

2.8 Activities of Post Doctoral Researchers

(1) Dr. Guang Wen

Refereed Journal Publications

1. Wen, G., Voroney, R.P., McGonigle, T.P., and Inanaga, S., 2003: Can ATP be measured in soils treated with industrial oily waste? *Journal of Plant Nutrition and Soil Science*, Germany. 166:724-730.

Soil samples were collected from a field with a long-term (10 yr) oily wastewater application history, containing 70 mg g⁻¹ of oil and grease and an accumulation of heavy metals, tillage and nitrogen (N) fertilization. Prior to ATP extraction, the soils were incubated at 22 °C and a water potential of -60 kPa for 21 d and 2 d for the long- and short-term trials, respectively. The light emitted from the bioluminescence reaction was partly quenched in the extract of autoclaved long-term waste treated soil, and curvilinearly responded to the addition of ATP at concentrations higher than 4 ng ATP per assay in contrast to the linear response from the pure extractant and the extract of control soil. Calibration curves developed from the extracts of autoclaved soils were used for calculating ATP in that given soil. ATP determined in the long-term treated soil was as high as 3201 ng g⁻¹ soil. Still, residual oil to ATP concentration ratio was about an order of magnitude higher in the long- than in the short-term waste treated soil, reflecting the accumulation of recalcitrant material. In the short-term treated soils, ATP ranged from 355 to 760 ng g⁻¹ soil, and responded to the rate of waste application, tillage and fertilization. The use of ATP measurement has potential for assessing land management effects and developing recommendation for enhanced biodegradation of the oil waste.

2. Wen, G., Schoenau, J.J., Charles, J.L., and Inanaga, S., 2003: Efficiency parameters of nitrogen in hog and cattle manure in the second year following application. *Journal of Plant Nutrition and Soil Science*, Germany. 166:490-498.

The efficiency of nitrogen (N) derived from different manures in the years following application must be determined to optimize use of N and reduce impact on the environment. Five N efficiency parameters that were originally developed for commercial inorganic N fertilizers were selected to measure the manure N efficiency in the second year following application of liquid hog and solid cattle manure in semiarid east-central Saskatchewan, Canada. The measures were applied at two sites (Dixon and Burr) at four rates covering a range from zero to 912 kg N ha⁻¹ in 1997. A canola (*Brassica napus* L.) crop was grown in 1997 followed by a spring wheat (*Triticum aestivum* L.) in 1998 without fertilization. Tested by the wheat, N utilization efficiency (NUE) was similar between the two manures at either site, but it was higher at Dixon site, where the soil properties were better, than at the Burr site (P<0.07) with cattle manure. Nitrogen physiological efficiency (NPE) was not affected by either manure source or soil. At the Burr site, N agronomic efficiency (NAE) and N recovery rate (NRR) were all higher with the hog than with the cattle manure (P<0.08 and P<0.07, respectively), but N harvest index (NHI) was lower with the hog than with the cattle manure (P<0.04). The similar trends of the NAE, NRR and NHI between the hog and cattle manure were also found at the Dixon site. However, the differences in NRR between the hog and cattle manure in the second year was rather small in contrast to the large differences in the year of application. Despite that

the wheat crop utilized residual hog and cattle manure N equally efficient in producing grain yield, an higher grain N concentration and a higher NHI with the cattle than with the hog manure revealed different N supply dynamics between the two. Possibly due to the low proportion of ammonium (NH₃)-N in the total N and the high C : N ratio in the cattle manure, mineralization of cattle manure N provided more available N in the later stage of wheat growth than did the hog manure. The N efficiency parameters were useful tools in understanding the impact of residual manure N on wheat production on the Canadian prairies.

3. Curtin, D. and Wen, G., 2004: Plant cation-anion balance as affected by the ionic composition of growing medium. *Plant and Soil*. (in press)

4. Mooleki, S.P., Schoenau, J.J., Charles, J.L., and Wen, G., 2004: Effect of rate, frequency and incorporation of feedlot cattle manure on soil nitrogen availability, crop performance and nitrogen use efficiency in east-central Saskatchewan. *Canadian Journal of Soil Science*. (in press)

5. Wen, G., Voroney, R.P., Inanaga, S., An, P., and Abe, J., 2004: Modification and application of a soil ATP determination method. *Soil Biology and Biochemistry*. (revised)

Accurate estimation of microbial adenosine 5'-triphosphate (ATP) is a pre-requisite to quantify the impact of varying environment on soil biomass activity. We investigated the effectiveness of a best claimed soil ATP determination method (PA) (Webster et al., 1984) in 10 Ontario (Canada) soils collected along a 100m transect and spanned a textural class gradient ranging from a sandy loam to clay loam with increased organic matter. Modifications of the method involved using the extract of autoclaved soil to make the standard curve, as it was found that the light emitted by ATP luciferin-luciferase bioluminescence reaction in the pure extractant was different from that in the light emission. On average, internal standard calibration method (ISM) measured a smaller amount of extracted ATP (1199 ng ATP g⁻¹ soil) and a lower recovery of ATP spike (82.4 ± 7.2%) than did the standard curve method (SCM) (126 ng ATP g⁻¹ soil and 91.2 ± 4.5%, respectively) (P<0.05 for both comparisons). However, the average total estimated ATP was higher with ISM (1474 ± 102 ng ATP g⁻¹ soil) than with SCM (1373 ± 88 ng ATP g⁻¹ soil) (P<0.07). While the recovery rates determined using SCM were consistent among the soils tested, the rates measured using ISM was negatively correlated with soil clay and organic matter content, implying that the later assay was affected by the soil properties. Our results confirmed that the recovery rates obtained by the PA method were the highest among those reported, when only SCM was used.

Seminar presented

1. "Use of organic wastes for plant production" at ALRC, June, 2003.
2. "Parameters of nitrogen in hog and cattle manure in Canadian prairies" at the Research Farm, College of Agriculture and Life Sciences, University of Tokyo, September 5, 2003.
3. "What is something we still have to know in thousands of years manure application practice and studies? – An example to explain philosophy in "INTRODUCTION" writing" at ALRC, November, 2003.
4. "Effectiveness of sulfur fertilizer in crop rotation" at the International Natural Farming Research Center, January 14, 2004.
5. "How to propose, define and verify a model: My experience with writing "A model of oxidation of an elemental sulfur fertilizer in soils" " at ALRC, January, 2004.

(2) Dr. Hidetoshi Mochizuki

Summary of research

Effects of water content, solute concentration, and temperature on thermal conductivity of sand and nonswelling clay

The main objective of this study is to clarify the effect of water content, NaCl concentration of soil solution, and temperature on thermal conductivity of sand and nonswelling clay. Thermal conductivities of Tottori dune sand and Kaolin, which is artificial nonswelling clay were measured under several water content, NaCl concentration, and temperature with heat probe method by KD2.

Thermal conductivities of the sand and the clay increased steeply in low water content range, gradually in middle and high range. This trend was common even among NaCl-affected samples at any temperature. Their thermal conductivities decreased linearly with NaCl concentration, especially in middle water content range. The higher was temperature, the greater was the decrease. Although thermal conductivity of NaCl-free samples were raised above 25 °C, those of NaCl-affected samples didn't change.

A new experimental formula was proposed to predict thermal conductivity of them, which is a function of water content, NaCl concentration, and temperature. As a result of the comparison between calculated thermal conductivity with that model and previous models, and measured one, it was possible to calculate thermal conductivity more easily and precisely than previous models.

Publications:

1. Fujikawa, T., Mochizuki, H., and Miyazaki, T., 2003: Soil Physical Properties of Fresh Volcanic Ash and Recovery of Agricultural Field in Miyake Island, *J. of JSIDRE*, 71(6), pp. 479-482 (in Japanese)
2. Mochizuki, H., Sakaguchi, I., and Inoue, M., 2003: Comparison of the Methods Measuring of Soil Thermal Conductivity, *J. Jpn. Soc. Soil Phys.*, 93, pp. 47-50 (in Japanese)
3. Mochizuki, H., Mizoguchi, M., and Miyazaki, T., 2003: Effects of Water Content and NaCl Concentration on Thermal Conductivity of Swelling and Nonswelling Clays, *Trans. of JSIDRE*, 225, pp. 55-61 (in Japanese)
4. Mochizuki, H., Sakaguchi, I., and Inoue, M., 2003: Effects of water content, sodium chloride concentration, and temperature on thermal conductivity of Tottori dune sand, The Japanese Society of Irrigation, Drainage and Reclamation Engineering. 2003 Annual meeting, pp. 238-239 (in Japanese)
5. Mochizuki, H., and Sakaguchi, I., 2003: Effects of Water Content, NaCl Concentration, and Temperature, on Thermal Conductivity of Sand, ASA-CSSA-SSSA Annual Meetings Abstract CD-ROM
6. Mochizuki, H., Mizoguchi, M., and Miyazaki, T., 2003: Thermal conductivity model of saline sand, Proceedings of the 2nd Asian Conference on Unsaturated Soils, pp. 399-402
7. Sakaguchi, I., Mochizuki, H., Inoue, M., and Inanaga, S., 2003: Latent heat transfer component of heat conduction in salt-affected nonswelling clay, 44th Japanese Society of Soil Physics Symposium, pp 54-55 (in Japanese)

(3) Dr. Naru Takayama

Summary of research

Climatic Feature of Rainfall in the Loess Plateau in China

We have researched on environmental monitoring to support anti-desertification activities in the Loess Plateau. In this thesis, the spatial distribution, the variance (stability) and the trend of annual precipitation were studied. In addition, the stability of precipitation in the summer rainy season was estimated from the viewpoint of seasonal feature of precipitation. As a result, it was clarified that the rainy season is not equally stable between in the east side and in the west side of the Loess Plateau, even if the annual precipitation is at the same level.

Research Activities

The loess plateau in China is semi-arid area located at E100° to 115° and N34° to 40°. About 70% of the annual precipitation is concentrated in the summer and loess soil is very highly erodible, so a steep gully is formed in Loess Plateau. I tried to construct model to estimate monthly precipitation over the Loess Plateau area by using routine meteorological data and digital elevation model (GTOPO30).

Publications:

Takayama, N., Kimura, R., Kamichika, M., Matsuoka, N. and Xingchang Z., 2003: Climatic Feature of Rainfall in the Loess Plateau in China. *J. Agric. Meteorol.*, (Submitted).

Takayama, N., Hayakawa, S. and Onomoto, S., 2004: Development of Frost Damage Prediction Technique Using Digital Elevation Model (DEM) in Air Temperature Estimation. *J. Agric. Meteorol.*, (Submitted).

National work shops and meetings

Takayama, N., Kimura, R., Kamichika, M. and Hayakawa, S., 2003: Feature of the nocturnal cooling on the mountainous region, and estimation of the amount of cooling. *Abstracts of Annual Meeting of the Society of Agricultural Meteorology of Japan* held in (Morioka City), 214.

Takayama, N., Kimura, R. and Kamichika, M., 2003: Feature of Rainfall in the Loess Plateau in China. *Abstracts of Annual Meeting of the Chugoku-Shikoku Chapter of the Society of Agricultural Meteorology of Japan* held in (Ehime City), 74-77.

(4) Dr. Hisashi Tomemori

Summary of research

Fundamental research for sustainable agricultural development in arid land was conducted.
(Recycling system of phosphate in soil-water by porous glass materials)

Phosphate which is increased by human activities is a key factor of eutrophication. In the meanwhile, phosphate is an essential element for normal growth of plants, and is applied to farmland as fertilizer to maintain high crop productivity. It is predicted that phosphate will be exhausted in 21st century. Therefore, the other phosphate resources are required.

We discovered that phosphate concentration in solution was decreased by coexistence of porous glass materials. In this research, we analyzed the mechanism which is the decrease of phosphate concentration by coexistence glass materials, and discussed the application of the removal of phosphate from water systems followed by the reuse of phosphate containing porous glass materials as fertilizers.

A part of this research is patent pending.
(Research and development of hydroponics systems)

In arid land, good-quality water for agriculture is difficult to get, and water causes the salt accumulation problem by irrigation in many cases. Then, I studied hydroponics systems which prevents problems such as salt accumulation, and which can be adapted for the arid area.

This topic is also studied the following year continuously.
(Examination activities)

A research on the actual condition of salt accumulation in the Loess Plateau of China was conducted.

(5) Dr. Yuanbo Liu

Summary of research

My research at ALRC includes:

1) Quantitative analysis of temporal factors on satellite images

Remote sensing is effective to monitor land surface change. Such effectiveness is complicated by various temporal factors such as sun position, satellite status and its position, and atmospheric conditions. Based on theoretical analysis, I simulated the effects of the temporal factors on Landsat TM images. Results showed that that temporal factors affect pixel values in either multiplicative or additive ways. For change detection study, in which spatial heterogeneity of the atmosphere is not yet concerned rigorously, absolute correction is equivalent to relative correction.

2) Predication of future water demand following global warming in arid area

I joined in the international research projects “Impact of climate changes on agriculture production system in arid areas” as a joint researcher. Cooperating with Prof. Yano, I analyzed GCM data and further used SWAP model to simulate the future water demand in the case of Turkey area. We generated climate scenarios based on both GCM and observed data. We found that, in the case of grass as a perennial crop, irrigation water increased significantly in Siverek as a result of the relatively large temperature rise in the created scenarios; but it did not increase in Adana due to the low temperature rise. In the case of maize as an annual crop, irrigation amount did not increase owing to the reduced growth period.

Publication

- 1) Liu, Y., Nishiyama, S., and Yano, T., 2003: Radiometric correction for change detection: analysis in bi-temporal space. *The International Archives of the Photogrammetry and Remote Sensing*. XXXIV-7/W14.
- 2) Liu, Y., Nishiyama, S., and Yano, T., 2004: Analysis of four change detection algorithms with a case study. *International Journal of Remote Sensing*. 25(11): 2121-2139
- 3) Liu, Y., Nishiyama, S., Yano, T., and Kusaka, T., 2004: Change detection in a forest well-maintained area using Landsat TM data. *Asian Journal of Geoinformatics*. 4(3):3-8.
- 4) Yano, T. and Liu, Y., 2004: Future change of water demand following global warming in arid area. *In: The Interim Report of ICCAP*. Kyoto : Research Institute for Human and Nature. Pp. 45-48
- 5) Liu, Y., Yano, T., Nishiyama, S., and Kimura, R., Radiometric correction for linear change detection techniques: analysis in bi-temporal space. *International Journal of Remote Sensing*. (in review)

Oral Presentation

- 1) Future change of water demand following global warming in arid area. Research Meeting of ICCAP. Kyoto: Research Institute for Human and Nature. Dec. 9-10, 2003.
- 2) Radiometric correction for change detection: analysis in bi-temporal space. ISPRS International Workshop on Monitoring and Modeling of Global Environmental Change. Oct. 21-22, 2003. Kyoto, Japan

(6) Dr. Satoru Muranaka

Summary of research

Evaluation of soybean root function reducing salt uptake

Reducing salt uptake is one of the characteristics of salt tolerant cultivars in non-halophyte crops including soybean. Although several functions contributing to this characteristic have been reported, the effectiveness of each function on cultivar difference in salt tolerance is not clear yet. Grafting was used to partition the shoot and root functions of a tolerant soybean cultivar (Lee) and two sensitive cultivars (Harosoy and Nakasennari) as they relate to salt uptake. All grafted plants with cultivar Lee as the root stock maintained high photosynthetic rate and growth under 60 mM NaCl treatment, despite the salt sensitivity of the scion. There was also a low sodium concentration in the leaves, indicating that the root of

Lee has high ability to reduce salt uptake to the shoot. The lower salt uptake rate of Lee was further demonstrated when energy transfer from shoot to root was interrupted by phloem cutting. These results show that a non-energy dependent function in the soybean root is accountable for cultivar differences in salt uptake rate and salt tolerance of Lee.

Publication:

Muranaka, S., and Inanaga, S., 2003: Non-energy dependent function inherent in soybean root is accountable for cultivar difference of salt uptake rate. *Root Research* 12: 211. (in Japanese)

(7) Dr. Ryoji Nakazawa

Summary of research

1. Mechanism of phosphate-adsorption by porous glass materials

Eutrophication in closed water system (such as lakes and ponds) has been progressed by human activities year after year. Phosphate is a key factor of eutrophication, and is released from human activities. On the other hand, phosphate is an essential element for normal growth of plants, and is applied to farmland as fertilizer to maintain high crop productivity. The shortage of phosphate deposits within 21st century is predicted. We have been investigating the agricultural use of “porous glass material”. As a result, we discovered the decrease in phosphate concentration in solution by coexistence of the porous glass material. Porous glass materials are recycling materials made from milled waste glass (including bottles etc.) and heat-degradable and gas-generating compounds (such as CaCO₃). Therefore, I analyzed the mechanism of the decrease in phosphate concentration by coexistence of porous glass material. Porous glass material was made from waste bottle glasses and shells of blue mussel (*Mytilus galloprovincialis*). Phosphate concentration in solution decreased by coexistence with porous glass material, and it is clarified that porous glass material adsorbs phosphate on the surface. The phosphate-adsorption was caused by calcium added as gas-generating compounds, and it implies the increase of calcium in the materials results in the increase of its phosphate-adsorption. Moreover, the phosphate-treated porous glass material contained phyto-available phosphate. From the results, it is suggested that phosphate in water systems can be removed by using porous glass material, followed by reuse of the phosphate-containing glass material as fertilizer.

2. Factors affecting the formation of water-stable aggregates with sandy soil

Improvement of soil properties is benefit for tree planting and food production in arid land. Especially, water conductivity and water-holding capacity should be improved in the land. To improve the two parameters simultaneously, the development of aggregates is useful. Especially, a water-stable aggregate that is not destroyed even by soaking is important for agriculture.

Several investigators reported the contributors of aggregates such as clay, humus, oligosaccharide, phenol compounds etc. It is speculated that these factors works as connector among bigger soil particles (such as sand and silt). However, the direct proof that those factors contribute to aggregates formation has not been reported. In addition, interactions between those factors in aggregates formation have not been determined.

Therefore, the degree of the contribution of those factors to aggregates formation compared quantifiably, and clarified the formation of water-stable aggregates with sandy soil.

I examined the effects of several reagents on the formation of water-stable aggregates with sandy soil. The findings indicated in this paper are as follows; 1) it is confirmed that water-stable aggregates is able to be formed even by using sandy soil as basic material. 2) It is suggested that oligosaccharide plays an essential role in the aggregates formation. 3) Clay synergistically interacts with oligosaccharide in the aggregates formation. It is suggested that clay is not able to contribute to aggregates alone, but it help the aggregates formation by oligosaccharide.

Publications:

- (1) Maeda, Y., Ota, T., Unno, H., Nakazawa, R., and Takenaga, H., 2003: Effects of calcium on reduction of salt-stress in seedlings sheep grass (*Aneurolepidium chinese*) and reed canarygrass (*Phalaris arundinacea* L.). Grassland Science, Vol.49, pp. 391 ~ 394
- (2) Wada, M., Hosaka, M., Nakazawa, R., Kobayashi, Y., and Hasegawa, T., 2004: The solubilization of unheated cattle Achilles tendon with actinidin under natural and acidic conditions. Food Science and Technology Research, Vol.10, pp.35 ~ 37
- (3) Nakazawa, R., Kameda, Y., Ito, T., Ogita, Y., Michihata, R., and Takenaga, H.: Selection and characterization of Ni-tolerant tobacco cells. Biologia Plantarum (in press)