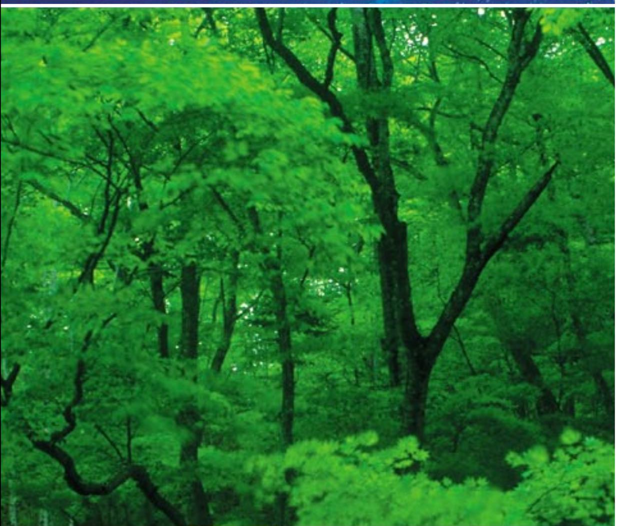
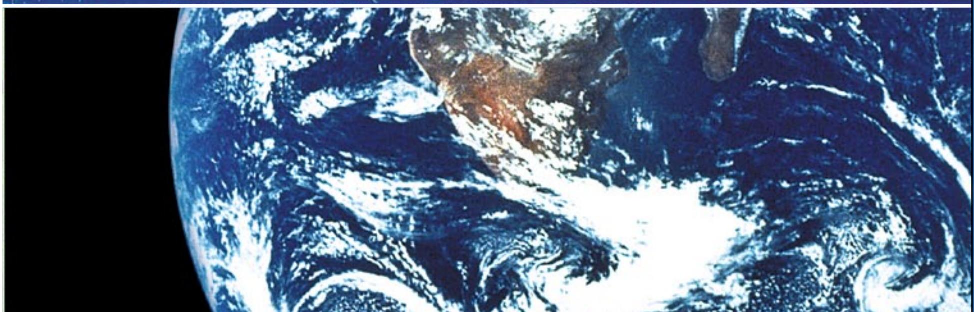
The 4th IWA-ASPIRE Conference & Exhibition

Toward Sustainable Water Supply and Recycling Systems

2nd Announcement

Call for Papers





2-6 October 2011

Tokyo International Forum, Tokyo, Japan

Organizer **The 4th IWA-ASPIRE Organizing Committee**

Co-Organizers
Bureau of Waterworks, Tokyo Metropolitan Government
Bureau of Sewerage, Tokyo Metropolitan Government
Japan Society on Water Environment
Japan Water Works Association
Japan Sewage Works Association

The 4th IWA-ASPIRE Conference & Exhibition

Welcome Message

The 4th IWA-ASPIRE Conference & Exhibition will take place in Tokyo, the capital of Japan, for five days from October 2 to 6, 2011.

The 21st century is called “the age of water.” Securing safe and sufficient water supplies and creating suitable water environment have become urgent issues worldwide. The Asia-Pacific region, also, needs to maintain and develop its sound water supply and recycling systems with the increasing population and the accelerating urbanization.

Under these circumstances, the main theme of the 4th IWA-ASPIRE Conference has been set as “Toward Sustainable Water Supply and Recycling Systems.” We believe that this conference will provide great occasions for experts in all water-related sectors including governments, academics, utilities and industries to gather together for making beneficial presentations and discussions in various fields in a timely manner and actively communicating with the various parties concerned. There will be session meetings, poster sessions, and workshops. Moreover, social events to allow the participants to exchange information in a relaxed atmosphere.

The Exhibition to be held at the same venue will present the latest technologies, products and services in a variety of areas, offering excellent opportunities for business exchanges.

We very much look forward to your participation in the 4th IWA-ASPIRE Conference & Exhibition.

【Co-chairs of the Organizing Committee】

Professor Shinichiro Ohgaki

Dr. Masaru Ozaki

Mr. Yoshihiko Misono

Program Outline

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<tr><td rowspan="3">3 October (Mon)</td><td rowspan="3">Opening Ceremony
Keynote Speech</td><td colspan="2">Session</td><td rowspan="3"></td></tr>
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<tr><td>Special Workshop</td><td colspan="2">Special Workshop</td></tr>
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<tr><td rowspan="3">5 October (Wed)</td><td>Session</td><td>Session</td><td rowspan="3">Closing Ceremony</td><td rowspan="3"></td></tr>
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Call for Papers

Key Dates

Abstract Submission Open
Early October, 2010

Abstract Submission Deadline
January 31, 2011

March 31, 2011 — **Authors notified of acceptance**
June 15, 2011 — **Full paper submission deadline**
June 30, 2011 — **Early bird registration deadline**

Abstract Submission Information

① Language

English

② Maximum Number of Words

500 words or less

③ Points to Note in Preparing Abstract

Abstracts are to be text only – no tables, diagrams, photographs, etc.

④ Conference Topics

Please select the field from below, and submit the abstract according to the chosen field.

(1) New Vision, Governance and Regulation
(2) Environmental Issues and Sustainability
(3) Environmental Sanitation and Health Related Issues
(4) Risk Management
(5) Finance and Efficient Management
(6) Education, Training and Capacity Building
(7) Customer Service / Communication
(8) Improvement of Revenue Water Ratio (Non Revenue Water Reduction, Leakage Prevention)
(9) Maintenance and Renewal of Facilities
(10) Instrumentation and Operation
(11) Water Quality Management
(12) Drinking Water Treatment
(13) Water Distribution and Supply Systems
(14) Wastewater Treatment
(15) Sewage and Industrial Wastewater Collection, Treatment and Management
(16) Small Scale Treatment Systems
(17) Water Reuse, Rainwater Harvesting
(18) Water Quality Monitoring and Modeling
(19) Water Resource Management and Protection
(20) Watershed Management and Eutrophication
(21) Wetland Systems
(22) Sludge Management and Resources Recovery

⑤ Abstract Submission Deadline

January 31, 2011

⑥ Abstract Submission Guidelines

- Abstracts are to be submitted online. Please follow the submission guidelines on the website-
  http://www.aspire2011.org/abst.html
- Abstracts can be submitted as “oral” or “poster”. Please note abstracts submitted as “oral” may get accepted as poster after peer review;Oral and poster presentations will be regarded equal status.

⑦ Others

- Non-members of IWA may be welcomed to submit abstracts.
- You may submit more than one abstract.
- You may amend or withdraw abstracts online until the submission deadline.
- Obtain consent from co-authors prior to submission.
- The official language of the conference is English. No simultaneous interpretation service will be available.

Presentation Selection

- Abstracts will be selected based on logicality, originality, novelty and benefit, etc.
- Papers for the purpose of advertising products will not be accepted.
- The decision on acceptance or non-acceptance will be made by the 4th IWA-ASPIRE Program Committee.

Events Following Abstract Submission

- When contributors are notified of their tentative selection into the program, they will be notified of the type of presentation they will be invited to give (i.e.“oral” or “poster”).
- For an oral presentation, please submit a full paper (eight A4 pages or shorter including all references, tables and figures) on or before the deadline (June 15, 2011).
- For a poster presentation, submission of a full paper is optional. Please submit a full paper, however, if the presenter wishes to publish the paper in IWA journals, etc.
- All the full papers accepted will be published on proceedings to all delegates who attend the conference other than the collection of abstracts.

Outstanding Papers

① Publication in Journals, etc.

Selected oral and poster papers, will be published in the following media after peer review:

- IWA journals
  - Water Science and Technology
  - Water Science and Technology : Water Supply
  - Water Practice and Technology, etc.
- “Journal of Water and Environment Technology,” electronic journal in English of the Japan Society on Water Environment

② Awards

- A student competition will be organized for the Best Student Awards.
- A poster competition will be organized for the Best Poster Awards.

For Call for Papers Information

The 4th IWA-ASPIRE Call for Papers Desk
c/o Japan Convention Services, Inc.
TEL : +81 3 3500 5935 (Mon.-Fri./9:30-17:30 JST)
FAX : +81 3 5283 5952
E-mail : abstract@aspire2011.org

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Oral Presentation Program

13:30 - Monday October 3

13:30 - 15:00 Monday October 3 12-1: Drinking Water Treatment Membrane (1)		Room : Hall B5 (1)
Co-chairs	Satoshi Takizawa (The University of Tokyo, Japan) Masaru Oneda (Tokyo Metropolitan Waterworks Bureau, Japan)	
Time	Session Code	Title/Authors
13:30-13:45	12-1-1	Comparison between Pre-treatment Methods in Water Purification Process Using NF-membrane Kazuhiro Ehara Tokyo Metropolitan Waterworks Bureau, Japan
13:45-14:00	12-1-2	Effect of Mixing-enhanced Preoxidation on Fouling Mitigation of Microfiltration in Groundwater Treatment Jr-Lin Lin, Chih-Pin Huang, Yao-Shian Wang National Chiao-Tung University, Taiwan
14:00-14:15	12-1-3	Performance of Hybrid MF Membrane Systems Using Polytetrafluoroethylene(PTFE) and Ceramic Membrane Ikuma Hayakawa[1], Hiroyuki Nishimura[1], Masayuki Hara[1], Yoshimitsu Komatsu[1], Iwao Tsuda[2], Masami Oya[2] [1]Osaka Municipal Water Bureau, Japan, [2]Hanshin Water Supply Authority, Japan
14:15-14:30	12-1-4	High Concentration PAC-MF System for Drinking Water Treatment at Low Temperature Cong Ma, Shuli Yu Harbin Institute of Technology, China,
14:30-14:45	12-1-5	A Study on the Effect of Feed Water Quality and Pretreatment on NF Membrane Fouling Chun-Hsi Lai, Yu-Heng Chen, Hsuan-Hsien Yeh Cheng Kung University School of Environmental, Taiwan
14:45-15:00	12-1-6	Application of CFD Simulation in the Design of Microfiltration System for Potable Water Treatment Heekyong Oh, Jungyeol Eom, Seounghun Kang, Heecha Yoo, Euisin Lee DAEWOO Institute of Construction Technology, Korea

13:30 - 14:45 Monday October 3 14-1: Wastewater Treatment Membrane Process		Room : Hall B5 (2)
Co-chairs	Taro Urase (Tokyo University of Technology, Japan) Masaki Takaoka (Kyoto University, Japan)	
Time	Session Code	Title/Authors
13:30-13:45	14-1-1	Development of Water Reclamation System from Treated Wastewater Using Ceramic Membranes Shinya Saito[1], Motoharu Noguchi[2], Michiko Aoki[1], Hideki Kozono[1] [1]Bureau of Sewerage Tokyo Metropolitan Government, Japan, [2]Metawater Co. LTD., Japan
13:45-14:00	14-1-2	Fouling of a Reverse Osmosis Membrane by Three Types of Surfactants Naoyuki Kishimoto, Honami Kimura Ryukoku University, Japan
14:00-14:15	14-1-3	Preliminary Experiment of Combined Sewer Treatment by Ceramic Membrane Masaaki Hinoue[1], Yuji Furuya[2], Norihide Nakada[1], Naoyuki Yamashita[1], Hiroaki Tanaka[1] [1]Kyoto University, Japan, [2]METAWATER Co., Ltd., Japan
14:15-14:30	14-1-4	Preparation of Single-walled Carbon Nanotubes/PVC Membrane and Its Antibacterial Property Fangbo Zhao[1], Feng Qiu[1], Xiaohui Zhang[2], Han-Shin Kim[3], Shuili Yu[4], Hee-Deung Park[3], Satoshi Takizawa[5] [1]Harbin Engineering University, China, [2]No 4 Hospital of Harbin Medical University, China, [3]Korea University, Korea, [4]Tongji University, China, [5]University of Tokyo, Japan
14:30-14:45	14-1-5	Separation of Oil/Water Emulsion Using Nano-particlesTiO_2/Al_2O_3PVDF UF Membranes and Evaluation of Fouling Mechanism Xuesong Yi[1], Shuili Yu[2], Wenxin Shi[1], Yong Wang[1], Nan Sun[1], Shuo Wang[1], Limei Jin[1], Cong Ma[1] [1]Harbin Institute of Technology, China, [2]Tongji University, China

9:00 - 10:30 Wednesday October 5
2-6: Environmental Issues and Sustainability
Environmental Water (2)
Room : G408

Co-chairs	Yosuke Matsumiya (Japan Sewage Works Association, Japan) Masahiko Sekine (Yamaguchi University, Japan)	
Time	Session Code	Title/Authors
9:00-9:15	2-6-1	Performance of Gracilaria Edulis Growth in Brackish Shrimp Pond Water Using Tank Culture System. Lavania Baloo, Mohd Fadhil Md Din, Shamila Azman, Akira Kikuchi, Haryati Jamaludin University of Technology Malaysia, Malaysia
9:15-9:30	2-6-2	Characterization of Microbial Community Dechlorinating PCP to Phenol with the Presence of Soil Chunfang Zhang, Lizhen Ye, Zhiling Li, Daisuke Suzuki, Toyoko Demachi, Arata Katayama Nagoya University, Japan
9:30-9:45	2-6-3	Benthic Remediation by Oxygenation of the Mixed Effluent from the Desalination Plant and the Sewage Treatment Plant Koreyoshi Yamasaki, Ryouich Watanabe, Hiroki Iyooka, Tomoko Minagawa Fukuoka University, Japan
9:45-10:00	2-6-4	Identification of Water and Nutrient Dynamics in Sweet Sorghum Plantation under Different Fertilizing Scenarios to Support Better Agro-ecological Management Krissandi Wijaya, Tasuku Kato, Koushi Yoshida, Keigo Noda, Hisao Kuroda Ibaraki University, Japan
10:00-10:15	2-6-5	Spatio-Temporal Quantification and Characterization of Drought Patterns in Bangladesh Kazi Akter[1], Md. Rahman[2] [1]University of Tokyo, Japan, [2]Bangladesh University of Engineering and Technology, Bangladesh
10:15-10:30	2-6-6	Microsensor Measurements of Seasonal Variations in Microbial Activities in Lake and Marine Sediments Lashitha Rathnayake[1], Hisashi Satoh[1], Shigeru Montani[1], Hideaki Maki[2], Masahiro Thakahashi[1], Satoshi Okabe[1] [1]Hokkaido University, Japan, [2]National Institute for Environmental Studies, Japan

9:00 - 10:30 Wednesday October 5
14-17: Wastewater Treatment
Monitoring and Modeling of Wastewater Treatment Processes
Room : G410

Co-chairs	Hiroki Itokawa (Japan Sewage Works Agency, Japan) Guanghao Chen (The Hong Kong University of Sciences and Techreology, Hong Kong)	
Time	Session Code	Title/Authors
09:00-09:15	14-17-1	Performance Evaluation of Wastewater Treatment Facilities by the Use of Activated Sludge Model (ASM) Takao Araki, Kaoru Kariya, Naofumi Furuyashiki, Kiyoshi Mizufune Tokyo Engineering Consultants, Japan
09:15-09:30	14-17-2	A Kinetic Expression for the Growth and Decay of Nitrite Oxidising Bacteria Bing Liu[1], Daisuke Naka[1], Ian Jarvis[1], Rajeev Goel[2], Hidenari Yasui[1] [1]The University of Kitakyushu, Japan, [2]Hydromantis Environmental Software Solutions, Inc., Canada
09:30-09:45	14-17-3	A Metabolic Model for Aerobic Biological Degradation of Long-chain Fatty Acids Yuki Ishizaki[1], Daisuke Naka[1], Rajeev Goel[2], Hidenari Yasui[1] [1]The University of Kitakyushu, Japan, [2]Hydromantis Environmental Software Solutions, Inc., Canada
09:45-10:00	14-17-4	Model Development of Sponge Carrier Process Using CFD-DEM with Permeable Particles Magnus So[1], Daisuke Naka[1], Rajeev Goel[2], Hidenari Yasui[1] [1]The University of Kitakyushu, Japan, [2]Hydromantis Environmental Software Solutions, Inc., Canada
10:00-10:15	14-17-5	Treatment Performance of Domestic Sewage in a Full-scale Oxidation Ditch with Dual DO Control Technology Taku Fujiwara[1], Xiaoqiang Chen[2], Kazuo Nakamachi[3], Toshikazu Hashimoto[4], Yukio Kawaguchi[4], Hiroshi Tsuno[5] [1]Kochi University, Japan, [2]EhimeUniversity, Japan, [3]Maezawa Industries, Inc, Japan, [4]Japan Sewage Works Agency, Japan, [5]Kyoto University, Japan
10:15-10:30	14-17-6	Feed forward Air Volume Control System for GHG Reduction in Wastewater Treatment -Development of New Air Volume Control System by Monitoring Electric Conductivity as an Indicator of Water Quality- Mayuko Takahashi, Kazuki Furusawa Bureau of Sewerage, Tokyo Metropolitan Government, Japan

11:00 - 12:30 Wednesday October 5 **2-8: Environmental Issues and Sustainability** **Others**		Room : G408
Co-chairs	Krissandi Wijaya (Ibaraki University, Japan) Liew Wai Loan (Universiti Teknologi Malaysia, Malaysia)	
Time	Session Code	Title/Authors
11:00-11:15	2-8-1	Water Supply Business Alongside Environmental Challenges Tetsuya Murakami Yokohama Waterworks Bureau, Japan
11:15-11:30	2-8-2	"Win-Win Approach" in New Cooperation between Water Wholesaler and Retailer Akihiro Miyagawa, Masuhiro Hamamoto, Shinji Ito Hiroshima City Waterworks Bureau, Japan
11:30-11:45	2-8-3	Energy Assessment of a New Water Management System Nishimura Shunsuke, Masashi Ogoshi, Ayako Miyamoto National Institute for Land and Infrastructure Management, Japan
11:45-12:00	2-8-4	Analysis of Climate Change and Its Effect on the Tokyo Waterworks Yoichi Yamamoto, Norio Arai, Kenta Furukawa, Chihiro Takamatsu Tokyo Metropolitan Waterworks Bureau, Japan
12:00-12:15	2-8-5	Evaluation of the Earth Plan 2004 and Action in the Future Toshifumi Sasaki, Masaki Ishiguro Bureau of Sewerage, Tokyo Metropolitan Government, Japan
12:15-12:30	2-8-6	Pollutant Discharge Reductions with the "Soft Interventions" in Households and Natural Purification Effects in the River Sections Yoshiaki Tsuzuki[1], Yoneda Minoru[2] [1]Shimane University, Japan, [2]Kyoto University, Japan

11:00 - 12:15 Wednesday October 5 **14-20: Wastewater Treatment** **Enhanced Biological Phosphorus Removal**		Room : G410
Co-chairs	Toshiaki Saito (Nihon University, Japan) Atsuko Michinaka (National Cheng Kung University, Taiwan)	
Time	Session Code	Title/Authors
11:00-11:15	14-20-1	Selected Interactions between Methane Recovery from Wastewater Sludge and Phosphorus Removal Stanislaw Rybicki, M. Cimochowicz-Rybicka Cracow University of Technology, Poland
11:15-11:30	14-20-2	The Least Squares Method for the Titrimetric Determination of the Concentration of VFAs Soo Koon Lee, Hak Koon Yeoh, Adeline Seak May Chua, Gek Cheng Ngoh University of Malaya, Malaysia
11:30-11:45	14-20-3	The Comparative Characterization on dPAO in SBR Hansaem Lee, Yun Zuwhan Korea University, Korea
11:45-12:00	14-20-4	Effects of High Phosphorus Loading on Enhanced Biological Phosphorus Removal Process under Shorter SRT Chih-Hsun Hsu, Wei-Chin Chang, Jian-Jyun Chen, Jhong-Syun Wu National Yunlin University of Science and Technology, Taiwan
12:00-12:15	14-20-5	Influence of External Carbon Source and Behavior of Cation for Phosphorus Removal Efficiency Phosphorus in BNR Process Kyung-Sok Min, Yoon-Mi Choi, Koo-Ho Kwon, Si-Won Kim, Tae-Woo Lee, Si-yeol Bae Kyungpook National University, Korea

Identification of Water and Nutrient Dynamics in Sweet Sorghum Plantation under Different Fertilizing Scenarios to Support Better Agro-ecological Management

K. Wijaya*, T. Kato*, K. Yoshida*, K. Noda* and H. Kuroda*

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Abstract
Materials budget in the sweet sorghum plots with various fertilizations has been quantified to confirm the effectiveness of the crop in reducing excessive nutrient loads and producing biofuel. Through the experiment on the three replicated plots (18 m^2) of the KCS-105 cultivar with digested-sludge- (SF), chemical- (CF), and no-fertilizer (NF) each, in which the SF dosage was equalized to the CF one (120 kgN ha^{-1}; 107 kgP ha^{-1}; 120 kgK ha^{-1}), at the FS Centre of Ibaraki University, Japan from July to Dec. 2010, we found that materials balance at each compartments, except soil and percolation zone, were not significantly different among the treatments. In average, 40 and 38% of the total water, 23 and 75% of the total N, and 3 and 97% of the total P input were respectively uptaken by the crop and percolated, and only 22% (water) and 0.1-2.3% (nutrients) were leached by the runoff. The high percolated nutrients attributed to the rainstorms during Sep.-Oct. (10-40 mm h^{-1}) involving the soil with high total porosity (70%) and saturated hydraulic conductivity (18.8 mm h^{-1}). Although the brix were similar among the treatments, the peak crop height and coverage at the SF plot were 5-30% higher than others.

Keywords
Sweet sorghum; water and nutrients balance; crop uptake; organic sludge fertilizer, agro-ecological management

INTRODUCTION

Excessive nitrogen and phosphorous induced by agricultural activates over aquatic environment has been of major concern among researchers as well as stake holders to be identified and remedied for sustainable ecosystem since both are the most potential eutrophication sources. It arises mainly from their exaggerated fertilisation on soils susceptible to leaching through the extreme surface and sub-surface flow mainly during rainstorm events that might be essentially affected by certain land uses such as type of tillage and cover crops (Yang et al., 2009). The negative implication may also contribute to rising nitrogen dioxide emission, one of the hazardable greenhouse gasses, to the atmosphere causing climate change and global warming (Jungkunst, et al., 2006), in which the impact is about three hundred times higher than carbon dioxide.

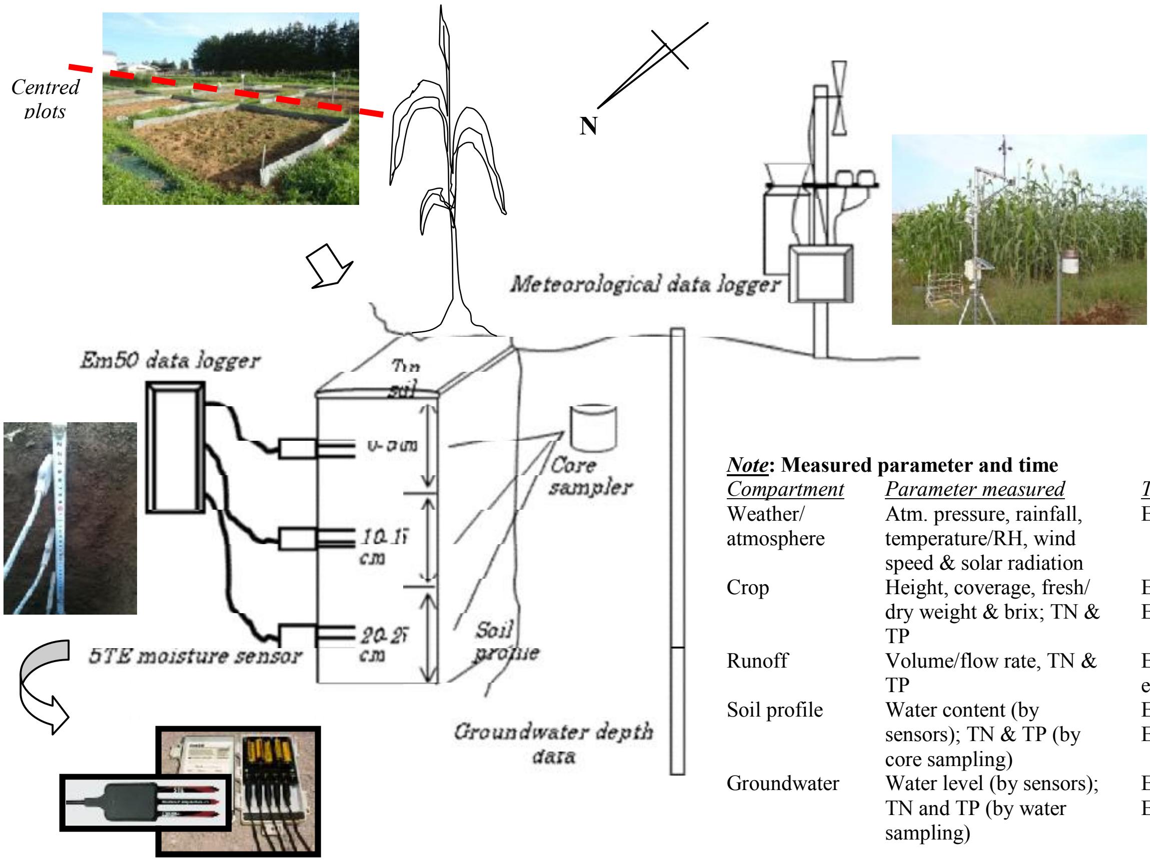
Sweet sorghum becomes worldly popular as an alternative energy crop producing high sugar content for biofuel (Curt et al., 1995). The crop has also good characteristics in wide adaptability, drought resistance, water logging tolerance, saline resistance, and high yield of biomass for feeds, so that it can be cultivated, as rotation crop for sugar cane in some tropical countries, at non-irrigable and dry land where the others are less resistance into drought (Habyarimana et al., 2004; Farre and Faci, 2006). Furthermore, Yoshida et al. (2010) reported that the crop is effective in up-taking water and nitrogen respectively up to 60 and 80% depending on the seeding and fertilisation time. This provides basic information for further studies as well as practical efforts in developing appropriate bioremediation technology to minimize the excessive nutrients, mainly nitrogen and phosphorus, contamination on ecological environment within wider and complex system.

The objective of this study was to quantify water, nitrogen, and phosphorus budget at the sweet sorghum cropping plots under various fertilizer treatments including digested-sludge, chemical, and no-fertilizer. The study complements and confirms the previous Yoshida et al. (2010) findings, of which the research was performed with the single type of fertilizer applied.

MATERIALS AND METHODS

Experimental site and field monitoring

A number of the water and nutrient balance-related parameters including soil water content, groundwater level, surface runoff volume, meteorological and phenological characteristics were monitored at the sweet sorghum cropping plot of the FS Centre of Ibaraki University, Japan (a clay loam Humic Allophane soil/Haludands, Haplic Andosolos; Table 1) during a cultivation period from July to December 2010. Following the soil tillage with approximately 25 cm in depth, three replicated sub-plots (numbered from the left as P1-P3, P4-P6, and P7-P9; 18 m^2 in large each) with three fertilizer treatments such as digested-sludge- (SF), chemical- (CF), and no-fertilizer (SF) were prepared (Figure 1). The dosage of the SF was equalized to that of the CF, i.e., 120 kgN ha^{-1}, 107 kgP ha^{-1}, and and 120 kgK ha^{-1}. The KCS105 cultivar of the sweet sorghum (SS) crop was sowed at the plots with 0.8 m x 0.15 m in interval. Each plot was bordered by the acrylic sheets to avoid overland flow from surroundings, and the three southern sub-plots (i.e., P1, P2, and P3) were equipped with outlet pipes and runoff collectors.



***Note*: Measured parameter and time**

Compartment	*Parameter measured*	*Time*
Weather/ atmosphere	Atm. pressure, rainfall, temperature/RH, wind speed & solar radiation	Every hour
Crop	Height, coverage, fresh/ dry weight & brix; TN & TP	Every week; Every month
Runoff	Volume/flow rate, TN & TP	Every rainfall event
Soil profile	Water content (by sensors); TN & TP (by core sampling)	Every hour; Every month
Groundwater	Water level (by sensors); TN and TP (by water sampling)	Every hour; Every week

Figure 1. Schematic diagram of the field data collection at the sweet sorghum plot

Table 1. Soil physical properties of the Filed Science Centre, Ibaraki University, Japan

Parameters	Unit	Value
Texture (sand : silt : clay) (Humic Allophane/*Haplic Andosolos*)	g g^{-1}	0.51 : 0.31 : 0.18
Bulk density	g cm^{-3}	0.74
Total density	g cm^{-3}	2.45
Total porosity	%	70
Organic matter	%	16
Saturated hydraulic conductivity	mm d^{-1}	451

Soil water content at the three centred plots (i.e., P4, P5, and P6) and control point with 5, 15, and 25 cm in depth was measured and monitored by the moisture sensors (P4 and P5: Decagon's ECH_2O-10 sensors and HOBO data logger; P6 and control: Decagon's 5TE sensors with Em50 data logger). Groundwater levels of the plots were monitored by HOBO's water logger, while the surface runoff flows were measured at every rainfall events by the collectors. The meteorological parameters including atmospheric pressure, rainfall, temperature, relative humidity, wind speed, and solar radiation were monitored by HOBO's weather station. Furthermore, total nitrogen (TN) and phosphorus (TP) are sampled from all compartments monitored such as crop, surface runoff, soil profile, and groundwater (parameters and its sampling schedule are tabulated in the *Note* of Figure 1). The samples were then analyzed in laboratory respectively by the Automatic Total Nitrogen Analyzer (TN-308P), Yanako and the U-2800 Spectrophotometer, Hitachi.

Water and nutrients budget calculation

Water budget was determined by quantifying the incoming and outgoing water flux into soil profile or crop root zone over certain period of time. Rainfall (P) and irrigation (I) add water to the root zone, and part of them might be lost by runoff (R) and deep percolation (Pc) toward groundwater. The water in the root zone might be also depleted to the atmosphere by evapotranspiration (ET). Thus, the change in water budget within soil profile (ΔS_w) can be calculated by Equation (1). Accordingly, the change in nutrients (i.e., nitrogen and phosphorus) load within soil profile can be determined by Equation (2).

$$\Delta S_w = P_w + I_w - R_w - Pc_w - ET_w \tag{1}$$

$$\Delta S_n = P_n + I_n + F_n - R_n - Pc_n - Up_n \tag{2}$$

where, P_w, I_w, R_w, Pc_w, and ET_w is the added or depleted water respectively by the rainfall, irrigation, runoff, percolation, and evapotranspiration, while P_n, I_n, F_n, R_n, Pc_n, and Up_n is the nutrient load respectively by the rainfall, irrigation, fertilizer application, surface runoff, percolation, and crop uptake. The ET was determined by comparing the change in soil water content (ΔS_w) and the actual evapotranspiration (ET_o) by Penman-Monteith, in which if the former is superior to the latter, the ET was equalized to the ET_o instead of ΔS_w, and vice versa.

RESULTS AND DISCUSSION

Water budget

Although the soil water contents were insignificantly different among the treatments (i.e., 0.49-0.55 cm^3 cm^{-3}), their temporal changes particularly at the top layer of 0-20 cm were sensitively affected by the rainfall (Figure 2). The high portion in the total pore space (70%) as well as the saturated hydraulic conductivity (451 mm d^{-1}) (Table 1) within the root zone might be the reason for the sensitiveness (Miyazaki, 1996), since they might quickly enhance the water recharge into the soil profile encouraging the sudden increase in the groundwater level up to 5-10 cm below the soil surface particularly at the rainstorms during Sep.-Oct (Figure 3A). Accordingly, the runoff rate at the same period was less sensitive to the rainfall compared to the formers (Figure 3B). It revealed that both soil physical parameters has essential role in controlling the runoff as well as deep percolation (Pagliai and Sequi, 1981; Wijaya et al., 2010).

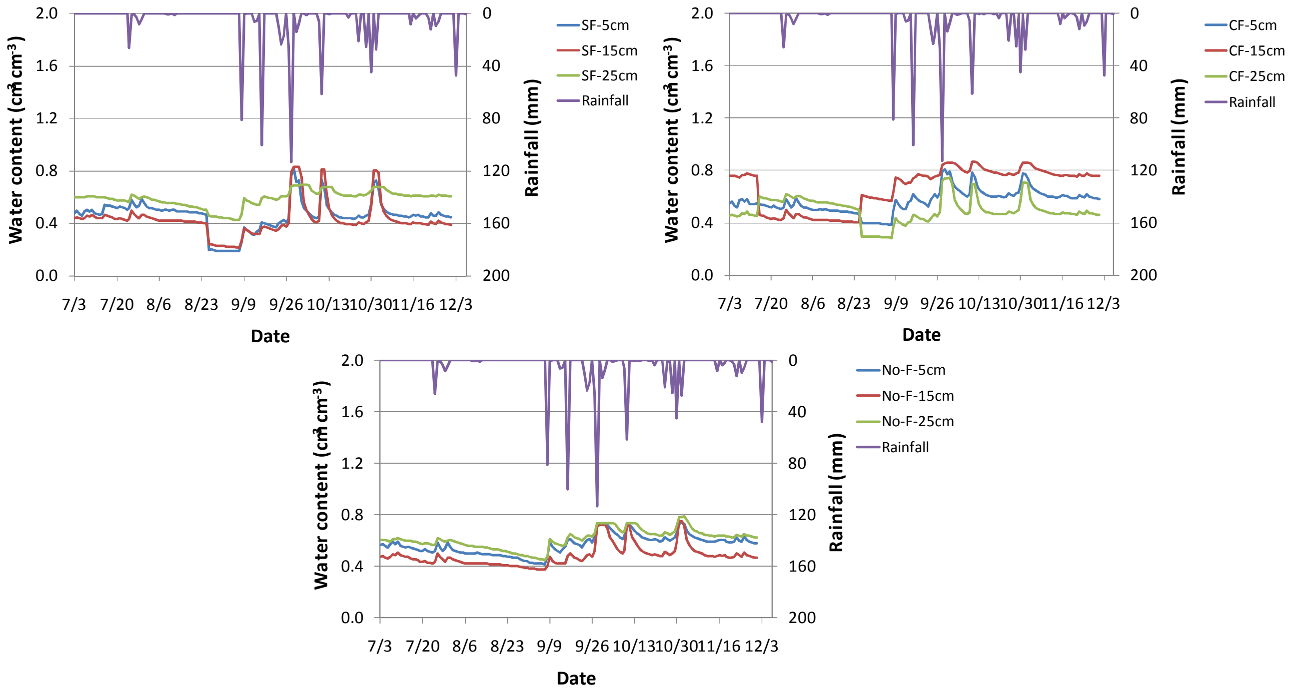


Figure 2. Change in soil water content at the sweet sorghum plot

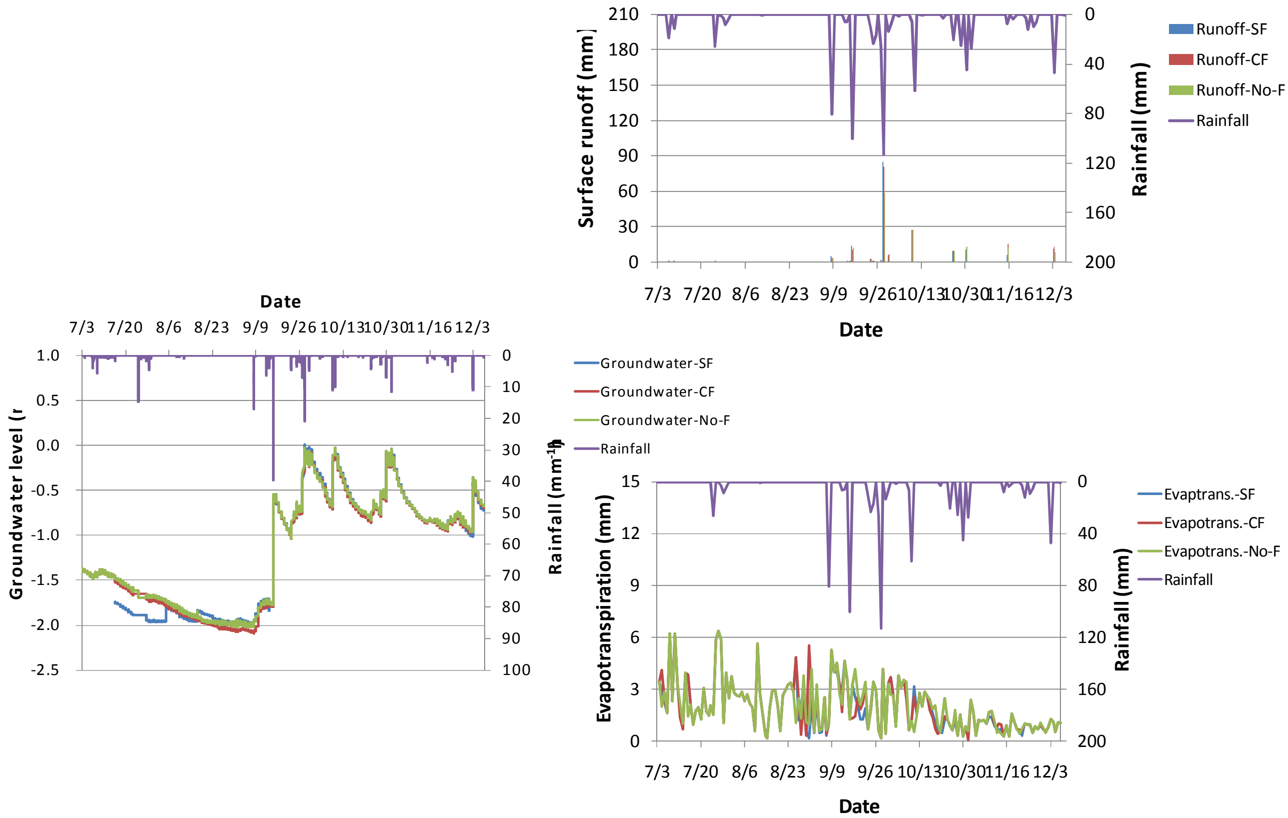
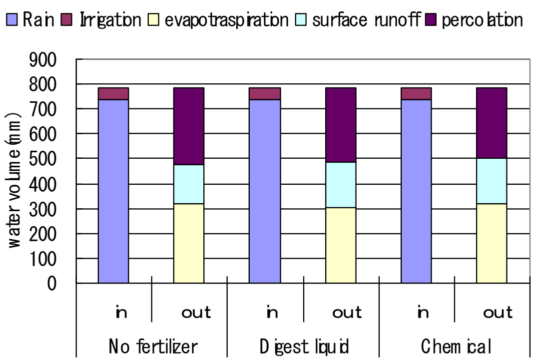
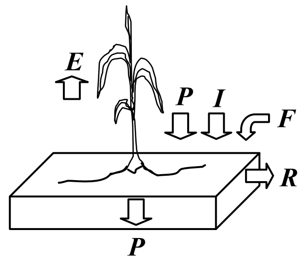


Figure 3. Change in groundwater (A), runoff (B), and ET (C) at the sweet sorghum plot

The water uptakes were similar among the treatments (Figure 3C, 4) and strongly correlated to the soil water content (Figure 2). At the initial stage of 0-65 days after sowing (DAS), 60% of the ET required water was supplied from the soil, and the remaining was sufficed by the irrigation. It indicated that the water supply might be major limiting factor for the crop growth at the initial stage (Curt et al., 1995; Farre and Faci, 2006). In overall, the water budget, of which 40%, 24%, and 36% of 830 mm in total water input throughout cultivation period were respectively depleted by ET, runoff and percolation, was identified (Figure 4 and its *Note*).





Note: **Tabulated water budget for the sweet sorghum (mm)**

Plot	*Rain*	*Irr.*	*ET*	*Runoff*	*Perc.*
SF	783.73	46	303.64	180.40	300.70
CF	783.73	46	318.94	184.38	281.41
No-F	783.73	46	317.48	158.35	308.90

Figure 4. Water budget at the sweet sorghum plot under three fertilizer treatments

Nutrient budget

The soil TN and TP were gradually decreased at each plot at the initial stage of 0-70 DAS, and then remained constant at the flowering to maturity stage of 70-140 DAS (Figure 5). Specifically, the decrease in CF was highest (59 kgN ha^{-1}; 132 kgP ha^{-1}), followed by SF (32 kgN ha^{-1}; 112 kgP ha^{-1})

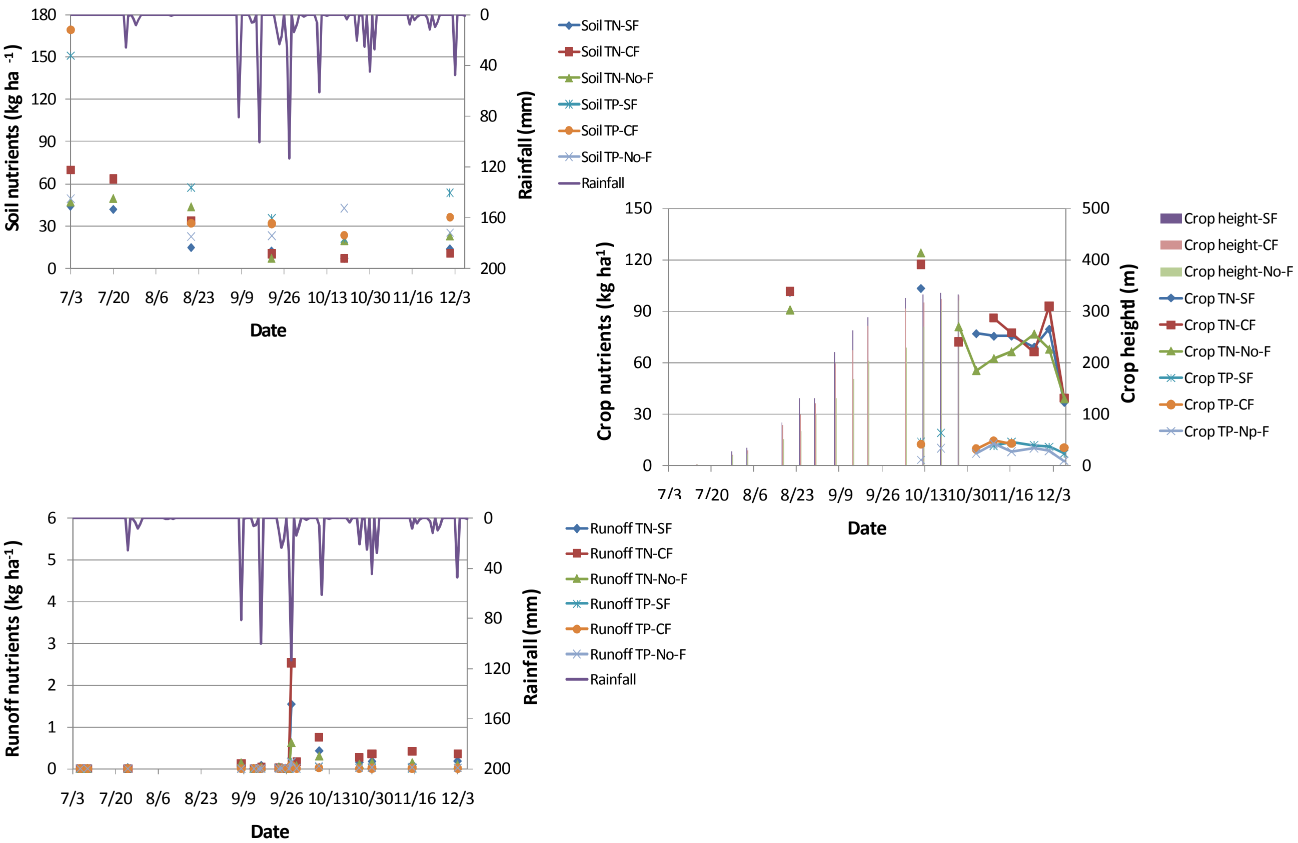
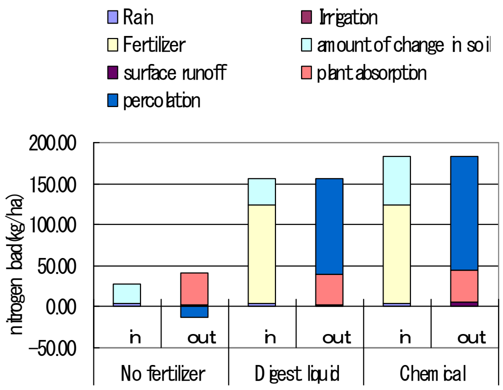


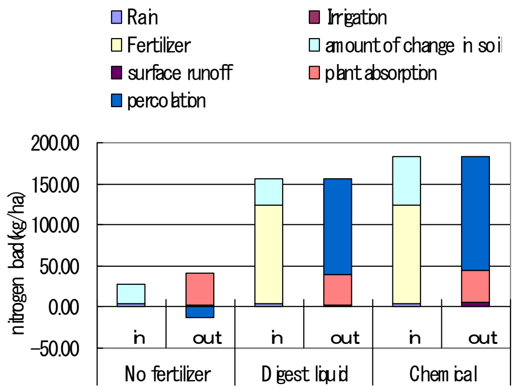
Figure 5. Change in soil (A), runoff (B) and crop (C) nutrients at the sweet sorghum plot

and No-F plot (24 kgN ha^{-1}; 16 kgP ha^{-1}). The losses in overall might attributed to either the increasing crop uptake at the initial stage (23% TN; 3% TP) or particularly the extreme percolation during the rainstorms (74% TN; 96% TP), and irrelevant to the runoff (3% TN; 0.9% TP). This agreed respectively with van Oosterom et al. (2010) clarifying the significant nutrients uptake in the sweet sorghum at the vegetation stage, and with (Yang et al., 2009) observing the extreme nutrients losses during the unusual rainstorms.



Note: **Tabulated nitrogen budget for the sweet sorghum (kg ha^{-1})**

Plot	*Rain*	*Irr.*	*Fertz.*	*Soil*	*Uptake*	*Runoff*	*Perc.*
SF	3.71	0.29	120	-31.55	37.20	2.93	115.43
CF	3.71	0.29	120	-58.64	39.40	5.10	138.14
No-F	3.71	0.29	0	-24.46	39.07	1.73	-12.33



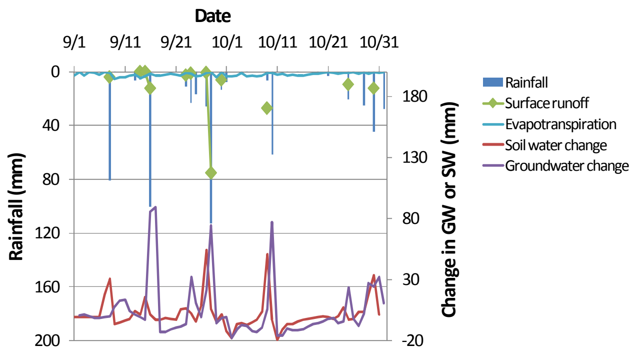
Note: **Tabulated phosphorus budget for the sweet sorghum (kg ha^{-1})**

Plot	*Rain*	*Irr.*	*Fertz.*	*Soil*	*Uptake*	*Runoff*	*Perc.*
SF	0.22	0.15	107	-111.98	7.09	0.33	213.03
CF	0.22	0.15	107	-132.21	10.59	0.18	232.88
No-F	0.22	0.15	0	-15.84	2.89	0.40	12.50

Figure 6. TN (A) and TP (B) budget at the sweet sorghum plot under three fertilizer treatments

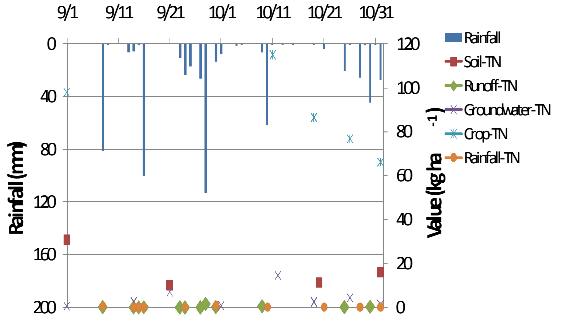
Rainstorm

The nutrients losses induced by the runoff and other related processes, in which the rainfall intensity at the unusual storm events is considered to be the most key factor leading to such depletion, has been investigated (Hussein, 1996; Hollinger et al., 2001; Yang et al., 2009). According to this study,



Note: **Tabulated water and nutrients budget during the rainstorm**

		Water budget (mm)	TN budget (kg ha^{-1})	TP budget (kg ha^{-1})
INPUT	*Rain*	600.4	2.5	0.2
	Irr.	-	-	-
	Fertz.	-	107.4	104.7
OUTPUT	*Runoff*	151.6	2.8	0.3
	Perc.	335.3	55.7	95
	Uptake	-	66.3	8.5
Change in Soil		113.5	-14.8	1.12
Groundwater		286.4	34.0	6.2
In-Outflow		-48.9	-21.7	-88.8



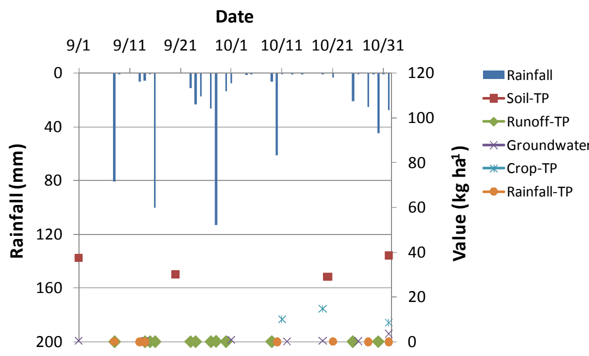


Figure 7. Change in water (A), TN (B) and TP (C) at the sweet sorghum plot during the rainstorms

the rainstorm of 61.4-113 mm d^{-1} (11-39.4 mm h^{-1}) occurred at least four times during Sep.-Oct. 2010 and enhanced the significant losses of nitrogen and phosphorus particularly by the percolation (45% TN; 88%TP) and subsurface flow (18% TN; 83%TP) (Figure 8 and its *Note*). The latter was considered as the In-Outflow of the shallow groundwater that received the water recharge from the rainstorm percolation with the total porosity of 0.15 (assumed; Table 1). This agreed with Kolenbrander (1981) study of which the leached nitrogen increases up to 20-25% when the water surplus (rainfall minus ET) reaches ≥475 mm at soil water ≥60 cm. The extreme percolation and subsurface flow losses was predominantly due to the high saturated conductivity (3.6-57.6 mm h^{-1}) as well as the low dry bulk density (0.67-0.82 g cm^{-3}) of the soil (Figure 9) allowing the nutrients to be easily drained from the soil and shallow groundwater mainly during the rainstorms (Yang et al. 2009).

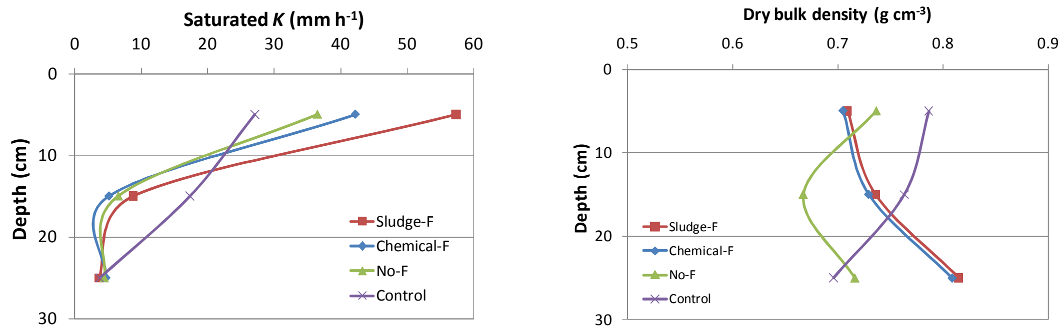


Figure 8. Saturated hydraulic conductivity (A) and dry bulk density (B) of the sweet sorghum soil

Growth and yield of the sweet sorghum

Among the treatments, the heights of the crop was similar at 30-35 DAS, and then increased until its peak (80-90 DAS) at which those of the SF was respectively 6 and 30% higher than those of CF and No-F plot (Figure 9A). The SF crop was superior in its land coverage (91.4%) compared to the CF (91.1%) and the No-F crop (85.8%) (Figure 9B). As consequence, the fresh and dry biomass of the former (50.3; 11.1 t ha^{-1}) was higher than others (CF: 46.5; 10.4 t ha^{-1} and No-F: 33.3; 7.8 t ha^{-1})

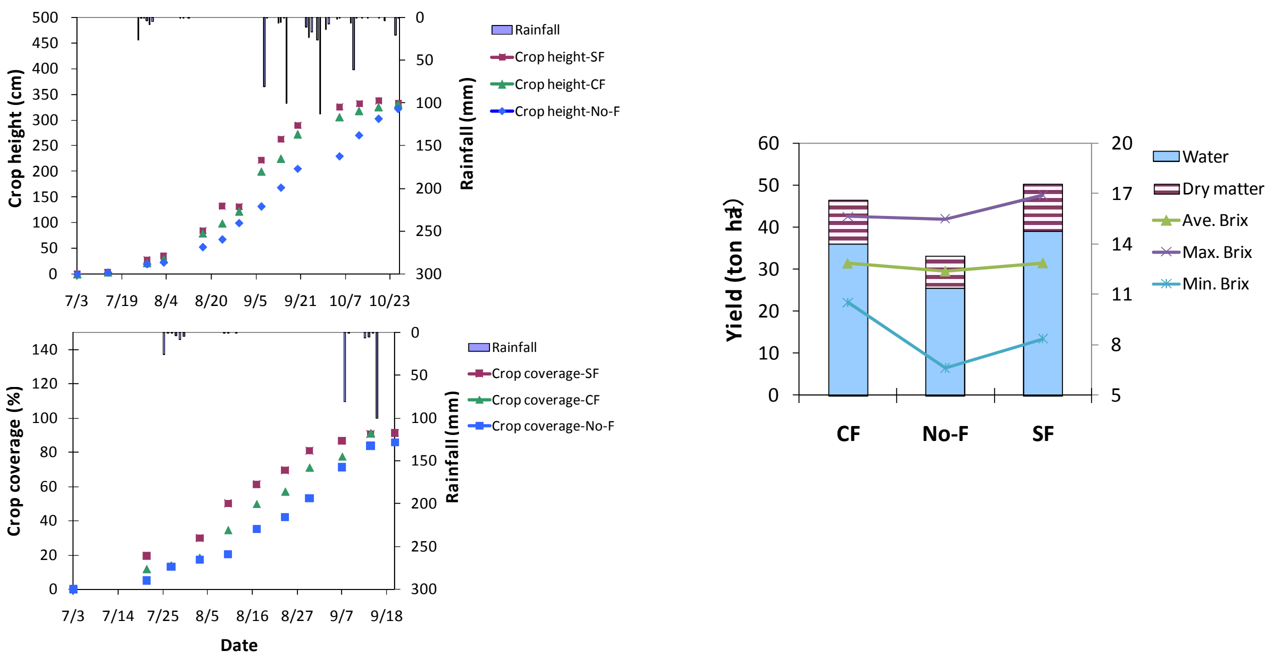


Figure 9. Height (A), coverage (B), and harvested (157 DAS) biomass weight and brix (C) of the sweet sorghum crop under three fertilizer treatments

(Figure 9C), but their brix were in average not different (SF: 12.9; CF: 12.9; No-F:12.4). This revealed that the treatments effects most on the vegetative growth (Nemeth, 2009), and they have no direct impact on the sugar content, except at different harvesting stage (Almodares et al., 2007).

CONCLUSIONS

Water and nutrients budget at the sweet sorghum plots with three fertilizer treatments such as SF, CF, and No-F were confirmed. In general 76% of the total water supplied at the plots was depleted by the ET and percolation, while the remaining was drained by the runoff. The high losses of the formers were respectively due to the active crop uptake at the initial stage and the unusual rainstorms on the plot with high portion of the soil pore space well as saturated hydraulic parameters contributing to the sensitive change in the shallow groundwater level. As consequence, the losses of the nutrient applied by the percolation and subsurface flow particularly at CF and SF plot were extremely high compared to others. The total and dry biomass weights were affected by the treatments, but the sugar content was not. Regarding the whole results, the appropriate schedule for the sowing/harvesting and fertilizer application to avoid the potential nutrients losses at the rainstorm and also to yield the good quality of biofuel are essential for the sustainable sweet sorghum cultivation as well as for better agro-ecological system.

Acknowledgement

This study was supported the Ibaraki University Bio-fuel Society (IBOS) Project under the Ministry of the Environment of Japan. We thank to Ms. Arisa Tani and Ms. Saki Hashimoto, also other members of Laboratory of Water Environment Restoration Engineering, Ibaraki University, Japan for their helps and supports in conducting the experiment.

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Fw: (IWA-ASPIRE) Abstract No. 00399 Accepted

1 message

Krissandi Wijaya <kwijaya77@yahoo.com> Mon, Apr 11, 2011 at 8:22 AM
To: "Dr. Kato" <tkato@mx.ibaraki.ac.jp>
Cc: "Dr. Yoshida" <ayoshid@mx.ibaraki.ac.jp>, "Dr. Noda" <anod@mx.ibaraki.ac.jp>, "Prof. Kuroda" <kuroda@mx.ibaraki.ac.jp>, kwijaya77@gmail.com

Dear Kato-sensei,
(Cc: Yoshida-sensei, Noda-san, Kuroda-sensei)

Here I would like to forward the acceptance letter of our abstract (attached PDF file) to be presented as an oral presentation at the 4th IWA-ASPIRE Conference in Tokyo. The full paper are now being prepared and would be sent to you later to meet your reviews and comments.

Yoroshiku onegaitashimasu.

With best regards,
Sandy

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Dear Dr. Krissandi Wijaya,

Thank you for your abstract submission to the 4th IWA-ASPIRE Conference & Exhibition which will be held on Oct 2 - 6, 2011 at Tokyo International Forum, Tokyo, Japan.
It is our pleasure to inform you that your abstract below has been accepted for an Oral presentation at the 4th IWA-ASPIRE:

Presentation Style: Oral Presentation
Abstract Submission No: 00399
Abstract Title: Identification of Water and Nutrient Dynamics in Sweet Sorghum Plantation under Different Fertilizing Scenarios to Support Better Agro-ecological Management

The presentation schedule will be decided by the 4th IWA-ASPIRE Program Committee, and notified to you by e-mail. We plan to contact presenters around the end of June 2011.

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College of Agriculture, Ibaraki University

Presented at the 4th IWA-ASPIRE Conference & Exhibition October 2nd-6th, 2011 in Tokyo, Japan.

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Presentation Date: 5 October, 2011

Presentation Title: Identification of Water and Nutrient Dynamics in Sweet Sorghum Plantation under Different Fertilizing Scenarios to Support Better Agro-ecological Management

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Identification of Water and Nutrient Dynamics in Sweet Sorghum Plantation under Different Fertilizing Scenarios to Support Better Agro-ecological Management

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Abstract
Materials budget in the sweet sorghum plots with various fertilizations has been quantified to confirm the effectiveness of the crop in reducing excessive nutrient loads and producing biofuel. Through the experiment on the three replicated plots (18 m^2) of the KCS-105 cultivar with digested-sludge- (SF), chemical- (CF), and no-fertilizer (NF) each, in which the SF dosage was equalized to the CF one (120 kgN ha^{-1}; 107 kgP ha^{-1}; 120 kgK ha^{-1}), at the FS Centre of Ibaraki University, Japan from July to Dec. 2010, we found that materials balance at each compartments, except soil and percolation zone, were not significantly different among the treatments. In average, 40 and 38% of the total water, 23 and 75% of the total N, and 3 and 97% of the total P input were respectively uptaken by the crop and percolated, and only 22% (water) and 0.1-2.3% (nutrients) were leached by the runoff. The high percolated nutrients attributed to the rainstorms during Sep.-Oct. (10-40 mm h^{-1}) involving the soil with high total porosity (70%) and saturated hydraulic conductivity (18.8 mm h^{-1}). Although the brix were similar among the treatments, the peak crop height and coverage at the SF plot were 5-30% higher than others.

Keywords
Sweet sorghum; water and nutrients balance; crop uptake; organic sludge fertilizer, agro-ecological management

INTRODUCTION

Excessive nitrogen and phosphorous induced by agricultural activates over aquatic environment has been of major concern among researchers as well as stake holders to be identified and remedied for sustainable ecosystem since both are the most potential eutrophication sources. It arises mainly from their exaggerated fertilisation on soils susceptible to leaching through the extreme surface and sub-surface flow mainly during rainstorm events that might be essentially affected by certain land uses such as type of tillage and cover crops (Yang et al., 2009). The negative implication may also contribute to rising nitrogen dioxide emission, one of the hazardable greenhouse gasses, to the atmosphere causing climate change and global warming (Jungkunst, et al., 2006), in which the impact is about three hundred times higher than carbon dioxide.

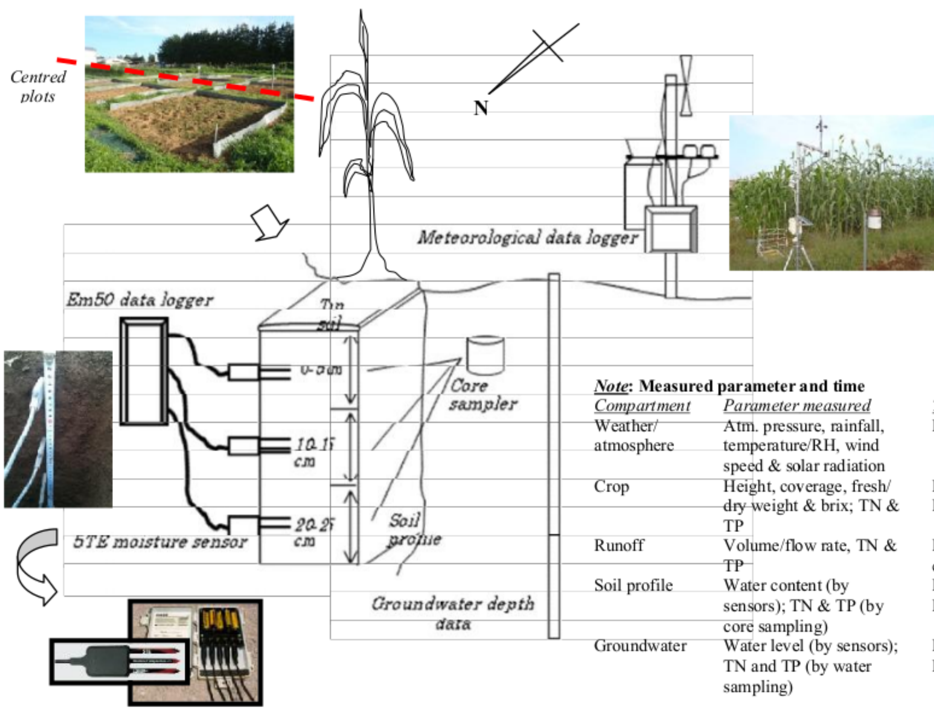
Sweet sorghum becomes worldly popular as an alternative energy crop producing high sugar content for biofuel (Curt et al., 1995). The crop has also good characteristics in wide adaptability, drought resistance, water logging tolerance, saline resistance, and high yield of biomass for feeds, so that it can be cultivated, as rotation crop for sugar cane in some tropical countries, at non-irrigable and dry land where the others are less resistance into drought (Habyarimana et al., 2004; Farre and Faci, 2006). Furthermore, Yoshida et al. (2010) reported that the crop is effective in up-taking water and nitrogen respectively up to 60 and 80% depending on the seeding and fertilisation time. This provides basic information for further studies as well as practical efforts in developing appropriate bioremediation technology to minimize the excessive nutrients, mainly nitrogen and phosphorus, contamination on ecological environment within wider and complex system.

The objective of this study was to quantify water, nitrogen, and phosphorus budget at the sweet sorghum cropping plots under various fertilizer treatments including digested-sludge, chemical, and no-fertilizer. The study complements and confirms the previous Yoshida et al. (2010) findings, of which the research was performed with the single type of fertilizer applied.

MATERIALS AND METHODS

Experimental site and field monitoring

A number of the water and nutrient balance-related parameters including soil water content, groundwater level, surface runoff volume, meteorological and phenological characteristics were monitored at the sweet sorghum cropping plot of the FS Centre of Ibaraki University, Japan (a clay loam Humic Allophane soil/Haludands, Haplic Andosolos; Table 1) during a cultivation period from July to December 2010. Following the soil tillage with approximately 25 cm in depth, three replicated sub-plots (numbered from the left as P1-P3, P4-P6, and P7-P9; 18 m^2 in large each) with three fertilizer treatments such as digested-sludge- (SF), chemical- (CF), and no-fertilizer (SF) were prepared (Figure 1). The dosage of the SF was equalized to that of the CF, i.e., 120 kgN ha^{-1}, 107 kgP ha^{-1}, and and 120 kgK ha^{-1}. The KCS105 cultivar of the sweet sorghum (SS) crop was sowed at the plots with 0.8 m x 0.15 m in interval. Each plot was bordered by the acrylic sheets to avoid overland flow from surroundings, and the three southern sub-plots (i.e., P1, P2, and P3) were equipped with outlet pipes and runoff collectors.



***Note*: Measured parameter and time**

Compartment	*Parameter measured*	*Time*
Weather/ atmosphere	Atm. pressure, rainfall, temperature/RH, wind speed & solar radiation	Every hour
Crop	Height, coverage, fresh/ dry weight & brix; TN & TP	Every week; Every month
Runoff	Volume/flow rate, TN & TP	Every rainfall event
Soil profile	Water content (by sensors); TN & TP (by core sampling)	Every hour; Every month
Groundwater	Water level (by sensors); TN and TP (by water sampling)	Every hour; Every week

Figure 1. Schematic diagram of the field data collection at the sweet sorghum plot

Table 1. Soil physical properties of the Filed Science Centre, Ibaraki University, Japan

Parameters	Unit	Value
Texture (sand : silt : clay) (Humic Allophane/*Haplic Andosolos*)	g g^{-1}	0.51 : 0.31 : 0.18
Bulk density	g cm^{-3}	0.74
Total density	g cm^{-3}	2.45
Total porosity	%	70
Organic matter	%	16
Saturated hydraulic conductivity	mm d^{-1}	451

Soil water content at the three centred plots (i.e., P4, P5, and P6) and control point with 5, 15, and 25 cm in depth was measured and monitored by the moisture sensors (P4 and P5: Decagon's ECH$_2$O-10 sensors and HOBO data logger; P6 and control: Decagon's 5TE sensors with Em50 data logger). Groundwater levels of the plots were monitored by HOBO's water logger, while the surface runoff flows were measured at every rainfall events by the collectors. The meteorological parameters including atmospheric pressure, rainfall, temperature, relative humidity, wind speed, and solar radiation were monitored by HOBO's weather station. Furthermore, total nitrogen (TN) and phosphorus (TP) are sampled from all compartments monitored such as crop, surface runoff, soil profile, and groundwater (parameters and its sampling schedule are tabulated in the *Note* of Figure 1). The samples were then analyzed in laboratory respectively by the Automatic Total Nitrogen Analyzer (TN-308P), Yanako and the U-2800 Spectrophotometer, Hitachi.

Water and nutrients budget calculation

Water budget was determined by quantifying the incoming and outgoing water flux into soil profile or crop root zone over certain period of time. Rainfall (*P*) and irrigation (*I*) add water to the root zone, and part of them might be lost by runoff (*R*) and deep percolation (*Pc*) toward groundwater. The water in the root zone might be also depleted to the atmosphere by evapotranspiration (*ET*). Thus, the change in water budget within soil profile (ΔS_w) can be calculated by Equation (1). Accordingly, the change in nutrients (i.e., nitrogen and phosphorus) load within soil profile can be determined by Equation (2).

$$\Delta S_w = P_w + I_w - R_w - Pc_w - ET_w \tag{1}$$

$$\Delta S_n = P_n + I_n + F_n - R_n - Pc_n - Up_n \tag{2}$$

where, P_w, I_w, R_w, Pc_w, and ET_w is the added or depleted water respectively by the rainfall, irrigation, runoff, percolation, and evapotranspiration, while P_n, I_n, F_n, R_n, Pc_n, and Up_n is the nutrient load respectively by the rainfall, irrigation, fertilizer application, surface runoff, percolation, and crop uptake. The *ET* was determined by comparing the change in soil water content (ΔS_w) and the actual evapotranspiration (ET_o) by Penman-Monteith, in which if the former is superior to the latter, the *ET* was equalized to the ET_o instead of ΔS_w, and vice versa.

RESULTS AND DISCUSSION

Water budget

Although the soil water contents were insignificantly different among the treatments (i.e., 0.49-0.55 cm^3 cm^{-3}), their temporal changes particularly at the top layer of 0-20 cm were sensitively affected by the rainfall (Figure 2). The high portion in the total pore space (70%) as well as the saturated hydraulic conductivity (451 mm d^{-1}) (Table 1) within the root zone might be the reason for the sensitiveness (Miyazaki, 1996), since they might quickly enhance the water recharge into the soil profile encouraging the sudden increase in the groundwater level up to 5-10 cm below the soil surface particularly at the rainstorms during Sep.-Oct (Figure 3A). Accordingly, the runoff rate at the same period was less sensitive to the rainfall compared to the formers (Figure 3B). It revealed that both soil physical parameters has essential role in controlling the runoff as well as deep percolation (Pagliai and Sequi, 1981; Wijaya et al., 2010).

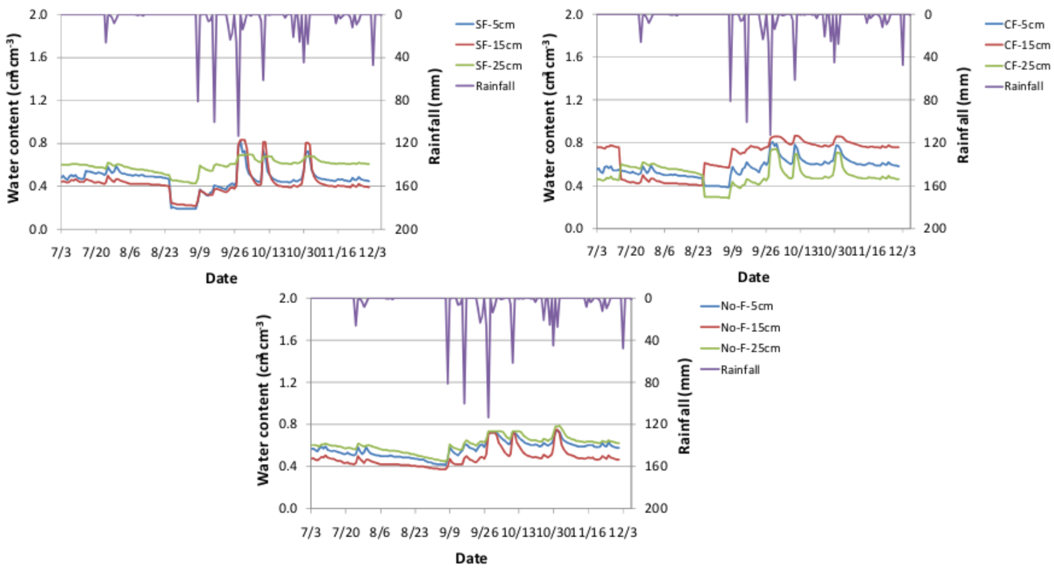


Figure 2. Change in soil water content at the sweet sorghum plot

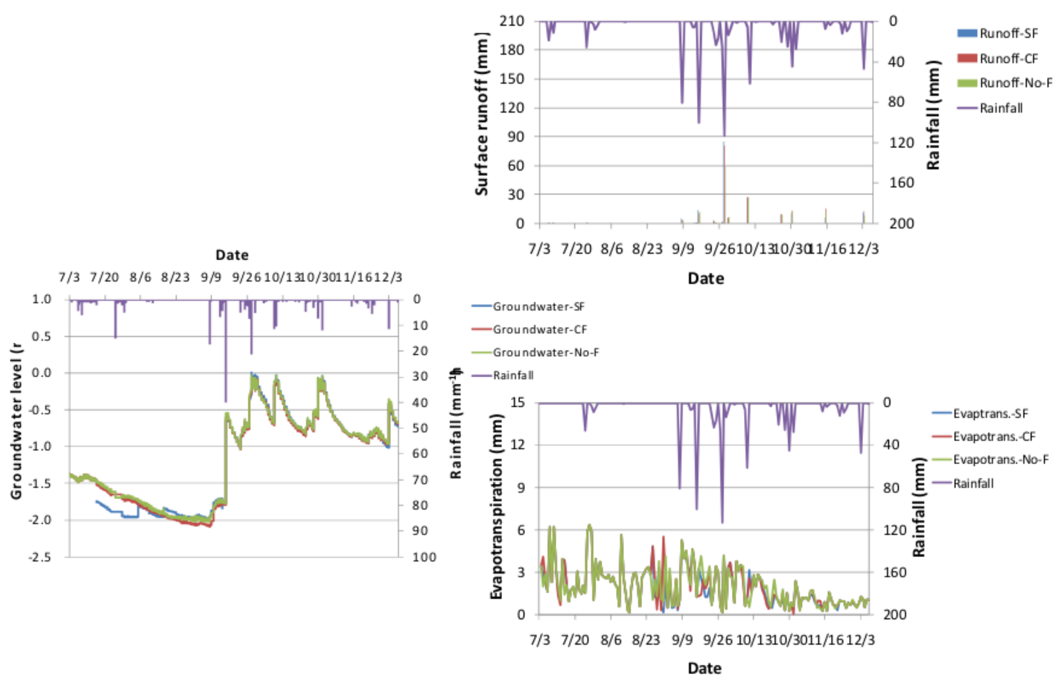
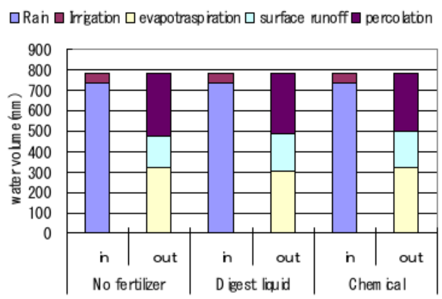
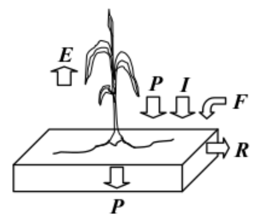


Figure 3. Change in groundwater (A), runoff (B), and ET (C) at the sweet sorghum plot

The water uptakes were similar among the treatments (Figure 3C, 4) and strongly correlated to the soil water content (Figure 2). At the initial stage of 0-65 days after sowing (DAS), 60% of the ET required water was supplied from the soil, and the remaining was sufficed by the irrigation. It indicated that the water supply might be major limiting factor for the crop growth at the initial stage (Curt et al., 1995; Farre and Faci, 2006). In overall, the water budget, of which 40%, 24%, and 36% of 830 mm in total water input throughout cultivation period were respectively depleted by ET, runoff and percolation, was identified (Figure 4 and its *Note*).





Note: **Tabulated water budget for the sweet sorghum (mm)**

Plot	*Rain*	*Irr.*	*ET*	*Runoff*	*Perc.*
SF	783.73	46	303.64	180.40	300.70
CF	783.73	46	318.94	184.38	281.41
No-F	783.73	46	317.48	158.35	308.90

Figure 4. Water budget at the sweet sorghum plot under three fertilizer treatments

Nutrient budget

The soil TN and TP were gradually decreased at each plot at the initial stage of 0-70 DAS, and then remained constant at the flowering to maturity stage of 70-140 DAS (Figure 5). Specifically, the decrease in CF was highest (59 kgN ha^{-1}; 132 kgP ha^{-1}), followed by SF (32 kgN ha^{-1}; 112 kgP ha^{-1})

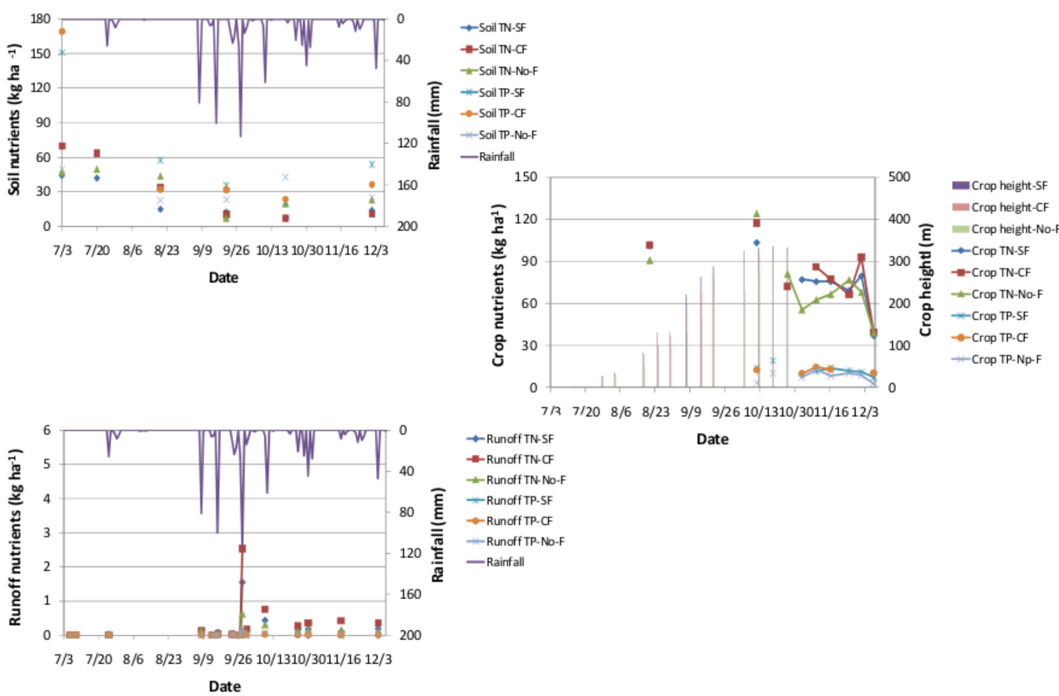
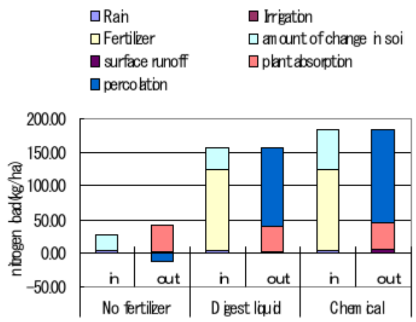


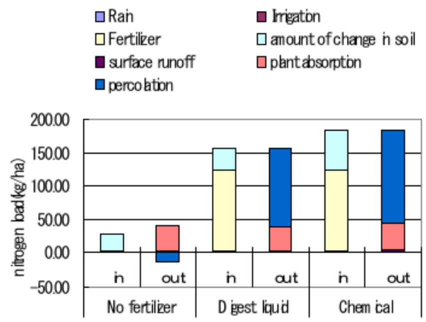
Figure 5. Change in soil (A), runoff (B) and crop (C) nutrients at the sweet sorghum plot

and No-F plot (24 kgN ha^{-1}; 16 kgP ha^{-1}). The losses in overall might attributed to either the increasing crop uptake at the initial stage (23% TN; 3% TP) or particularly the extreme percolation during the rainstorms (74% TN; 96% TP), and irrelevant to the runoff (3% TN; 0.9% TP). This agreed respectively with van Oosterom et al. (2010) clarifying the significant nutrients uptake in the sweet sorghum at the vegetation stage, and with (Yang et al., 2009) observing the extreme nutrients losses during the unusual rainstorms.



Note: **Tabulated nitrogen budget for the sweet sorghum (kg ha^{-1})**

Plot	*Rain*	*Irr.*	*Fertz.*	*Soil*	*Uptake*	*Runoff*	*Perc.*
SF	3.71	0.29	120	-31.55	37.20	2.93	115.43
CF	3.71	0.29	120	-58.64	39.40	5.10	138.14
No-F	3.71	0.29	0	-24.46	39.07	1.73	-12.33



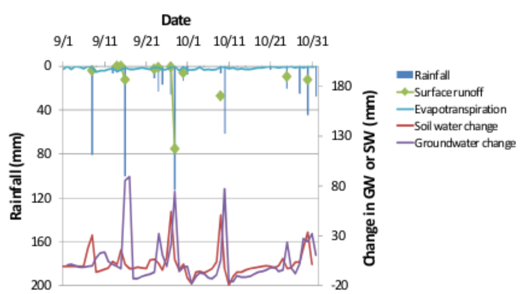
Note: **Tabulated phosphorus budget for the sweet sorghum (kg ha^{-1})**

Plot	*Rain*	*Irr.*	*Fertz.*	*Soil*	*Uptake*	*Runoff*	*Perc.*
SF	0.22	0.15	107	-111.98	7.09	0.33	213.03
CF	0.22	0.15	107	-132.21	10.59	0.18	232.88
No-F	0.22	0.15	0	-15.84	2.89	0.40	12.50

Figure 6. TN (A) and TP (B) budget at the sweet sorghum plot under three fertilizer treatments

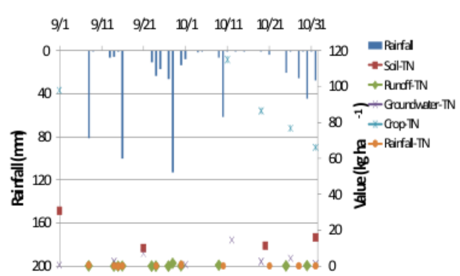
Rainstorm

The nutrients losses induced by the runoff and other related processes, in which the rainfall intensity at the unusual storm events is considered to be the most key factor leading to such depletion, has been investigated (Hussein, 1996; Hollinger et al., 2001; Yang et al., 2009). According to this study,



Note: **Tabulated water and nutrients budget during the rainstorm**

		Water budget (mm)	TN budget (kg ha^{-1})	TP budget (kg ha^{-1})
INPUT	*Rain*	600.4	2.5	0.2
	Irr.	-	-	-
	Fertz.	-	107.4	104.7
OUTPUT	*Runoff*	151.6	2.8	0.3
	Perc.	335.3	55.7	95
	Uptake	-	66.3	8.5
Change in Soil		113.5	-14.8	1.12
Groundwater		286.4	34.0	6.2
In-Outflow		-48.9	-21.7	-88.8



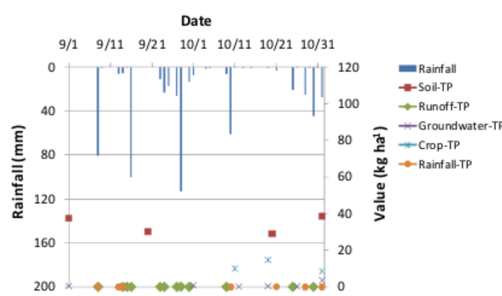


Figure 7. Change in water (A), TN (B) and TP (C) at the sweet sorghum plot during the rainstorms

the rainstorm of 61.4-113 mm d^{-1} (11-39.4 mm h^{-1}) occurred at least four times during Sep.-Oct. 2010 and enhanced the significant losses of nitrogen and phosphorus particularly by the percolation (45% TN; 88%TP) and subsurface flow (18% TN; 83%TP) (Figure 8 and its *Note*). The latter was considered as the In-Outflow of the shallow groundwater that received the water recharge from the rainstorm percolation with the total porosity of 0.15 (assumed; Table 1). This agreed with Kolenbrander (1981) study of which the leached nitrogen increases up to 20-25% when the water surplus (rainfall minus ET) reaches ≥475 mm at soil water ≥60 cm. The extreme percolation and subsurface flow losses was predominantly due to the high saturated conductivity (3.6-57.6 mm h^{-1}) as well as the low dry bulk density (0.67-0.82 g cm^{-3}) of the soil (Figure 9) allowing the nutrients to be easily drained from the soil and shallow groundwater mainly during the rainstorms (Yang et al. 2009).

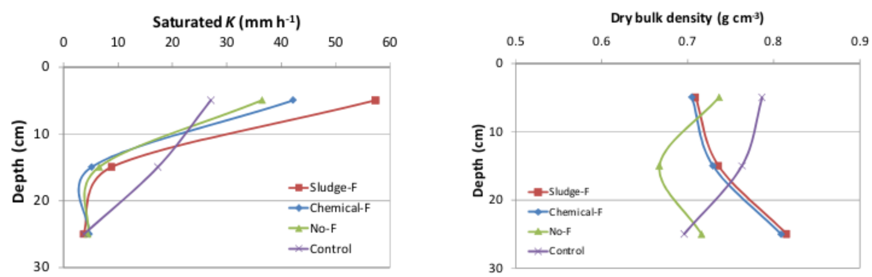


Figure 8. Saturated hydraulic conductivity (A) and dry bulk density (B) of the sweet sorghum soil

Growth and yield of the sweet sorghum

Among the treatments, the heights of the crop was similar at 30-35 DAS, and then increased until its peak (80-90 DAS) at which those of the SF was respectively 6 and 30% higher than those of CF and No-F plot (Figure 9A). The SF crop was superior in its land coverage (91.4%) compared to the CF (91.1%) and the No-F crop (85.8%) (Figure 9B). As consequence, the fresh and dry biomass of the former (50.3; 11.1 t ha^{-1}) was higher than others (CF: 46.5; 10.4 t ha^{-1} and No-F: 33.3; 7.8 t ha^{-1})

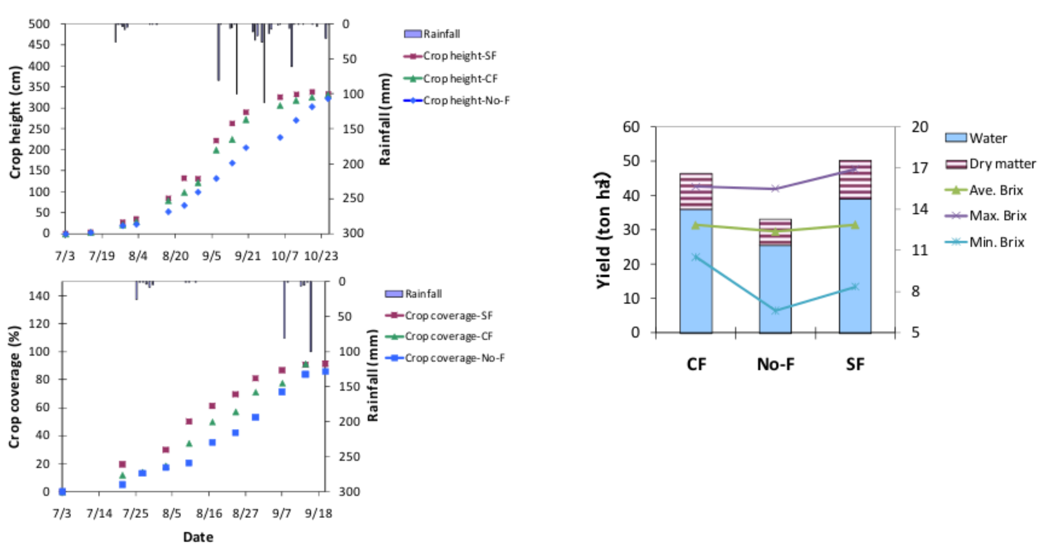


Figure 9. Height (A), coverage (B), and harvested (157 DAS) biomass weight and brix (C) of the sweet sorghum crop under three fertilizer treatments

(Figure 9C), but their brix were in average not different (SF: 12.9; CF: 12.9; No-F:12.4). This revealed that the treatments effects most on the vegetative growth (Nemeth, 2009), and they have no direct impact on the sugar content, except at different harvesting stage (Almodares et al., 2007).

CONCLUSIONS

Water and nutrients budget at the sweet sorghum plots with three fertilizer treatments such as SF, CF, and No-F were confirmed. In general 76% of the total water supplied at the plots was depleted by the ET and percolation, while the remaining was drained by the runoff. The high losses of the formers were respectively due to the active crop uptake at the initial stage and the unusual rainstorms on the plot with high portion of the soil pore space well as saturated hydraulic parameters contributing to the sensitive change in the shallow groundwater level. As consequence, the losses of the nutrient applied by the percolation and subsurface flow particularly at CF and SF plot were extremely high compared to others. The total and dry biomass weights were affected by the treatments, but the sugar content was not. Regarding the whole results, the appropriate schedule for the sowing/harvesting and fertilizer application to avoid the potential nutrients losses at the rainstorm and also to yield the good quality of biofuel are essential for the sustainable sweet sorghum cultivation as well as for better agro-ecological system.

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