

2. Research Activities (Apr.2003-Mar.2004)

2.1 Outline of Activities

(1) Center

Arid Land Research Center (ALRC) is an independent department of Tottori University and at the same time is a National Joint-use Research Institute of the Ministry of Education, Culture, Sports, Science and Technology. The mission of the ALRC is to conduct research on desertification and to develop sustainable agricultural practices in arid and semi-arid areas. The door is open to all teachers of national universities who are engaged in this field of study.

ALRC was designated as a candidate to be qualified as a 21st Century COE program (Program for Arid Land Science). The aim of this program is to construct the new arid land science that is unparalleled worldwide. The ALRC etc. (including the predecessor), have accumulated knowledge and technology of plant production and vegetation recovery in sands over the past 80 years. We are advancing this knowledge and technology to those that are used easily for the arid lands on the world. To achieve our goal, we fuse knowledge and technology of public health and energy engineering. The mission of this program is to contribute towards environmental sustainability through development of technical package that will be easily adopted by arid land inhabitants. Achievement of this objective forms the foundation of designing our national arid land science as a worldwide top-level program in this field. Consequently this will contribute to increasingly technological support of Japan as a UNCCD ratification country.

In 2001, we started for the Core University Program (by JSPS) focusing on combating desertification and developmental utilization in inner area of China between Arid Land Research Center, Tottori University and Water and Soil Conservation Research Institute, CAS in China.

Organization, Management, and Funding Subsidies

ALRC is managed by the Director, a Conference composed of professors and associate professors, a Board of Management composed of members from outside as well as professors of ALRC, the five research divisions, two office sections (the international research cooperation section and the joint-use section) and the technical section. In practice the Conference and the Board of Management operate our Center.

The five divisions are:

- 1) Arid Land Environment: Natural Environment, Water Resources
- 2) Biological Production: Plant Ecophysiology, Plant Production
- 3) Afforestation and Land Conservation: Revegetation and Grassland Development, Land Conservation
- 4) Comprehensive Measures to Combat Desertification
- 5) Arid Land Sciences (Visiting)

The three full-time divisions from 1) to 3) each have two professors and two associate professors. The full-time division of 4) has one professor. The Visiting division has two visiting professors and one associate professor from Japan and, three visiting professors from abroad. In addition, three Post-Doc researchers and four COE researchers are stationed at ALRC. Nine office staff (four clerks and six associate clerks), four technical officers and two research support technicians support the research and education.

With regard to the funding, subsidies for scientific study in the fiscal year of 2003, a total of five themes were adopted:

Scientific Research (B)	: 2,
Scientific Research (C)	: 1,
Encouragement of Scientists	: 1,

Research Fellowship for Young Scientists	: 1,
With regard to other research funding, a total fourteen themes were accepted:	
Scholarship Contribution	: 6,
Entrusted Research	: 3,
Joint Researches with private enterprises	: 5,

Joint-Use Research, Education, Publication

During the fiscal year of 2003, 55 Joint-Use Researchers (Teachers from national and private universities) were attached to the Center. The number of students as of June 2004 is 66 (15 Ph.D. Students, 29 Master Students, 11 Undergraduate Students, 3 Trainees and 3 Foreign Research Students).

Seminars were often held by a large number of internal and external experts. The foreign visiting professors periodically give seminars.

Annual report has been published since the establishment of ALRC, which provides a brief overview of the activities in its various divisions and also summarizes our research and education.

The 13th seminar of Joint Research was held on December 2, 2003 at Arid Land Research Center, Tottori University. Twenty seven poster presentations were performed.

(2) Divisions

1) Division of Arid Land Environment

Subdivision of Natural Environment

Subdivision of Natural Environment conducts research on evaluation of the natural environment and the exploitation of natural resources and energy for the development of arid and semi-arid areas from the point-of-view of meteorology and climatology.

The staff in the subdivision consists of Dr. Kamichika M. (Professor), Dr. Kimura, R. (Assistant Professor), and Ms. Yonehara, A. (Associate Clerk, also assigned for the Subdivision of Water Resources). There were two Doctoral student, three master's students, three undergraduate students and one research students (from Mongolia) in the fiscal year of 2003. Mr. Sasaki and Sakamoto found an employment with private companies. Mr. Yano and Yamada entered the master's course of Tottori University.

In the fiscal year of 2003, the following researches have been conducted in Japan.

(1) MICROCLIMATE: Heat, water and CO₂ balance were observed in the grass lands (National agricultural research center for Kyushu Okinawa region) and sorghum field (Arid Land Research Center). Dr. Tang, C. (Graduate School of Science and Technology, Chiba University), Dr. Ooba, K. and Dr. Nakamoto, K. (National Agricultural Research Center for Kyushu Okinawa Region) have conducted the joint research of this subdivision 'Researches on modification of microclimate of agricultural fields in arid lands'.

(2) REMOTE SENSING: Under theme 'Comprehensive study on the evaluation of soil, water, and vegetation resources' for joint research, cooperative works have been still continued with Dr. Ishiguro, E. (Faculty of Agriculture, Kagoshima University), Dr. Matsuoka, N. (Faculty of Horticulture, Chiba University) and Dr. Moriyama, M. (Faculty of Engineering, Nagasaki University). 2003 was the third year that we started for the Core University Program between ALRC and the Institute of Soil and Water Conservation, Chinese Academy of Sciences, so we have been continuing the analysis of satellite data for the purpose of combating desertification in the Loess Plateau, China. We, including Dr. Takayama, N. (researcher, ALRC) began to make field observations.

(3) WIND EROSION: Relationship between the wind climate and sand movement have been investigated by measuring sand movement every month in the Tottori Sand Dune and observing the wind speed and direction which have been measured automatically in a sand dune. Dr. Kawamura, T. (Graduate School of

Humanities and Sciences, Ochanomizu University) cooperated in this study.

(4) MEASUREMENT OF NATURAL ENERGY: The electric power by solar radiation and wind have been studied as a cooperative study with Dr. Hayashi, T. (Faculty of Engineering, Tottori University). Study on the recycling use of agricultural water resources was conducted using the method of distillation.

Overseas research in the fiscal year of 2003 was as follows: Dr. Kamichika conducted the field observations in the Ryudougou basin located in Shenmu district, Shanxi Province, China for Japan-China Joint Project from Aug. 3 to 15, Nov. 13 to 17 in 2003, and Mar. 8 to 12 in 2004. Dr. Kimura analyzed the heat and water balances in the Loess Plateau based on the observation of previous year.

(1) Parameters used for a three-layered soil model are determined for the purpose of understanding the soil water content and heat balance on the Loess Plateau, China. Seasonal variation of the soil water content was simulated by using the actual meteorological data for the Loess Plateau.

(2) We illustrated the potential distribution of vegetation by overlapping the existing vegetation distribution with the distribution of the index we used, which was estimated from the soil water content. Also, we described the aridity distribution in the plateau.

Subdivision of Water Resources

Staff and students: The staff consists of Dr. Yano, T. (Professor), Dr. Yasuda, H. (Assoc. Prof.) and Ms. Yonehara, A. (Associate Secretary, also assigned for the Subdivision of Natural Environment), one Doctoral, one Master's, and 1 non-degree student.

Research: Research has been conducted in Japan and abroad on efficient water and soil management for water saving irrigation and saline water irrigation from the view point of protecting lands from desertification and for the sustainable agricultural utilization of arid lands.

Studies in Japan: Our efforts in Japan have been made to carry out research themes on water and soil management for water saving irrigation and saline water irrigation based on a simulation approach as well as an experimental approach. Research on the measurement of stem flow through herbaceous plants and arboreal plants was also conducted to establish the measurement technology for the stem heat balance method and the heat pulse method. Furthermore we conducted researches on water management method for reuse of drainage water in agricultural lands equipped with subsurface drainage system under arid and semi-arid climate.

Overseas Research: A research on 'Crop productivity change following climate change and soil environment change' was commenced related to a research project on 'Impact of climate change on agricultural production in arid areas' of the Research Institute for Humanity and Nature which was newly established in Kyoto as an Inter-University Research Institute of Ministry of Education, Culture, Sports, Science, and Technology. This research project is supposed to be conducted for five years from 2002 fiscal year mainly in a semi-arid area with the Mediterranean Sea climate in the Republic of Turkey. In line with this research, Dr. Yano visited Turkey in March to conduct field survey on water resources and agriculture.

Cooperative researches have been conducted with the following researchers: Prof. Nishiyama, S. (Faculty of Agriculture, Yamaguchi University), Prof. Murakami, M. (Kochi University of Technology), Chikushi, J. (Biotron Institute, Kyushu University), Dr. Odani, H. (School of Environmental Science, University of Shiga Prefecture), Dr. Takeuchi, S. (Faculty of Engineering, Kyushu Kyoritsu University) and Dr. Aoda, T. (Faculty of Agriculture, Niigata University). One new research project has started with Dr. Watanabe, T. (Research Institute for Humanity and Nature). The titles for these research projects are listed in the joint research section of this Annual Report.

2) Division of Biological Production

Subdivision of Plant Ecophysiology

Staff: The staff consisted of Dr. S. Inanaga (Professor), Dr. Y. Sugimoto (Associate Professor, transferred

to Kobe University Graduate School of Science and Technology as a professor from 1. June. 2003) and Ms. M. Fukunaga (Associate Clerk, also assigned to the Subdivision of Plant Production).

Studies in Japan: The main research work of the division is on eco-physiological studies of plant growth and yield responses to salinity and drought stress, biochemical and molecular-biological studies on plant salt stress and control of parasitic weeds of semi-arid areas. Joint researches have been conducted with several researchers (Drs. J. Abe of Univ. of Tokyo, E. Tanimoto of Nagoya City Univ., H. Shimizu and P. An of the National Institute for Environmental Studies, T. Kobata of Shimane Univ., and T. Takahashi and H. Araki of Yamaguchi Univ.) on root system development under arid conditions. In other joint research activities, studies on plant growth responses to salt and drought stress were conducted with Dr. Qiman (Visiting Associate Professor of Xinjiang Agriculture University), Dr. Deng Xi-Ping (Professor, Institute of Water and Soil Conservation of the Chinese Academy of Sciences) and Dr. Li Jian-Min (Professor, China Agricultural University). Also, studies on sustenance of oasis ecology have been conducted with Dr. T. Matsui (with Funding from Mitsubishi Heavy Industries, LTD.) as a joint research. In addition, Dr. Inanaga assumed leadership of the 21st Century COE Program (Sub-title: Arid Land Science Program) launched in 2002 by The Ministry of Education, Culture, Sports, Science and Technology. He was also appointed the Japanese Coordinator of the JSPS Core University Program, focusing on combating desertification and enhancement of rural development in inland China. Twelve research papers were published during the year.

Studies abroad: Dr. Inanaga visited the Chinese Academy of Sciences and the Institute of Soil and Water Conservation (CAS) under the auspices of the JSPS Core University Program. He also visited: –Uzbekistan to attend the Meeting of Board of Trustees of ICARDA (The International Center for Agricultural Research in the Dry Area) and the UNU-ICARDA Joint Seminar and –Saudi Arabia and Syria to attend the meetings on Joint Research and Education Program. Dr. Inanaga assumed the position of adjunct professor of the United Nation University, visiting professor of China Agricultural University and became a member of the Academic Committee of National Key Laboratory of Soil Erosion and Dryland Agriculture of the Chinese Academy of Sciences.

Students: There were six Ph.D. students [one in 3rd grade – T. Inoue, five in 2nd grade – W. Tsuji, T. Hattori, N. Yasuda (transferred to Kobe University Graduate School of Science and Technology from October), P.A.M. Bulli, (government-financed foreign student from Sudan, reinstated to his position of ARC. Sudan, from May, 2004) and Li Xiangjun (government-financed foreign student from China)]. There were eight M.Sc. students (four in 2nd grade – K. Ikeda, M. Ito, K. Sonobe and Y. Hiraoka and four in 1st grade – K. Ishii, T. Hatanaka, A. Hirano and P.B.S. Gama (a government-financed foreign student from Sudan) and four undergraduate students (two in 4th grade – Y. Asamitsu and M. Watanabe and two in 3rd grade – O. Kaseda and N. Kodama).

One of the M.Sc. students, K. Ikeda, joined the Japan Overseas Cooperation Volunteers (JOCV) and three other students are continuing their studies at the United Graduate School of Agricultural Sciences Tottori University (K. Sonobe) and Kobe University Graduate School of Science and Technology (M. Ito and Y. Hiraoka); an undergraduate student (Y. Asamitsu) is continuing her studies at the M.Sc. level at Graduate School of Agricultural Science, Tohoku University.

Additional assignments: Dr. Inanaga was a councilor of the Japanese Society of Sand Dune Research and the Japanese Association for Arid Land Studies. He was also appointed a member of Desertification Division of the Committee for planning research projects on global environmental issues by The Ministry of the Environment. Dr. Inanaga was also an expert personnel of the Committee of Policy on Food, Agriculture and Rural Community of The Ministry of Agriculture, Forestry and Fisheries of Japan; the president of the committee to activate Tottori Sand Dune and a member of the executive committee on the New Discovery of Tottori Sand Dune.

Subdivision of Plant Production

The subdivision is composed of Dr. Kunio Hamamura (Professor), Dr. Masao Toyama (Associate Professor), Ms. Mitsue Fukunaga (Associate Clerk), 2 doctoral course students, Mr. Wenjun Han (from April) and Mr. Baolin Zhang (from October), both from China, 4 students in the master course, Ms. Yoko Ogino, Mr. Daisuke Morita, Mr. Shunichiro Nishino and Mr. Mitsuru Tsuge, 4 senior students (Undergraduate), Ms. Ikuko Shudo, Mr. Takashi Doi, Mr. Hiroyuki Nakajima, and Mr. Makoto Yamabuki (last 3 students are from July) and 1 visiting scientist from China, Mr. Yong Wang (from Jan. to Mar.,04). Associate professor, Masao Toyama retired from his position because he reached the retirement age.

The research includes broad spectrum of problems concerning the utilization of plant resources in dry areas. The focuses were put on crop production problems pertaining to arid and semi-arid lands, and an additional attention is put on Xerophyte and Halophyte studies. Crop production systems under dry conditions were studied with emphasis put on crop tolerance against water deficiency and salinity. The major subjects studied were the ecology of drought and salt tolerant plants in arid areas, effects of salt on a halophyte, *Salicornia bigelovii*, the root nodule formation of pigeon pea under different fertilization , interaction between Rhizobium and Mycorrhiza, effects of mulching materials on sweet potato production, effects of environmental conditions on potato quality, ash content in plant leaves, drought tolerance of upland rice, salt tolerance of Sedum plants, and effects of water holding substances and soil amending materials.

Dr. Hamamura visited China 2 times under exchange program between the North-west Sci. and Tech. University of Agriculture and Forestry, China, and Tottori University to study on combating desertification in Inland China.

3) Division of Afforestation and Land Conservation

Subdivision of Revegetation and Grassland Development

The present staff of this subdivision consists of Dr. Tamai, S. (Professor), Dr. Yamanaka, N. (Associate professor), Ms. Hamamoto, N. (Associate Clerk, also assigned for the Subdivision of Land Conservation), 5 Master's, and 4 undergraduate students. Our research focuses on afforestation in semi-arid areas, especially on the plant communities and their specific characteristics. The research mainly includes: (1) the distribution of plants in semi-arid land and its specific characteristics, (2) the maintenance mechanisms of plant communities in arid areas, (3) the relationships between water and nutrient dynamics, and the growth of trees, (4) the dynamics of plants on sand dunes, (5) the salt tolerance of woody plants.

The most important research in this subdivision is the prevention of desertification and afforestation in semi-arid areas by native plants and we are analyzing vegetation of China mainly.

Studies on the revegetation and natural vegetation are in progress in Turkey, Brazil and China. In August, Dr. Tamai visited Turkey to conduct field survey on forest vegetation, which is related to research project on 'Impact of climate change on agricultural production in arid areas' of the Research Institute for Humanity and Nature. Dr. Tamai also visited Brazil in November to conduct the research on revegetation and grassland development.

Dr. Yamanaka visited Xaanxi Province of China in April, August, October, November 2003 and March 2004 to conduct the research on the revegetation of Loess Plateau.

While the distribution and growth of trees in semi-arid areas mainly depend upon water conditions of the soil, nutrients connected with water also play an important role on the growth of trees. Then research on water and the nutrients dynamics of trees and in the soil with the growth of trees has been conducted. This investigation aims to clear the dynamics of nutrients in the soil with changing soil water potential using six large scale lysimeters in vinyl houses. Drought tolerance and nutrient dynamics of *Salix* species indigenous to China were studied in 2002.

Salinity of the soil in semi-arid land sometimes becomes a hazard for the germination, establishment and growth of trees. Studies on the ecology and ecophysiology of salt tolerant trees are in progress. In 2003,

Salinity effects on the growth of *Populus alba*, *Tamarix austromongolicas*, and Mangrove trees were mainly investigated.

Studies on afforestation of hardwood (ex. *Robinia pseudoacasia*) in pine forests damaged by pine wilt disease on coastal sand dunes, are also in progress. Ecological researches of plants on sand dunes and studies on growth and reproductive characteristics of woody plants in arid areas have also been conducted.

Cooperative research on the drought stress tolerance of trees was conducted with the scientists for joint research of the Center. And a number of trainees from abroad were taken on.

Subdivision of Land Conservation

The main studies in this subdivision were on the dynamic movement of moisture and salt in the soil under arid conditions. The mechanism of soil erosion by water and break down of soil aggregate were also studied in order to promote research on the mechanism and control of desertification. The staff was made up of Dr. T. Yamamoto (Professor), Dr. M. Inoue (Associate Professor), Ms. N. Hamamoto (Associate Clerk assigned to the entire Division) and sixteen students. Four students are enrolled in the doctoral course at the United Graduate School of Agricultural Sciences, Ten as master course students and two as undergraduates in the Faculty of Agriculture.

The main domestic research titles are (1) Assessment of water and solute transport characteristics during salt accumulation and leaching, and establishment of suitable soil management for sustainable agricultural production in arid and semi-arid regions, supported by Monbukagakusho Grant-in-Aid for Scientific Research B(2), (2) Evaluation and standardization of in situ measurements of soil hydraulic and solute transport properties supported by Monbukagakusho Grant-in-Aid for Scientific Research B(1), (3) Effect of water pollution on clogging of emitters and filters of a microirrigation system supported by Ministry of Agriculture, Forestry and Fisheries since 1992, (4) Prevention of water erosion by revegetation soil bed with sedum plants in green roof supported by Nishimatsu Construction Co., Ltd., (5) Improvement of soil permeability using zeolite supported by Maeda Construction Co., Ltd., (6) Finally, under the 21st century COE Program for Arid Land Science, studies on environmental monitoring and soil restoration technology were initiated using three dimensional soil water erosion analyzing system, monitoring system for water flow and solute transport and desertification mechanism analysis system installed in Arid Land Dome.

For joint research with other divisions in universities, the staff carried out (1) Studies on soil degradation in arid land with Dr. T. Nishimura (Tokyo Univ. of Agric. and Tec.), Dr. K. Roy (Nihon Univ.) and Dr. Y. Ishikawa (Akita Prefecture Univ.), (2) Studies on analysis of surface conditions in arid land by remote sensing, together with Dr. K. Torii (Kyoto Univ.), (3) Studies on salt accumulation and leaching using the monitoring system for water flow and solute transport, together with Dr. Y. Kihara (Shimane Univ.), H. Cho (Saga Univ.) and Dr. S. Yamamoto (Tottori Univ.), (4) Free subject on arid land studies, together with Dr. N. Sasaki (Hirosaki Univ.), Dr. N. Toride (Saga Univ.), Dr. T. Kasubuchi (Yamagata Univ.), Dr. K. Kamiya (Gifu Univ.), Dr. Y. Takeshita (Okayama Univ.), Dr. T. Tanigawa (Osaka Prefecture Univ.), Dr. H. Fujimaki (Tsukuba Univ.), Dr. K. Kosugi (Kyoto Univ.), Dr. Y. Mori (Shimane Univ.) and Drs. K. Inosako and T. Yamada (Tottori Univ.).

Dr. T. Yamamoto started a joint research on rehabilitation of degraded soils using artificial zeolite with Dr. V. Rasiah of the Tropical Research Institute, Mareeba, Queensland Province and Dr. L. Martin of the Muresk Agricultural Facility of Curtin Univ., Perth, West Australia Province in Australia. These Provinces have an excellent technology to support export of large agricultural products to the world. However, soil degradation by acidification is a major problem due to irrigation practices and/or use of modern agricultural technology. Within the year, soil analysis research was mainly carried out for bare soil in field plots mixed with artificial zeolite. Also, Mr. Y. Shimura and Miss A. Satoh who were MS students, stayed one month in both areas where they helped in carrying out the joint research as well as studying agriculture problems in arid lands.

Dr. Inoue conducted joint research projects supported by Monbukagakusho Grant-inAid for Scientific

Research B(1) & B(2) from 2001. He made oral presentation on 'Development of dielectric soil moisture sensor' during the annual meeting of the Japanese Society of Sand Dune Research held in Yonago city on 27 July, and on 'In-situ test of soil hydraulic properties using PR1 simple automatic soil moisture meter' during annual meeting of JSIDRE, Chugoku-Shikoku branch in Kochi city on 15 Oct. 2003. He also made a poster presentation on 'Effect of salt concentration on measurement of soil water content based on dielectric constant' at a symposium of the Soil Science Society held in Okayama city on 22 Nov. The project with Tokushima prefecture on 'Development of a simple technique for measuring nitrate nitrogen in soil water of sand dune fields' was started for 3 years. Dr. Inoue also visited the Soil and Water Conservation Institute of the Chinese Academy of Sciences on 2-8 Sep., 19-24 Oct. and 13-17 Nov. 2003 and 1-8 March 2004, based on the Core University Program of 'Studies on combating desertification and development in the inland region of China'. During trip he measured the soil temperature and moisture distribution patterns to determine the relationship between soil degradation and reduction in crop yield following repeated vegetable cultivations in plastic greenhouses in winter season. He made a presentation on 'Environmental monitoring of cucumber greenhouse culture of Yan'an district, - A change of soil water storage using profile probe -' at the Japan-China Joint Open Seminar in Yangling city on 14 Nov. He had two open seminar lectures on 'Measurement of soil water and solute transport and its hydraulic properties in dune sand' in the Faculty of Agriculture, Saga University on 16 May, and on 'Development of economical and sustainable agricultural technology in arid and semi-arid areas' in SCS on 27 June.

We invited Dr. M. Naruoka, who graduated from our laboratory and was working in the Japan Green Resources Corporation to talk on 'Environment surrounding agricultural development overseas and field examination' in our seminar on 18 June. Our candidate for the Ph.D. M. Arai talked on the 'Evaluation of sodic soil aggregate stability using ethanol-water mixtures' at the 2003 annual meeting of the American Society of Agronomy held in Denver, U.S.A. in November. Our other candidate for the Ph.D. N. Higashi made a presentation on 'Implementation of Automated Infiltration Soil Water Sampler: Application to unsaturated soil in dune fields' during the in 2003 Fall meeting of the American Geophysical Union held in San Francisco, U.S.A. in December.