2. Research Activities (Apr.2004-Mar.2005)

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 Facility. 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 universities who are engaged in this field of study.

The ALRC's Program for Arid Land Science was adopted as a 21st Century COE program. 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, the office 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 has 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 eight COE researchers are stationed at ALRC. Eleven office staff (five clerks and six associate clerks), four technical officers and one research support technician support the research and education.

With regard to the funding, subsidies for scientific study in the fiscal year of 2004, a total of four themes were adopted:

Scientific Research (B)	: 1,
Scientific Research (C)	: 1,
JSPS Fellowships	: 2

With regard to other research funding, a total thirteen themes were accepted:

Scholarship Contribution	: 6,

Entrusted Research	: 3,
Joint Researches with private enterprises	: 4

Joint-Use Research, Education, Publication

During the fiscal year of 2004, 53 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 14th seminar of Joint Research was held on December 7, 2004 at Arid Land Research Center, Tottori University. Twenty one poster presentations were performed.

About the 21st COE Program, Tottori Workshop “Capacity Building for Combating Desertification in Collaboration with Tottori Uni. and the International Organizations” and the Open Seminar were held on May 21, 2004 and Feb. 8, 2005, respectively.

(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). Dr. Kamichika assumed the sub-director from April 2004, and also Dr. Kimura was promoted to the assistant professor. There were three Doctoral student, five master's students, four undergraduate students and one foreign researcher (from China) in the fiscal year of 2004. Ms. Takagi found an employment with private companies (NOVA). Mr. Nureki entered the master's course of Tottori University.

In the fiscal year of 2004, the following researches have been conducted in Japan.

(1) MICROCLIMATE: Heat, water and CO_2 balance were observed in the grassland (Arid Land Research Center). CO_2 observation under the mulching condition was also conducted for the purpose of clarification of environmental condition in the soil. 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), Dr. Hayakawa, S. (Faculty of Agriculture, Yamaguchi University) and Dr. Moriyama, M. (Faculty of Engineering, Nagasaki University). Research themes were rainfall analysis, vegetation vigor change after the Earth and stone disaster, and soil surface temperature and/or the soil water content analysis using the remote-sensing techniques.

(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. Also, we analyzed sand dune movement using the air survey data.

(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 2004 was as follows: Dr. Kamichika conducted the field survey in Oman for developing the road from 23 July to 29 July 2004. He observed in the Liudaogou basin located in Shenmu district, Shanxi Province, China for Japan-China Joint Project from Aug. 4 to 13 2004, and conducted the field survey for collecting the data as to the climatic production from 25 Jan. to 29 2005. Dr. Kimura observed in the Liudaogou basin located in Shenmu district, Shanxi Province, China for Japan-China Joint Project from 31 May to 9 June 2004, and from 4 August to 13 2004.

Subdivision of Water Resources

The subdivision of water resources is carried out research on development of water resources, conservation of water resources, irrigation and drainage to prevent the desertification and to develop the sustainable agriculture in arid and semiarid regions.

Staff and students: The staff consists of Dr. Anyoji, H. (Professor), Dr. Yasuda, H. (Assoc. Prof.) and Ms. Yonehara, A. (Associate secretary, also assigned for the subdivision of natural environment), one doctoral student, one master's student and one post-doctor researcher.

Research in Japan: Research on efficient use of water in irrigation, accurate estimation of plant transpiration and soil evaporation, reduction of soil evaporation in irrigation, effective use of rainfall in irrigation scheduling, and up-scaling of soil hydraulic properties has been conducted in Japan and abroad to prevent the desertification and to develop the sustainable agriculture in arid and semiarid regions.

Studies in Japan: Our efforts in Japan have been made to carry out research on hydraulic design of irrigation systems, partitioning of plant transpiration and soil evaporation from evapotranspiration, scale dependence of soil hydraulic properties, and runoff and infiltrated water from rainfall in the laboratory and a green house.

Overseas Research: Hydrological data are collecting at the Loess Plateau in China as activities of the 21st COE research program. Data of ground water table, soil moisture and rainfall were collected in 2004. The analysis of rainfall time series in the Loess Plateau of China was presented at the Japanese-Chinese joint seminar. Also, research on the solute movement in heterogeneous soil was carried out jointly at Lund University in Kingdom of Sweden.

Cooperative researches had been conducted with the following researchers: Prof. Nishiyama, S. (Faculty of Agriculture, Yamaguchi University), Prof. Takuma, K. (Faculty of Agriculture, Tottori University), Dr. Takeuchi, S. (Faculty of Engineering, Kyushu Kyoritsu University) and Dr. Aoda, T. (Faculty of Agriculture, Niigata University). 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. P. An (Assistant Professor) and Ms. E. Tomemori (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 plant indicators of desertification. Joint researches have been conducted with several researchers (Drs. J. Abe of Univ. of Tokyo, E. Tanimoto of Nagoya City Univ., H. Shimizu of the National Institute for Environmental Studies 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. U. Qiman (Associate Professor of Xinjiang Agriculture University), Dr. Y.Q. Ma (Professor, Institute of Water and Soil Conservation of the Chinese Academy of Sciences), Dr. Abdelbagi M. Ali (Professor, Agricultural Research Corporation, Sudan) 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, 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. Thirteen 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: –Syria to

attend the Meeting of Board of Trustees of ICARDA (The International Center for Agricultural Research in the Dry Area) and to set up the oversea research base of the COE program in ICARDA. –The United Arab Emirates to carry out the project about the sustenance of oasis ecology. Dr. Inanaga assumed the position of member of the advicesary board of Xinjiang Agricultural University, China. Dr An visited the Institute of Soil and Water Conservation and the Institute of Genetics and Developmental Biology, of the Chinese Academy of Sciences (CAS), Beijing Normal University, Xinjiang Agricultural University and Shanghai Jiaotong University, ICARDA in Syria and University of Wales in the United Kingdom to conduct the researches carried out in the subdivision and those involved in the Core University and the COE programs.

Students: There were five Ph.D. students [one in 4th grade – T. Inoue, three in 3rd grade – W. Tsuji, T. Hattori, and Li Xiangjun (government-financed foreign student from China), one in 1st grade – K. Sonobe]. There were five M.Sc. students (four in 2nd grade – K. Ishii, T. Hatanaka, A. Hirano and P.B.S. Gama (a government-financed foreign student from Sudan), one in 1st grade – T. Nagamori, three undergraduate students (4th grade – O. Kaseda, N. Kodama and M. Watanabe).

One of the M.Sc. students, T. Hatanaka, got employed in Ina Food Industry Company, one student is continuing his studies at the United Graduate School of Agricultural Sciences Tottori University (P.B.S. Gama) and three other are continuing their studies at the subdivision; an undergraduate student (M. Watanabe) got employed in Ajinomoto General Foods, the other two are continuing their studies at the M.Sc. level at the subdivision (O. Kaseda) and division of integrated life science, Graduate School of Biostudies, Kyoto University (N. Kodama).

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), (Associate Professor post is vacant), Ms. Emako Tomemori (Associate Clerk), 2 doctoral course students, Mr. Wenjun Han and Mr. Baolin Zhang , both from China, 4 students in the master course, Mr. Daisuke Morita, Mr. Shunichiro Nishino, Mr. Mitsuru Tsuge, and Mr. Toshihiro Tachikawa, 4 senior students (Undergraduate), Mr. Hiroyuki Nakajima, Mr. Makoto Yamabuki, Mr. Hironori Akita and Mr. Tsuyoshi Nobuhara (last 2 students joined on July) and 3 visiting scientists from China, Mr. Yong Wang (from Jan.2004 to Jan.,2005). Dr. Longchang Wang (invited by Goho International Life Science Foundation), and Mr. Changhon Fen.

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*, 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, effects of slow releasing fertilizers on peanut yields, effects of restricting root zones of pepper, and response of Alfalfa to water stress and fertilizer application.

Dr. Hamamura, Mr. Han and Mr. Tachikawa visited Dali Irrigation Areas in Central China 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. Plant samples were corrected

on the salt affected areas and their ash content in root, stem, leaf an seed were analyzed.

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), 1 Doctor's, 5 Master's, and 1 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 China and carried out the researches on the relations between salt tolerance of halophyte and under ground water level. In September He 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, July, October 2004 and March 2005 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 of *Salix* species, *Quercus* species and *Robinia pseudo-acacia* planted in China was studied in 2004.

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 pseudo-acacia*) 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 dynamics 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 consisted of Dr. T. Yamamoto (Professor), Dr. M. Inoue (Associate Professor), Ms. N. Hamamoto (Associate Clerk assigned to the entire Division) and fourteen students. Five students are enrolled in the doctoral course at the United Graduate School of Agricultural Sciences, Seven as master course students, one as an undergraduate in the Faculty of Agriculture and one research student.

The main domestic research titles are (1) Development of measurement techniques for solute transport in undisturbed soil column and downward flow from the root zone in irrigated farmland in arid regions. This

research is supported by Monbukagakusho Grant-in-Aid for Scientific Research B (2), (2) Effect of water pollution on clogging of emitters and filters of a microirrigation system supported by the Ministry of Agriculture, Forestry and Fisheries since 1992, (3) Improvement of soil permeability using zeolite supported by Maeda Construction Co., Ltd., (4) Development of a simple technology for measuring nitrate nitrogen in soil water of sand dune fields supported by the Tokushima Agricultural, Forestry and Fisheries Technology Support Center Agriculture Institute, (5) 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 the 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. T. Tanigawa (Osaka Prefecture Univ. and Dr. Y. Ishikawa (Akita Prefecture Univ.), (2) Studies on analysis of surface conditions in arid land by remote sensing, with Dr. K. Torii (Kyoto Univ.), (3) Studies on salt accumulation and leaching using the monitoring system for water flow and solute transport, with Dr. Y. Kihara (Shimane Univ.) and H. Cho (Saga Univ.), (4) Free subject on arid land studies, with Dr. N. Sasaki(Hirosaki Univ.), Dr. N. Toride (Saga Univ.), Dr. Y. Takeshita (Okayama Univ.), Dr. K. Roy (Nihon Univ.), Dr. H. Fujimaki (Tsukuba Univ.), Dr. Y. Mori (Shimane Univ.) and Drs. K. Inosako and T. Yamada (Tottori Univ.).

Dr. T. Yamamoto continued a joint research on rehabilitation of degraded soils using artificial zeolite (AZ) with Dr. L. Martin of the Muresk Agricultural Facility at Curtin Univ., Perth, western Australia. Wheat was cultivated in the experimental fields of 2,000 m^2 under the rainfed conditions from May to November. Three samplings of soil and crop were carried out during the season. Finally Dr. Martin submitted the 2004 final report in which he discussed the effect of AZ on the wheat growth and yield. Also, Mr. Nakaoka, a MS student, offered research support to the joint research and learnt some aspects of arid land agriculture during August to September. In addition, we invited Dr. Martin for one week. During this time, he gave a presentation on Western Australian agriculture.

Dr. Inoue conducted joint research projects supported by Monbukagakusho Grant-inAid for Scientific Research B(2) from 2004. He attended an Annual Meeting of the Japanese Association for Arid Land Studies, and an International Conference on ‘Living with Desert’ held in Tokyo on 18-19 May. He made oral presentations on ‘Soil moisture measurement of dune sand with high salt concentration using ADR moisture sensor’ during the Annual Meeting of the Japanese Society of Sand Dune Research held in Niigata city on 1-2 July, and on ‘Inverse estimation of soil hydraulic properties with HYDRUS-2D’ during Annual Meeting of JSIDRE, in Sapporo city on 7-8 Sep. 2004. He made a presentation on ‘Soil water content and salinity measurement and calibration of dune sand with high salt concentration using WET sensor’ during a meeting of the Chugoku-Shikoku branch of JSIDRE held in Okayama city on 12-13 Oct. 2004. He also made a poster presentation on ‘Effect of salt concentration on measurement of soil water using various soil moisture sensors based on dielectric constant’ at the 2004 annual meeting of the American Society of Agronomy held in Seattle, U.S.A. in November. He made a lecture on soil holding capacity at the special meeting on ‘the behavior and evaluation of unsaturated ground’. The joint research project with Tokushima prefecture on ‘Development of a simple technology for measuring nitrate nitrogen in the soil water of sand dune fields’ was started since 2003. Dr. Inoue also visited the Soil and Water Conservation Institute of the Chinese Academy of Sciences on 14-22 Sep. 2004 and 7-14 March 2005, based on the Core University Program of ‘Studies on combating desertification and development in the inland region of China’. During the 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.

Our candidate for the Ph.D. Naoko Higashi made a poster presentation on ‘Application of an Automated Infiltration Soil Water Sampler in Variably Saturated Sandy Soil’ at the 2004 annual meeting of the American Society of Agronomy held in Seattle, U.S.A. in November and also made an oral presentation

titled ‘Work toward the acquirements of monitoring technique to prevent soil and ground-water contamination, – Development of automated infiltration soil water sampler and application to unsaturated soil in dune fields – ‘ at the workshops of soil physic for young researchers held in Tokyo on 8 January.

Hossein Dehghanisanij who was a third grade of Ph.D. student, attended the 2005 ASAE/CSAE Annual Meeting held in Ottawa, Canada during August 1st to 4th and made a presentation on ‘Interaction of soil water content and soil solute salinity under drip irrigation in dune field’, and ‘Application of artificial zeolite to combat soil erosion. On September 27th, he received his Ph.D. degree on the topic: Influences of water quality and evapotranspiration on the scheduling of drip irrigation.