ministry of the Environment, Japan, is the project to develop state-of-the-art daily grid precipitation datasets over Asia, through extensive collaborations among data providers, data analysts including RIHN's project members, and climate modelers. It also aims for validating high-resolution General Circulation Models (GCMs) against the grid data products.

We emphasize that 1) the grid data will be developed from analysis of the long-term, rain-gauge-based observations based on Xie et al. (2007) algorithm, and that 2) orographic precipitation will be explicitly expressed. The grid data product to be developed will be used to evaluate the impact of climate change on the water resources, to force land surface models (such as hydrological and ecosystem models), and to validate high-resolution satellite products, etc.

The grid precipitation product will be available to all researchers for the scientific purposes from the following web-page. We welcome a wide spectrum of collaborations, particularly for collection of rain gauge data.

#### **9. Salinization Research in the US (7 FEB. 2008)**

*Kumud ARCHAYA & Mark STONE*  
Desert Research Institute (DRI), USA

#### **10. (4 MAR. 2008)**

##### **(1) The present status of Biotech crops in Egypt**

*Ahmed BAHIELDIN*  
Agricultural Genetic Engineering Research Institute (AGERI), Egypt

##### **(2) Sustainable Wheat Production: Is synthetic hexaploid the panacea?**

*Francis OGBONNAYA*  
International Center for Agricultural Research in the Dry Areas (ICARDA), Syria

#### **11. (4 MAR. 2008)**

##### **(1) The ecological regulation of soil erosion in red soil watershed and erosion control by different agro-ecosystems**

*Kun MA*  
Visiting researcher of Yokohama National University  
(Agricultural College of NingXia University, China)

Soil nutrition loss, soil erosion and its' spatial distribution under different eco-agriculture systems were studied in the red soil hilly area of southern China, by using the technology of runoff plot and the Fixed Soil Core Eu (europium) Tracer (FSCET). The soil erosion of JiangJia Tang watershed was also forecasted by RUSLE and AnnAGNPS models. The result showed: a rainfall erosivity model using daily rainfall amounts to estimate rainfall erosivity was validated. The daily model could adequately describe the temporal variation and seasonal distribution of rainfall erosivity. The coefficient of determination of model is 0.89. Soil erosion modulus and runoff index have no significantly difference under four kinds of eco--agriculture systems (including the measure of forest systems; agro-forest systems, agriculture systems, agriculture and engineering systems), when the slope gradient were less than 15 degree. Soil erosion modulus can reached  $1707.46 \text{ t.km}^{-2}.\text{yr}^{-1}$ ,  $2127.3 \text{ t.km}^{-2}.\text{yr}^{-1}$ ,  $2144.81 \text{ t.km}^{-2}.\text{yr}^{-1}$  and  $1847.06 \text{ t.km}^{-2}.\text{yr}^{-1}$  under the gradient greater than 15 degree, which were 10.78 times, 11.33 times, 8.55 times, 9.44 times separately, under the slope less than 15 degree. The amounts of soil erosion were different for four kinds of eco-agriculture systems during the different development stage. But soil erosion was serious in all the early stage of eco-agriculture mode, the soil erosion were gradually decreased in the middle stage to the agro-forest systems. When the slope gradient were less than 15 degree, the amount of soil and water loss were obviously decreased in the final stage on the condition of the forest and agro-forest systems. The relative differences of sediment yields predicted by RUSLE over monitored in 1-5catchment are 16.95%, -47.34%, -47.76%, 27.13% and -39.19% respectively. The sediment yields predicted are close to monitored.

**Key words:** Ecological regulation; Soil erosion; Agroecosystem; Red Soil

## **(2) Soil development and organic matter accumulation in two contrasting primary successional ecosystem chronosequences**

*Robert G. QUALLS*

Visiting researcher of Yokohama National University  
(University of Nevada, Reno, USA)

During the process of soil development, weathering may affect the tendency of for solid phase C to become stabilized and for dissolved organic matter in soils to be adsorbed. We used two classical examples of primary successional chronosequences which we visualize as representing two extremes of weathering rates: (1) the Mt. Shasta mudflow chronosequence which represents rapid weathering of volcanic andesitic material in soils of 77, 255, 616, and about 850 y of age, and (2) the Indiana Dunes chronosequence which represents weathering of sand dunes of 30, 400, 900, 10,000, and 12,000 y of age. We measured the accumulation of organic matter, development of properties that might be involved in the stabilization of organic matter, and adsorption of dissolved organic matter. In the mudflow chronosequence, accumulation of organic C and N was linear over the entire ~ 850 year history and development of adsorption capacity by weathering products controlled losses of dissolved organic matter. In the sand dune chronosequence, litterfall and organic C and N stocks increased to near a maximum in the 1st 400 yr of soil development and then increased only about 15% over the subsequent centuries. Thus soil organic matter content mirrored the rate of litter production in the sand

dune soils. However, slow weathering continued. This suggests that adsorbing materials tended to become saturated with C as fast as they formed during weathering. A failure to develop a strong adsorption capacity in the dune soils was also important in allowing high rates of leaching of dissolved organic N and P even in the oldest soils.

**12. (5 MAR. 2008)**

**(1) The Role of Roughness (Vegetation or Solid Elements) in Influencing Sediment Transport by Wind**

*Jack GILLIES & James KING*  
Desert Research Institute (DRI), USA

**(2) The State of Mongolian dust studies**

*Dulam JUGDER*  
Institute of Meteorology and Hydrology (IMH), Mongolia

**13. (12 MAR. 2007)**

**(1) Potential to Extend NERICA from a Viem Point of Water Use in Africa**

*Satoru TAKAHASHI*  
Professor, Tokyo University of Agriculture

The current water and agricultural condition in the most seriously affected countries (MSACs) of Africa corresponds well to the semi-arid area with an annual precipitation ranging from 250 to 600mm. The staple foods in those MSACs of Africa are dominated by miscellaneous cereals such as millet and sorghum, and yield of the cereals per hectare have been constant over the 20 years resulting in limited increases in the agriculture with miscellaneous cereals. The fact indicates that the poverty of the MSACs is in part due to the miscellaneous cereals as staple foods. Therefore, we propose to cultivate upland rice, NERICA, which has been recently established in Africa as a crop to alleviate poverty in semi-arid areas. Since rainfall distribution patterns in those semi-arid areas of Africa are typically fluctuated, water deficit for the cultivation is proposed to be supplied from ponds which collect precipitation in rainy season by the water-harvesting techniques. Further, “the irrigation by connected water reservoirs system” is also recommended as a measure for the condition of large fluctuations in rainfall characteristics.

**(2) Development of Fly Ash-Based Geopolymer and Its Effective Use for Stabilization of Soils**

*Tatsuya KOUMOTO*  
Faculty of Agriculture, Saga University

Portland cement, an essential material for infrastructures like building and bridge construction is said to discharge about 1 ton of carbon dioxide (CO<sub>2</sub>) to produce 1 ton of cement. Lime which is also essentially used to improve an agricultural soil and is also a construction material, discharges huge amount of CO<sub>2</sub> in the production process. An effort is desired to find and to make an effective use of an alternative construction material which enables the decrease in the use of cement and lime, and hence lowers CO<sub>2</sub> emissions, being a major source of environmental concern.

Geopolymer, which is a term covering a class of synthetic aluminosilicate materials, has been recently developed to use predominantly as a replacement for Portland-based cement and to solidify sludge polluted by heavy metals.

Geopolymer is generally formed by reaction of an aluminosilicate powder with an alkaline silicate solution at roughly ambient conditions and is solidified by polymerization as the metal ion (M<sup>m+</sup>) liquidated out from the filler, bonds with the acetic acid silicate by the reacting with the components of water glass (Si, O, H). Sodium silicate is used as alkaline silica and the fly ash is used as the filler. Fly ash which is known to be pozzolanic in nature and reacts with calcium hydroxide (Ca(OH)<sub>2</sub>) and alkali to form calcium silicate hydrates (CaSi) and other cement like compounds.

The fly ash-based geopolymer is developed by mixing fly ash with an activator which is a solution made by sodium silicate (law of water glass) and tap water.

In this lecture, firstly, the development of the geopolymer and the mechanical and chemical characteristics of mud which is collected from the bottom of the creeks in Saga Plain stabilized by the geopolymer are mentioned.

Secondly, the possibility of effective use of geopolymer as the material to prevent a physical deterioration of soils, an enlargement of desert, and so on, is introduced.

The fly ash is an industrial waste material from power station. This lecture aims to propose an effective use of fly ash as an ingredient of geopolymer.

#### **14. A Study of Human Subsistence Ecosystems among Arab Societies –To Combat Livelihood Degradation for the Post-oil Era- (14 MAR. 2008)**

*Hiroshi NAWATA*

Assoc. Professor, Research Institute for Humanity and Nature

This research project aims to promote basic studies to clarify human life support mechanisms and self-sufficient modes of production among Arab people who have survived more than a thousand years under a peculiar natural environment of drylands. Based on these research results, we intend to propose a scientific framework to strengthen their subsistence productivity and combat livelihood degradation in local communities of Arab people to prepare for the post-oil era.