2.7 Activities of Foreign Researchers

(1) Professor Menachem Agassi

Visiting Professor (June 2003-May 2004)

Soil Erosion Research Station, Ministry of Agriculture, Israel

Title: *Improvement of salinity soil by mulching organic matter.*

I would like to thank the director of the Arid Land Research Center Prof. S. Inanaga of Tottori University and my host Prof. T. Yamamoto, Head of the Division of Forestation and Land Conservation, for giving me the opportunity to spend one year as a visiting Prof. in ALRC. I enjoyed the time I spent in ALRC, both professionally and socially. It was a pleasure to work together with Prof. Yamamoto, Assoc. Prof. M. Inoue and their students. I would like to thank as well the administration of ALRC, especially Miss K. Takahashi, Mr. Y. Nagamura and Mr. T. Shimizu for their devoted assistance.

Summary of activities for 12 months (Jun. 1, 2003 to May 31, 2004)

My activities in ALRC were as follows:

Conferences and Annual Meetings

1) Key note lecture on the use of composted municipal solid wastes (CMSW) as a mulching material to control runoff, evaporation of soil water and soil erosion. Conference of the Japanese World Association Soil Water Conservation (JWASWC) at Tokyo University of Agriculture, November 2003.
2) Key note lecture on the advantages of implementation of water conservation practices in arid, semi-arid regions. Annual meeting of the Cooperative Researchers, Arid Land Research Center, Tottori University, December 2003.

Seminars and lectures

1) Physico-chemical processes leading to structural soil surface sealing. Tsukuba National Institute for Research, Department of Environmental Chemistry and the Department of National Resources, November 2003.
2) Soil surface sealing processes. Kyushu University, Fukuoka, Japan, Department of Soil Environmental Engineering, January 2004.
3) Effects of mulching with composted municipal solid wastes on minimizing rain water losses and hazards to the environment. Thailand society of Soil and Water Conservation, Bangkok, Thailand. February 2004.

Series of lectures held in Arid Land Research Center, Tottori University, Japan

1) The processes and factors that are leading to runoff and soil erosion by water.
2) Rainfall characteristics, analysis and temporal and spatial distribution.
3) Soil properties in regard with water erosion.
4) Soil surface sealing processes.
5) Using of composted municipal solid wastes as a mulching material.
6) Effect of prolonged irrigation with treated municipal effluents on runoff rates.
7) Effects of raindrops induced soil surface crust on soil water evaporation.

Assistance to students

Great part of my time was devoted to assisting and guiding ALRC, Ph.D. and post graduate students in writing their thesis and editing of English manuscripts submitted to reviewed journals, as well as conference presentations.

Together with Assoc. Prof. M. Inoue, I instructed M.Sc. student (Y. Kurata) in her thesis regarding the efficiency of mulching the soil surface with aluminum coated plastic membrane to control soil water evaporation.

Scientific visits

- Tokyo University of Agriculture, Assoc. Prof. M. Machito, Prof. T. Satoru, Assoc. Prof. W. Fumio, Dr. S. Sawahiko, Assoc. Prof. S. Eiichiro, Prof. T. Koji, Prof. R. Yasutomi.
- Tokyo University of Agriculture and Technology, Assoc. Prof. N. Taku.
- Tsukuba National Institute for Research, Department of Environmental Chemistry and the Department of National Resources, Prof. K. Hidetaka, Dr. S. Suzuki, Dr. N. Keiko, Dr. K. Tomijiro, Dr. O. Shigeo.
- Kyushu University, Prof. J. Chikushi, Prof. O. Masami, Prof. Y. Hisashi.
- Saga University, Prof. A. Tanaka.
- The University of Tokyo, Prof. E. Yamaji, Assist. Prof. V. Anbumozhi.

Research

<u>Effect of mulching with composted municipal solid wastes on minimizing rain water loss and hazards to the environment</u>

Dry land farming in arid and semiarid regions requires minimization of rainwater losses. The major causes for the loss of rainwater are: (i) runoff due to seal formation by raindrop impact, and (ii) evaporation from the wet soil surface. Mulching the soil surface is an effective way to prevent seal formation and water losses. We hypothesized that composted municipal solid waste (CMSW) could be used for mulching arable lands and minimizing rainwater losses without posing a hazard to the environment. Our objective was to study the effects of annual application of CMSW at the soil surface on rainwater retention in the soil, crop production and some hazards to the environment. The experiments were conducted for 4 years in

commercial rain fed wheat (Triticum aestivum) field. Amounts of 0, 100 and 300 m3 ha-1 CMSW were added annually to the soil surface prior to the rainy season. Water content in the soil was determined 4 times, soil salinity, and sodicity were determined twice and heavy metals in the soil and the yield were determined once every year. Yield was determined at the end of each growing season. Application of CMSW increased available water in the root zone mainly due to reduction in evaporation and almost doubled the yields. No considerable increase in salinity, sodicity and heavy metals was noted in the root zone following CMSW application. Our observations suggested that annual application of CMSW at the rate of 100 m3 ha-1 was enough to significantly minimize rainwater losses and increase yield under dry land conditions, without posing specific hazards to the environment.

(2) Associate Professor Zhongmin Xu

Visiting Associate Professor (October 2003-September 2004)

State Key Laboratory of Frozen Soil Engineering,

Cold and Arid Regions Environmental and Engineering Research Institute, C.A.S., China

Title: *Study on the sustainable development in arid regions from the view of ecological economics –taking Hei river as a case.*

(1) Summary of research activities for 12 months (Oct. 1, 2003 to Sep. 30, 2004):

I was invited to Arid Land Research Center, Tottori University for one year, working together with Prof. Hamamura. My research activities in the past one year were as follows:

Seminars presented

[1] seminar 1. Introduction to the integrated ecological economic research in Hei river. Arid Land research Center, Tottori University. Nov. 14, 2003. The same content presented at Research Institute for Humanity and Nature. Nov. 19, 2003.

[2] seminar 2. Assessing the benefits of restoring ecosystem service. Arid Land research Center, Tottori University. Dec. 18, 2003.

[3] seminar 3. Virtual water and Water management in China. Arid Land research Center, Tottori University. Mar. 27, 2004.

[4] seminar 4. Social adaptations to environmental impacts: from ecological footprint to ImPACTS model. Arid Land research Center, Tottori University. Aug. 25, 2004.

Scientific visits

[1] Japan International Research Center for Agricultural Sciences, Prof. Kazuo Nakamoto. 2003.11.17

[2] Tokyo University, Prof. Keiji Ohga. Agricultural development. 2003.11.18

[3] United Nations University, Prof. Iwao Kobori. 2003.11.18

[4] Research Institute for Humanity and Nature. Prof. Masayoshi Nakao. 2003.11.19

[5] Tokyo University, Associate Prof. Taikan Oki, 2004.3.5

[6] International Nature Farming Research Center, Prof. Hui-Lian Xu. 2004.8.4

[7] Research Institute for Humanity and Nature, Prof. Wang Genxu. 2004.8.5

(2) Title of articles

[1] Xu ZM., Cheng GD., Long AH., Loomis J., Zhang ZQ., Hamamura K., Evaluating the Performance of Different Willingness to pay question format for valuing Restoration of Watershed services. (Submitted to Environment and Development Economics and also being accepted as presentation paper in the international conference of environmental concern)

[2] Xu ZM., Cheng GD., Long AH., Zhang ZQ., Hamamura K., Applying information entropy to decide the sample amount and content in contingent valuation survey. Pakistan Journal of Social Sciences, 2004: 2(3).

[3] Xu ZM., Cheng GD., Zhang ZQ., Long AH., Hamamura K., Bennett J., Choice Modeling and its application to managing the Ejina Region, China. (Submitted to Environment and development Economics)

[4] Xu ZM., Ren FK., Ma SY., Guo TT., Comparison Analysis of the stated preference Techniques for valuing Environment. Journal of Glaciology and Geocryology. 2003.25(6):701-707 (In Chinese with English abstract)

[5] Xu ZM., Long AH., Zhang ZQ., Virtual water consumption calculation and analysis of Gansu province in 2000. ACTA GEOGRAPHICA SINICA. 2003.58(6):861-869. (in Chinese with English abstract, revised in ALRC).

[6] Long AH., Xu ZM., Zhang ZQ., Water footprint of northwestern China. Journal of Glaciology and Geocryology. 2003.25(6): 692-700. (in Chinese with English abstract)

[7] Xu Z M, Zhang Z Q. Long A H, et al., Comparison and application of different contingent valuation methods in measuring total economic value of restoring Ejina Banner's ecosystem services. ACTA ECOLOGICA SINICA, 2003, 23(9):1841-1850. (in Chinese with English abstract)

[8] Xu ZM., Cheng GD., Qiu GY., Social adaptation to environmental impacts: from Ecological footprint to ImPACTS model. (draft in English and Chinese).

[9] Costanza R., Jorgensen SE., Understanding and solving environmental problems in the 21st century: toward a new, integrated hard problem science. (Xu ZM., Zhang ZQ., Zhao WZ., et al., translated into Chinese), Yellow River water hydraulic press.2004. (in press, revised in ALRC)

(3) Results of research

1. Evaluating the Performance of Different Willingness to pay question format for valuing Restoration of Watershed services.

Based on a previous study on applying Contingent valuation Method (CVM) to analyze the total economic value of restoring Ejina ecosystem services by adopting the payment card format. To better

mimic price taking in market behavior, we use dichotomous choice format, double bounded dichotomous choice to reevaluate the objective. This paper compares protest rates and willingness to pay for payment card, dichotomous choice and double bounded dichotomous choice contingent valuation question formats. Using a chi-square test, the payment card had a significantly higher protest rate (6.7%) than dichotomous choice question format (2.2%). The median WTP of the single bound and double bound dichotomous choice exceed the payment card by a factor of nine and seven, respectively. Two factors appear to influence this result: (a) the payment card allows for zero WTP, while dichotomous choice does not, and (b) responses to the dichotomous choice questions suggest that yea saying at high bid amounts is possible. Yea saying may be more prevalent in our case study (a developing country) due to the social context of surveys performed by government institutions in undeveloped countries and the novelty of surveys in general. Suggestions for reducing yea saying are provided.

2. Choice Modeling and its application to managing the Ejina Region, China.

Decision makers face a range of choices on how to manage ecosystems. Appropriate decisions should be based on weighing up the benefits and costs of alternative ecosystem management strategies, including some monetary and non-monetary benefits/costs. This paper reports an application of the Choice Modeling (CM) method in rural China. The CM method was used to obtain estimates of the monetary benefits for various attributes and changing scenarios in the Ejina Ecosystem. Application of CM is described including the goals of the valuation practices, questionnaire design and survey management. Model results are used to estimate sample non-monetary values of various attributes and changing scenarios. Significant non-monetary value estimates are reported for ecosystem management changes in the Ejina region. These estimates provide information to assist in choosing appropriate alternative management options.

3. Virtual water consumption calculation and analysis of Gansu province in 2000

Demand for the increasingly scare water supply is rising rapidly with the growing population in Chinese arid land. There is a pressing need for governments to manage water resources efficiently and adopt policy reforms. A recently emerging strategy concept developed as a developed as a prospective long-term solution for increasing stress on water resources is known as virtual water. Virtual water is the water ‘embodied’ in a product, not in real sense, but in virtual sense. It refers to the water needed for the production of the product. Trade of commodities brings along trade of virtual water.

In this paper, we Firstly introduce the concept of virtual water, discuss its role in managing water resources and its social, economic, and political implications. virtual water strategy means countries or regions whose water is scarce achieve their water security and food security by importing water-intensive products from those whose water is abundant, which expands the solution of water resource scarcity to the political-economy system. The particular linkage of population, food, and trade has been the masterstroke of virtual water strategy research.

Secondly, we present the methodology to assess the virtual water content of crop product and livestock, and take Gansu province as a case to analysis the virtual water content in product and circulating

field. Owing to lack of rigorous statistical data of trade among province, the above results are then combined with the index of consume amount of product to get a picture of virtual water circulating in social-economy system of Gansu province. The calculation results show that the total volume of total product-related and consume-related virtual water are $222.02\times10^8 m^3$ and $183.75\times10^8 m^3$ respectively.

Thirdly, we discuss the political implications and potential applicability of virtual water associated with water security, economic benefit and consumption structure in Gansu province, and examines the advantage and disadvantage of virtual water strategy. The results show that virtual water trade is an instrument to achieve water security and efficient water use, and make a link between consumption patterns and the impacts on water. virtual water strategy have an added advantage of being environmentally sound, at the same time, the reliance on trade can hold some risks, including the uncertainty of supplies, market price instability and increasing environmental stress if appropriate policies are not in place.

Finally, we put forward some suggestions on how to implement a viable virtual water strategy in arid land, and believe future efforts may apply virtual water strategy to alleviate the press of water resources shortage in arid land.

4. Social Adaptation to Environmental Impacts: From Ecological Footprint to the ImPACTS Model.

The search for frameworks and indicators of sustainable development is a popular topic. In an attempt to analyse the relationship between ecological footprint (EF) and social development using existing data, we suggest that every country should increase their global share of EF within the sustainable scale of the Earth, rather than simply decreasing their EF. Examples from water shortage in northern China and China's food security and global CO_2 emission show that managing and mobilizing social resources should be considered an alternative to mitigating human impacts on the environment and adapting to these impacts. Based on formal ImPACT identity, a new "ImPACTS" identity as a framework for sustainability science was produced, where S denote the level of social resources, m is assigned to management and I is changed from formal environmental impacts to the trade-off between environmental impacts and development. Finally, we demonstrate the utility of ImPACTS by performing an empirical analysis of our integrated impacts assessment on the Earth by using existing data of EF and Human development index.

5. Applying information entropy to decide the sample amount and content in contingent valuation survey.

Contingent valuation methods are usually accompanied with large costs. The empirical analysis of Ejina ecosystem service survey shows that information entropy can be used to judge if survey sample amounts are appropriate. Analysis results showed that choosing 400 samples can get information equivalent to distribute 646 samples in our empirical survey. Simultaneously, the calculated average mutual information and statistical test showed that we should investigate related social economic information with interviewee to decreasing uncertainty. The categories of education level, income, census register and residence site of interviewee should be preferred investigated, which can get more average mutual information and have significant influence on mean willingness to pay than the categories of age

and sex. Usually, the higher average mutual information of interviewee's social economic information, the higher the influence of social economic information on the willingness to pay.

(3) Associate Professor Guoyu Qiu

Visiting Associate Professor (November 2003-October 2004)

Institute of Resources Science, Beijing Normal University, China

Title: *Separation of evapotranspiration into transpiration and soil evaporation.*

Summary of my research activities for 12 months (Nov. 1, 2003 to Oct. 31, 2004)

During my 1 year's staying in Arid Land Research Center, Tottori University as a visiting associated professor, by cooperation with Professor Yano, Professor Anyoji, and Dr. Yasuda, I mainly concentrated on the educations and researches as below:

1. Education activities:

(1) Supervise the postgraduate students in water resource lab.

(2) Give 4 seminars at Arid Land Research Center, Tottori University. The titles of the 4 seminars are:

- Researches on Evapotranspiration and Separately Estimating of its Two Components I. Determination of Soil Evaporation with Surface Temperature (Dec. 19, 2003)
- Researches on Evapotranspiration and Separately Estimating of its Two Components II. Determination of Plant Transpiration with Surface Temperature (Jan 16, 2004)_
- Researches on Evapotranspiration and Separately Estimating of its Two Components III. Determination of Evapotranspiration (Feb 20, 2004)Recently Progress of Desertification and its Combating in China （August 23, 2004）

(3) Invited to give 1 seminar in Kagoshima University，the title is "**中国西部における水資源及び環境問題について**", Jan. 20, 2004

Research Activities:

Based on the requirements of the contact, I have conducted two experiments. One is under the controlled environment to quantitatively separate evaporation and transpiration. Another is under the open field condition. Results are summarized and published.

Title of articles

(1) Qiu, G Y, T. Yano, et al., 2004 Theoretical Analysis and Experimental Verification of a Soil Evaporation Transfer Coefficient. Soil Science Society of American Journal (in press)

(2) Qiu, G Y, et al. 2004. Tendency of Desertification in China during Last 50 Years. International Symposium: Evaluation and Monitoring of Desertification, －Synthetic Activities for the

Contribution to UNCCD－. February 2nd, 2004, Tsukuba, Japan.

(3) Qiu, G Y et al., 2004. Remotely Detection of Environmental Stress of Vegetation by Three Temperatures Model. 6th APGC symposium, October 19-22, 2004, Tsukuba, Japan.

Results of research

Sustainable water management requires accurately estimation of soil evaporation (*LE*). By including the surface temperature of a dry soil, a three temperatures model was proposed to estimate of *LE* and its temperature term was defined as soil evaporation transfer coefficient (h_a). Though it has been primarily shown that h_a determines the boundaries of *LE*, further studies on its properties are necessary because h_a is also important for total evaporation and other *LE* related parameters. The objectives of this study are to investigate its relationships with aerodynamic resistance, soil surface resistance (r_s), and cumulative evaporation (E_c). Data from two experiments are used. One experiment was carried out in an open field, which was given in detail by previous study. Another experiment was carried out in a closed growth chamber at constant air temperature, humidity, and radiation. Measured parameters included *LE* and surface temperatures. Results show that (1) with the boundaries of $0 \leq h_a \leq 1$, *LE* is determined between its potential rate and zero. This consequence is further verified by average h_a for different soils; (2) during the period when evaporation is dominated by r_s, a linear relation between h_a and log (r_s) is obtained with $r^2 = 0.76$; (3) during stage 1 of evaporation, E_c increases with time while h_a remains constant. After stage 1 h_a linearly increases with E_c. These results suggest that h_a is an important coefficient for *LE*.

(4) Professor Anthony Egrinya Eneji

Visiting Professor (June 2004-May 2005)

University of Calabar, Nigeria

Title: *A study on the role of silicon in drought tolerance and growth of some plants of the Gramineae family.*

Summary of research activities for 10 months (June 1, 2004 to March 31, 2005)

My research explores the nutrient relations in the soil - plant system as they affect overall plant production. I also have broad interest in waste recycling for soil (water and nutrient) conservation in organic production systems. Currently, my study examines the role of silicate materials in relieving water stress and promoting growth of some species of the gramineae family. The study is being performed in the sub-division of Plant Ecophysiology, headed by Prof. Dr. S. Inanaga with Dr. P. An as Assistant professor.

Conferences/workshops attended

1. Visit to the peoples' Republic of China on a study trip and meetings under a Collaborative Research between Tottori University and the Chinese Academy of Science (19 – 28 November, 2004).

2. World Rice Research Conference held in Tokyo and Tsukuba, Japan (November 3-7, 2004).
3. The 6th International symposium on Plant Responses to Air Pollution and Global Changes held in Tsukuba, Japan (October 19-22, 2004).

Presentations

a) Ecological shifts associated with deforestation in tropical climates: field observations from Nigeria

Presented at the Joint Research Symposium of the ALRC, Tottori University on 7 December, 2004

Summary

One of the options for achieving an adequate food supply in tropical Africa is by putting more land into production. Very often, this requires clearing and developing new vegetation areas for agricultural production. Unfortunately large areas of forest are being cleared without caring for the consequences of the clearing method used. Results from our field study comparing mechanized (MC), semi-mechanized (SMC) and manual (MA) clearing in Nigeria showed that clearing was accompanied by soil compaction and sharp decreases in soil organic matter and nutrients. Consequently, maize yield during the first year after clearing which was 2.6 t/ha for MC, 3.8t/ha for SMC and 4.1t/ha for MA, decreased by 16 and 24% in SMC and MA during the second year. The lowest yield was observed in the MC plots. Mechanized clearing increased the variability of total N, and exchangeable Ca, Mg and Na but it decreased the variability of available phosphorus, exchangeable K, organic matter and soil texture. In general, broad-leafed weeds dominated during the first cropping cycle after clearing. In the second year, grass species (e.g. *Axonopus compresus* and *Eleusine indica*) began to emerge. This shift in native weed composition is often a principal cause of land abandonment and coincides closely with the period of depletion in soil fertility. None of the methods used for forest clearing showed any promise of sustainability in the long run. Therefore we recommend that once tropical forests are cleared for farming, conservation measures should be put in place to protect soil and stabilize crop yields. Economic and environmental considerations did not support mechanized approach to deforestation in tropical farming systems.

b) Characterization of agricultural wastes for recycling in organic farming systems

Presented at the Institute of Agricultural Modernization of the Chinese Academy of Science (November 23, 2004)

Summary

Organic waste products such as animal manure contain a large number of useful nutrients that are beneficial in organic farming systems. Animal manures are often processed for use by composting, during which organic matter is transformed into stable organic macromolecules of phenolic nature often referred to as humic substances. As a result, significant changes do occur in the content of the different constituent elements that may influence manure use for soil amendment and its disposal impact on the environment.

Chemical characterization of the changes during composting of soil-applied organic waste material is therefore necessary to clarify the nature of the organic matter and nutrients contained therein and predict their behavior on application to soils. From environmental perspective, it is important to reliably determine the availability of nutrients in waste products so that wastes can be diverted from landfill and recycled for

use as fertilizer and soil amendment. This should benefit farmers because such an efficient use could reduce mineral fertilizer requirements, especially for N, P and K.

During my study of commercial composting utilizing aerobic processes, the following parameters were measured in samples collected at different stages of composting: moisture content, temperature, total C, humic substance (HS) contents and fractions – fulvic acid (FA) and humic acid (HA), macro- and micro-nutrients. Total C and N declined by 18 and 10% in the final manure at the end of composting. During composting, HA became progressively, the dominant fraction of HS. Phosphorus increased by 31%, K by 12%, Mg by 11% and Ca by 6% respectively. The C/N ratio declined slightly from the initial value of 14.8 to 12.9 after the composting process. Among the micronutrients, the compost was highest in Fe and lowest in Cu content. Highly significant positive correlations were found between total N and HS, implying that HS may be the major determinant of N level in the manure. Zinc had significant positive correlations with HS and FA while Mn had a highly significant positive correlation with HA. Since the level of N tend to decline during composting, it might be necessary to supplement the manure with inorganic sources depending on soil nutrient status and crop requirement.

In a micro-scale study to compare aerobic and aerobic composting, total N decreased during aerobic composting, but it increased from 3 to about 4% under anaerobic conditions, because of the absence of losses in the form of ammonia and concentration effects due to a reduction in volume. Ammonium-N (NH_4-N) was the dominant inorganic N fraction, but the level fell below the maximum value of 400 mg/kg for a mature compost after 77d of aerobic composting. Total and exchangeable Na levels under anaerobic conditions exceeded those under aerobic conditions by 15 and 11%. Sodium concentration generally increased with time of composting, while the K content decreased with time under aerobic conditions. For Na and K, about 80 % of the total content was in exchangeable form. Conversely, about 85 % of total Ca and 90 % of total Mg in the composted manure were bound in organic fractions, as their presence in available form was relatively low. Marked increases in total Fe, Zn, Cu and Mn, especially under anaerobic conditions were noted during composting. In contrast, aerobic composting significantly decreased available Fe by 36%, Zn by 50%, Cu by 14% and Mn by 27% at 195d. The decreases were attributed to complexation with other ions and/or organic matter. The available Fe increased by 59% and Zn by 87%, while available Cu decreased by 16% and Mn by 22% under anaerobic conditions. Whereas 76 and 56% of the variations in available Fe and Zn were due to the changes in their total contents under anaerobic conditions, only 14 and 2% of such variations were so attributed under aerobic conditions. For available Cu and Mn, 65 and 39% of the variations in their levels under aerobic composting could be explained by the changes in total Cu and Mn compared with only 3 and 14% under anaerobic conditions. On the basis of these results, manures from sources such as anaerobic digesters may have a higher potential for metal, especially, Fe and Zn export to the environment upon application to soils. Factors other than total content may be responsible for the availability of Fe and Zn in aerobic compost. Since aerobically composted manure had low metal levels in available forms, it could ensure a slow release upon application to soils, which could be managed to synchronize with plant requirement.

c) Recycling livestock manure for rice production: potentials and problems identified from an experiment with four soils

Presented at the World rice research conference in Tokyo and Tsukuba, Japan, November (Nov. 7, 2004)

Summary

Understanding the effects of manure amendment on soil N mineralization is crucial for a better assessment of surface and underground water resources. Under laboratory conditions, surface (0 – 30 cm) samples of four soils: Andosol (A), red-yellow soil (RY), Masatsuchi (M) and Sandune soil (SD) were each treated with chicken manure (PM), cattle manure (CM), swine manure (SM), ostrich manure (OM) and urea, and incubated for 8 weeks at 25^{o}C. Nitrogen mineralization was studied in a 2 M KCl extract of samples collected at weekly intervals. Our observations showed that N mineralization differed according to soil and manure types. NH_4-N was the dominant fraction of mineral N during the early stages of incubation but appreciable increases in NO_3 (nitrification) levels were observed from the 7th week. The rate of net N mineralization was highest in urea-treated soils, and the priming effect of urea on soil N mineralization was noted across the soils. Nitrogen mineralization from manure-treated soils was very low, and in Andosol, CM and OM treatments exhibited negative N fertilizer effects. Ostrich and chicken manures significantly raised the pH of Masatsuchi and Sandune soils. Generally, the manures used in this study mineralized little N, suggesting low N fertilizer value in the short run, hence one should not over value their N effect. Of the four manure treatments investigated, net N mineralization was highest in PM, and the rate of mineralization did not correspond to the initial N content of the manures. When the manures and soils were evaluated for rice (*Oryza sativa*) growth and yield, the amended A and RY produced the best effects on all the rice parameters studied. However, the number of rice leaves were significantly more in RY than A. The manure effects on rice growth and biomass yield were ranked as CM > MM (CM+SM+PM) > SM > PM. The higher dry matter yield of rice in soils amended with CM and MM was attributed to better nutrient uptake and relatively lower levels of toxic factors they contained. Amending M and SD with manure significantly delayed seedling emergence during the first cropping. Masatsuchi amended with PM had lower shoot and root biomass during the first cropping cycle than even the control due to NH_4 toxicity. Although the manures contained significant amounts of plant-available nutrients which increased crop yields, they also left large residues of heavy metals in the soils. Averaged across soils, the level of extractable Fe in the soils increased by between 5% in PM and 71% in CM; Zn by between 312% in CM and 871% in SM; Mn by between 61% in PM and 172% in SM and Cu by between 327% in PM and 978% in SM. These results indicated a possible risk of trace element entering the food chain and contaminating crops, animals and water reserves. Therefore, the rate of application must be carefully regulated under commercial production, and possibly supplemented by conventional fertilizers as the soil and crop types may demand. In addition, a comprehensive nutrient management planning is suggested for protecting the environment.

Seminars

I presented the following informal seminars at the ALRC during the last 10 months:

1. Designing, conducting and reporting agricultural research
2. Agricultural production and research in Nigeria
3. Recycling of agricultural wastes in organic farming systems 1: processing and characterization
4. Recycling of agricultural wastes in organic farming systems 2: Soil nitrogen dynamics, plant growth and ecological problems

Other academic and research-related activities

In addition to the above, I carried out editorial work on numerous scientific documents, especially research manuscripts for staff and students of the ALRC and Faculty of Agriculture. I was also actively involved in advising graduate students on the design, analysis and interpretation of their data. This significantly improved the acceptance rates of their research information in relevant journals and books.

Title of articles

1. Eneji, A. E., S. Muranaka, S. Inanaga, T. Hattori, J. Li and P. An. Evaluating silicate treatments for plant growth in two moisture regimes. Arid Land Res. Mgt. (submitted)

2. Eneji, A. E., S. Muranaka, S. Inanaga, T. Hattori, J. Li and P. An. Comparison of silicon sources and nutrient relations among some species of the gramineae under deficit and adequate irrigation (in preparation).

3. Eneji, A. E., M. Irshad and S. Inanaga (2004). Agroforestry as a tool for combating soil and environmental degradation: examples from the tropics. Sand Dune Res. 51 (1):47-56.

4. Irshad, M, T. Honna, S. Yamamoto, T. Endo, A. E. Eneji and N. Yamasaki (2004). The effect of salt types on nitrogen release in manured soil. Sandune Res. 51(2): 67-72.

5. Inoue, T., S. Inanaga, Y. Sugimoto, P. An and A. E. Eneji (2004). Effect of drought on ear and flag leaf photosynthesis of two wheat cultivars differing in drought resistance. Photosynthetica 42 (4): 559-565.

6. Inanaga, S., Eneji, A. E., An, P. and Shimizu, H. 2004. A recipe for sustainable agriculture in drylands. Proceedings of the APGC 2004 conference in Tsukuba, Japan. Elsivier (in press).

7. Li, J. S. Inanaga, Z. Li, P. Wang and A. E. Eneji (in press). Optimizing irrigation scheduling for winter wheat in the North China Plain. Agri. Water Mgt. (accepted)

Results of research

Summary

Field water stress is a common feature among crops, especially in arid and semi-arid zones. Several field and greenhouse trials have shown that elemental silicon (Si) is beneficial to plants. However, results

from previous studies on the relationship between Si application and plant water use have been inconsistent. During the first part of this study, we designed a greenhouse experiment to examine the role of silicates in the drought tolerance, growth and nutrient relations in the following four grass species: Rhodes grass (*Chloris gayana* Kunth. Cv. Asatsuyu), Timothy grass (*Phleum pratense* L. cv. Kunpu), Sudan grass (*Sorghum sudanense* Piper. Cv. Beru Sudan) and Tall fescue (*Festuca arundinacea* Schreb. Cv. Southern cross). Two soil irrigation regimes: adequate irrigation at field capacity (6%) and deficit irrigation at half field capacity (3%) were used to compare the effects of three sources of silicates [silica gel, calcium silicate ($CaSiO_3$) and potassium silicate (K_2SiO_3)] applied at 2 Mg ha^{-1}. The chemical composition of these silicate sources were as follows: Calcium silicate (SiO_2-30%, MgO -5%, CaO - 40%); potassium silicate (K_2O - 20%, SiO_2-30%, MgO-5%, B_2O_3 -0.1%, CaO-6%) and silica gel containing 80% acid-soluble silicic acid and 20% residual H_2O. The responses of species varied according to silicate source; Rhode grass had the greatest response to silicate application and the response was best with either $CaSiO_3$ or K_2SiO_3 (117%). Sudan grass showed the highest biomass yield response (96%) with K_2SiO_3 but negative response with silica gel. Tall fescue showed a slight response (5.4%) only with K_2SiO_3 whereas Timothy grass exhibited a 13% yield response with silica gel and 24.5% response with K_2SiO_3. Overall, only K2SiO3 initiated positive yield responses across species, and may therefore be the recommended silicate for the sandy soil and grass species under study. Reasonable agreements were noted between Si uptake and P uptake in both adequate (r^2 =0.89) and deficit (r^2 = 0.82) irrigation treatments, indicating Si application favours P uptake possibly due to an increase in the water-soluble phosphorus in the soil. We are setting up a separate trial to prove this hypothesis. About 78 and 72% of nitrogen uptake was related with Si uptake under adequate and deficit irrigation treatments respectively. However, the uptake of Si under adequate water was poorly correlated with K uptake (r^2 = 0.29); under deficit water, the r^2 was as much as 0.56. Improvements in plant growth under deficit water conditions following Si application could therefore be linked to enhanced uptake of potassium. With adequate irrigation, K_2SiO_3 may yield greater biomass but $CaSiO_3$ may be preferred under deficit irrigation.

In another set of experiment, we studied the effect of direct application of variable rates (0, 2, 4 and 6 ton ha^{-1}) of Si as calcium silicate on the growth and water consumption by Rhode grass and Sudan grass in deficit and adequate moisture regimes. Here, the effect of Si on plant biomass was not significant as only the application rate of 6t/ha produced slightly more biomass than the control. The shoot and root dry mass varied significantly ($p<0.001$) only between irrigation and species treatments and their interactions. During the first cut, the shoot dry mass (SDM) was 5.7g/pot in the adequate irrigation, significantly exceeding that in the deficit irrigation by 68%. The mean SDM of Rhode grass was 5.2g/pot compared with 3.9g/pot for Sudan grass during the first cut. Plant water demand (PWD) decreased as the rate of Si increased, suggesting that the application of silicon could reduce drought stress and improve water economy. For the sandy soil under study, the reduction in PWD represents a water saving ranging from 7.6 to nearly 20%.

(5) Assistant Professor Levent Saylan

Visiting Assistant Professor (October 2004-September 2005)

Istanbul Technical University, Turkey

Title: *Investigation and comparison the energy, water and carbon dioxide exchanges of ecosystem in Japan*

Summary of research activities of 6 months (Oct. 1, 2004 to Mar. 31, 2005):

- Investigation of the related publications
- Investigation of the related research activities in the world
- Investigation of the CO_2 measurements and data analyzing techniques
    - Seasonal variation of CO_2 concentration
    - Seasonal distribution of Net Ecosystem Exchange, Gross Primary Productivity, TER (Ecosystem respiration) (daytime and nighttime)
- Analysis of Eddy Covariance (EC) approach and its applications on CO_2 and H_2O measurements
- Visiting the related research institute and scientists in Tsukuba, Ecosystem Gas Exchange Team, National Institute for Agro-Environmental Sciences for testing our CO_2 and H_2O sensor
- Investigation of calibration procedure of CO_2 and H_2O sensor
- Contact with the related scientists in the world
- Investigation of data gap filling methods (for the CO_2 measurements)
- Calculation of the fetch length and footprint source area for a possible experiment field and crop (for Eddy Covariance)
- Experiment design

Publications

Çaldağ, B. and **L., Saylan**, 2005. Sensitivity analysis of the CERES-Wheat model for variations in CO_2 and meteorological factors in northwest of Turkey, Int. J. Environ. Poll. (in press)

Toros, H., Deniz, A., **Saylan, L**., Sen, O. and M. Baloglu, 2003: Spatial Variations of Windchill in Turkey, Journal of Meteorology and Atmospheric Physics (accepted, in press, published online first)

Saylan, L., Ch. Bernhofer, F. H. Berger, T. Grünwald and B. Köstner, 2003, Growing season characteristics for a coniferous forest in Tharandt/Germany using CO_2-flux, satellite and meteorological data (It has been sent to the co-authors for their comments) (in preparation)

Proceedings

Çaldağ, B., **L. Saylan**, H. Toros, S. Sırdaş and F. Bakanoğulları, 2004. Drought

Analysis in northwest Turkey, Agroenvironment 2004 symposium, 20-24 October 2004, Udine, 169-179.

Toros, H., L. **Saylan**, B. Çaldağ, F. Bakanoğullari, O. Şen, and M. A. Gürbüz, 2004. Variations of the Rainwater pH and EC in northwest Turkey, Agroenvironment 2004 symposium, 20-24 October 2004, Udine, 735-739.

Erbek, F. S., M. Taberner, **L. Saylan**, Z. Aslan, D. Maktav, 2004. Soil moisture evaluation with multi temporal JERS radar data: A case study in the Turkgeldi Agricultural Administration Area, Thrace Region, Turkey, Agroenvironment 2004 symposium, 20-24 October 2004, Udine, 703-710.

Saylan, L., 2004, Agricultural meteorology of Turkey: Analysis and Evaluation, Agricultural Meteorology of Chugoku and Shikoku, No 17, Report of the Chugoku-Shikoku Chapter of the Society of Agricultural Meteorology of Japan, November 2004, in Arid Land Research Center, Tottori, 96-102.

Presentations in ALRC

Saylan, L., 2005, General Information about Turkey and Istanbul Technical University, 11 January 2005, 15.00-16.00, ALRC. Tottori University

Saylan, L., 2005, Agrometeorology of Turkey, 20 January 2005, 15:00-16:00, ALRC. Tottori University

Saylan, L., 2005, Potential impacts of climate change on agriculture in Turkey, 28 January 2005, 15:00-16:00, ALRC. Tottori University

Presentations in the other institutes

Şaylan, L., 2004, Agrometeorological situation in Turkey, 14 January 2005, 10:30-11:30 Ecosystem Gas Exchange Team, National Institute for Agro-Environmental Sciences, Kannondai 3-1-3, Tsukuba.

Title of a possible article

Estimation of CO_2 and H_2O exchanges in a grass field by using Eddy Covariance approach

Results of research

As above mentioned, the experiment has been designed during the first 6 months. In the second half of my stay, the necessary data for the study will be measured during the vegetation period of grass in Tottori.

(5) Professor John Gorham

Visiting Professor (January 2005-September 2005)

University of Wales, Bangor, the United Kingdom

Title: *Separation of evapotranspiration into transpiration and soil evaporation.*

Summary of research activities for 3 months (Jan. 5, 2005 to Mar. 31, 2005):

My research is based on the report (An *et al.*, 2002, Journal of Plant Nutrition 25: 407-423) of large differences in sodium and chloride concentrations in tissues of soybean varieties Dare and Tachiyutaka subjected to low or moderate salinity. Soybean is known to accumulate large amounts of chloride when subjected to salt treatment, and it may be possible to identify Quantitative Trait Loci (QTL) for this phenomenon using a mapping population derived from these varieties. In a similar exercise in rice (also a chloride accumulator) we identified a major QTL on chromosome 1 that controlled sodium and potassium concentrations in leaves, but found no QTL for chloride.

A physiological experiment was set up (with Dr. An and Ms. Li) to examine the effects of low salinity in solution culture on the solute composition of four varieties of soybean (Dare, Tachiyutaka, Lee and Tousan). Soybean is unusual in having a number of organic solutes that could act as cytoplasmic compatible or osmoprotectant solutes. These include the sugar alcohol, pinitol, the imino acid, proline, and the quaternary ammonium compound, trigonelline (nicotinic acid betaine). The second aim of the experiment is therefore to identify which of these solute(s) accumulates in response to a mild salinity stress.

Plants of the four soybean varieties (see above) have also been grown in pots for the production of F_1 hybrid seeds. The F_2 plants will be used for mapping the traits identified in the physiological experiments. A number of molecular markers are being tested for polymorphisms between the four varieties. These include, at present, 31 SSRs (microsatellites), one ISSR (Inter Simple Sequence Repeat) and 21 RAPD markers. The latter will also be used for RAF (Randomly Amplified DNA Fingerprinting).

Results of research

Preliminary data from the physiological experiment confirm that the American varieties Dare and Lee are more tolerant of salinity than Tachiyutaka and Tousan in terms of shoot growth and leaf chlorophyll contents. Inorganic ions are being analysed by ion chromatography. Another technique has been developed for analyzing sugars, sugar alcohols, amino acids and betaines on a Ca^{++}-form sugar HPLC column. (We thank Prof. Tamura for the use of this equipment).

Of the molecular markers tested so far, the SSR marker SAT_091 distinguishes Tachiyutaka from the other varieties, while SAT_036 and SATT014 differ between the American and Japanese varieties. Work on optimizing reaction conditions for the other primers continues.

Intended publications:

(1) Solute accumulation in soybean varieties differing in salt sensitivity. (in preparation)

(2) Sodium (chapter for Handbook of Plant Nutrition, eds.A. Barker and D.J. Pilbeam, Dekker, 2006) to be submitted March 2005.