**Education for Sustainable Development**  
*Challenges for Transformative Education and Research*

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The world is experiencing tremendous challenges entering into the 21st century. With the world vast and countries so diverse—geographically, culturally, socially, economically and politically— it is now home to more than six billion people, and before long planet Earth will be burdened by billions of people more. The enormous growing population is expected to use more natural resources to achieve economic growth, while imperiling moral social values and degrading the environment. These gargantuan problems cannot be addressed overnight, nor can they be solved by a few. Rather, they have to be tackled collectively by all world citizens and by all sectors of society for many generations through Education for Sustainable Development (ESD). While there is a general consensus that ESD is the way forward, instilling this new educational paradigm into peoples’ minds and hearts is a gigantic task. There is a need to change living and working styles and the behavior of people so that they conform to the values of ESD. Higher education institutions, as well as research institutions, together with non-formal education institutions, have great roles to play in this defining human endeavor.

In response to the United Nations Decade of Education for Sustainable Development (UN DESD 2005-2014), the United Nations University (UNU), in collaboration with UNESCO, the lead UN agency for the UN DESD Implementation, and other UN agencies and international organizations, spearheaded the promotion of Regional Centres of Expertise (RCEs) on ESD worldwide. An RCE is a network of existing formal, non-formal and informal education organizations, mobilized to deliver ESD to local and regional communities. An RCE builds an innovative platform for multi-sectoral and interdisciplinary information-sharing, dialogue and collaboration for promoting ESD among regional/local stakeholders. These include joint efforts for transformative education and research on ESD in all levels of education and knowledge creation. It is important that the lessons learned from these RCE activities are shared globally, through the so-called Global Learning Space on ESD, as they provide inspiration and knowledge to others wanting to make contributions for a sustainable future.

**Keywords:** ESD, regional centres of expertise, global learning space
Establishment of RCE Greater Phnom Penh for Promoting ESD in Cambodia

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Greater Phnom Penh covers Phnom Penh and 6 provinces such as Kampong Cham, Kampong Chhnang, Kampong Speu, Kandal, Prey Veng and Takeo. These provinces being close to Phnom Penh and have a strong relation in food demand-supply and economical aspect. Recently, in the Greater Phnom Penh, rapid increase in population causes many problems in environment, life quality, education and health, etc. Education is the key to develop the human resources. But it is not easy to improve education system. Although a net admission ratio for elementary school is 93.3%, a net enrollment ratio of lower secondary school is 34.8% and of higher secondary school only 14.8% based on the education statistics of MoEYS (2007/2008). Big number of students who didn’t continue to secondary schools starts working in agricultural sector. The poverty of farmers is a barrier for children to continue their study.

Rapid development of agricultural technologies in Greater Phnom Penh has significantly increased agricultural production. The majority of farmers apply agricultural chemicals. Agricultural chemicals released from farmlands to downstream cause the degradation of water environment. So, the education for sustainable development (ESD) in agricultural sector is very important for people, especially for the students in the elementary schools, as they will become farmers in the future. Establishing RCE may increase the opportunity to build the public awareness and perception of the importance of making harmony between farming practices and natural environment.

This presents an overview of the establishment of RCE Greater Phnom Penh in Cambodia and its activities. The vision of RCE Greater Phnom Penh is to promote ESD through the food, agriculture and environment education for sustainable development. One of current activities in the RCE is enhancing the food, agriculture and environment education for elementary schools through the organic farming activities at elementary schools and the facilitator training of elementary school teachers under the collaboration among government, university, local NGO and local community.

Keywords: ESD-education for sustainable development, RCE-regional centers of expertise, Phnom Penh
The ‘Jorani Project’ - Incorporating Principles of Sustainable Rural Development into the Education System of Cambodia

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An illustrated children’s book “Jorani and the green vegetable bugs” has been published in Khmer language to teach children about integrated pest management (IPM) in upland crops and the positive impacts on the environment and human health in Cambodia. Further books in the series are planned to teach the benefits of other sustainable land management practices.

The Maddox Jolie Pitt Foundation (MJP) in collaboration with the Ministry of Education, Youth and Sport, have commenced a pilot project, the ‘Jorani Project’, to determine where the books might fit in the Cambodian primary school curriculum. The project involves four primary schools in the district of Samlaut in Battambang province. Phase 1 of the project involves introducing the Jorani Project to school directors and teachers; Phase 2 involves development of the teacher guide; Phase 3 involves implementation in schools; and Phase 4, celebration and public launch.

Implementation involves teachers using the ‘Jorani’ unit as part of their lessons, with sets of books being distributed to the class. With assistance from agricultural advisers, teachers and students establish school gardens to observe good and bad insect activity and to conduct IPM experiments. Other education staff is invited to visit the schools to observe.

At the end of the program, teachers and students come together for a day to celebrate what they have learned. Education department representatives, parents, school directors and media are invited to attend. Activities include class presentations on their unique, insect-based culminating activities. Costumes are part of the activities and each student is presented with their own copy of the Jorani book and a certificate.

If the pilot proves successful, the Jorani Project will be rolled out to other primary schools in Cambodia and further books in the series will be produced.

Keywords: Jorani, sustainable rural development, education system, Cambodia
Building Capacity for Sustainable Rural Development  
- Lessons from Nepal 

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Rural development has been a buzzword among international development professionals for over 35 years. International donor communities, including bilateral aid agencies, INGOs, and Foundations, widely accepted the need for rural development to end hunger, poverty, inequality and unemployment in the developing countries. National planners and policy-makers in the developing countries adopted plans and policies to promote rural development. Rural development was addressed through various programs like training programs for local leaders, agricultural extension services for farmers, credit cooperatives for entrepreneurs, construction of farm to market access roads and irrigation schemes to increase crop yields. Of course progress has been made to improve the livelihood of many people in the rural areas. However, the rate of progress made in achieving rural development has not met the expectations of development professionals. Some of the changes noticed in the rural areas did not last long, and others could not be supported once the donors pulled-out, i.e., these were not sustainable.

In 1998, we initiated a series of micro-projects to promote sustainable livelihood in the village of Hamsapur, Nepal. Small grants were provided to organize change-oriented programs like farmers’ training, improved seed and seedlings for ginger, coffee and vegetable production for income generation, and supply of clean drinking water for the household. The objective of this paper is to present these micro-projects and share the some impacts.

We have learned that rural development can be sustainable if the local people have the capacity required to implement the project and maintain the program locally. This means the local people or the member of the beneficiary group need technical training and upgrading of skills. We also learned that sustainable rural development requires not only building the local capacity on a continual basis but also keeping the capacity locally through jobs in the rural areas.

Keywords: building capacity, sustainable rural development, Nepal
The Tropical Forages Selection Tool  
- An Education and Extension Tool for Rural Development

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An increasing demand for livestock products is projected over the coming years due to population increases, urbanization and rising incomes particularly in developing regions (Delgado et al. 1999). Significant opportunities exist for small-scale farmers to tap into this rising demand by increasing their livestock production and income potential through the use of appropriate forage production technologies. While the potential remains, the implementation is often hampered by a lack of information in relevant formats; the limited accessibility to that information; and incompatible languages for developing countries.

A tropical forages database and selection tool was developed to collate over 50 years of tropical forages research into a format that could be used by researchers, extension agents and farmers to provide them with relevant information about forages suitable for their local environmental and management conditions (Pengelly et al. 2005). This English language tool has been made available in both an Internet and CD based media. Access to information in an electronic form is rapidly advancing in the developing world. A simple tool to provide more information in a relevant and accessible format is likely to prove valuable as countries rise to the challenge of increasing animal production.

In an effort to address some of the challenges to provide more relevant forages information, the tropical forages selection tool and database has been translated into Khmer, Vietnamese and Indonesian. A web site and CD have been developed in each language along with printed material to help facilitate the dissemination of forages information throughout the researcher and extension communities in each country. The likely impact of these activities is to increase the awareness and interest in tropical forages as a viable and high quality feed alternative to crop residues particularly for small holder rice based farming systems.

Keywords: forage, selection tool, education and extension tool, rural development
Land Conservation of Upland Hills with Severe Erosion
- Promoting Field School to Increase Farmer’s Awareness

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Lack of knowledge and understanding of farmers about the risk of erosion have contributed to the rapid degradation of watersheds in Indonesia. A research was carried out to identify the topography and extend of landuse over the watershed to find out the eventual relationship between topographic characteristics and landuse that could explain the effect of agricultural expansion on hill areas on the erosion occurrence. In addition, farmer field school was also proposed to enhance farmer's awareness on the negative effects of soil erosion and the benefits of soil and water conservation. The erosion model was applied to calculate the erosion level in the upstream Bengawan Solo watershed and the calculation was performed under GIS environment. Some interviews were also conducted with the local farmer about their perceptions of soil erosion and the constraints of the present existing soil and water conservation measures.

The results found that more than 40% of the watershed area showed average annual soil loss >60 t/ha/yr. Topographic and land use are considered as the major factors that contribute to the high sediment transfer from upland areas. Spatial analysis showed that upland field activity on the steep slope (>35°) contributed a large fraction of soil erosion. Field investigation indicated that many farmers plant maize and cassava in the hilly area that are tilled repetitively and mostly left without vegetation cover. In addition, farmers are not making much effort to maintain land conservation measures. Thus, these areas need immediate attention for soil and water conservation activities to prevent further land degradation and its depleting productivity. A farmer field school is proposed to increase farmer’s awareness on the negative effects of soil erosion and the benefits of practicing soil and water conservation. Farmer field school involves simple experiments, regular field observations and group analysis. The knowledge gained from these activities enable participants to make their own locally-specific decisions about soil and water conservation practices.

Keywords: upland hills, erosion, GIS, farmer field school
The Challenges for Sustainable Development in Laos  
- Findings from Library and Reading Promotion Projects

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My presentation attempts to address challenges for sustainable development that Laos faces in a flood of foreign development assistance with a focus on the education sector in particular. The presentation intends to demonstrate possible solutions for the challenges, and trigger us to discuss about and act on the challenges commonly found in the development spectrum.

Findings were drawn from the experience in the school library and reading promotion projects that have been carried out by Action with Lao Children (ALC), a Lao/Japanese non-governmental organization (NGO) which works for the improvement of education in Laos.

The overwhelming international and foreign aids have turned the Lao who formerly lived in a self-sufficient way to become dependent on the external assistance. Disappointment was felt when I repeatedly confronted their dependent attitude and lack of initiatives. At the same time, it made me contemplate what foreign development/cooperation projects including ones of NGOs have done to the people and government of Laos for decades.

It is not an overnight work to break a vicious circle of the large external input and country's dependence on them. Nevertheless, we have to seek and try alternative ways for genuine empowerment which gives power and confidence back to the people again. The presentation will introduce ALC’s new attempt in the operation of school libraries which involves a network of community.

The above-mentioned approach for the operation of school libraries in Laos has a small geographical and activity scope, but it shares the spirit of community’s collaboration and ownership in common with the United Nations University’s Regional Centre of Expertise on Education for Sustainable Development (RCE). I hope sharing ALC’s experience and lessons learned in Laos will be somewhat useful in thinking of sustainable development in our neighboring country, Cambodia, and ways of development assistance from Japan and outside.

Keywords: sustainable development, school library, Laos
Rubber Farmers` Perception of Rubber Technologies in Dambae and Peam Cheang, Kampong Cham

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The main objectives of the study were to 1) determine the level of the farmers’ awareness on recommended technologies related to rubber tapping and 2) identify the farmers’ perceptions of rubber technologies. A multistage random sampling technique was use to select the sample. Totally, 92 rubber smallholders were selected from Dambae, nontraditional rubber region, and Peam Cheang, traditional rubber region. Data were collected through pocket voting and preference ranking which are the tools of participatory method. Friedman’s test and multiple comparisons were used to analyze data. The study showed that rubber farmers were not well aware of recommended technologies related to rubber tapping, for instance required girth (23%), height of measurement (34%), cup hanging (46%), thickness of tapping (21%) and tapping angle (21%). However, the awareness on tapping panel marking was high (97%). It was discovered that there were be significant differences in the participants’ rank ordered preferences for techniques, during immature and mature stage, related to rubber collection works and dissemination media (p < 0.001). Establishment of cover crop, land preparation, correct tapping method and latex preservation method were considered by the rubber smallholders as the most important techniques (p < 0.05) that they need the extension officers to address in designing extension activity programs for these regions. Workshop was the most preferred area (p < 0.05) of dissemination media through what the rubber farmers need the researchers and extension officers to transfer information and knowledge.

Keywords: rubber technology, pocket voting, preference ranking, participatory method
Crop Profit Groups and Farmer Participation in Research
- Some Experiences from Cambodian Upland Regions

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Reduction in poverty and improvement in food security are important issues for farmers and agricultural regions in Cambodia. In this paper we relate our approach and experience working in upland areas of Battambang Province to improve agricultural, environmental and social outcomes for farm families and villagers. Small farm sizes and observed low levels of agricultural productivity exacerbate poverty and food insecurity. We have approached this challenge by first investigating and demonstrating new agricultural methods (or technologies) in a farming systems context, through developing a network of farm trials and demonstrations. To this is added activity in contextual economic and social assessment of new versus old farming methods and management, with the objective of adoption of improved methods and associated increases in farm family incomes. We have formed Crop Profit Groups of local farmers to assess the economic costs and benefits of changed management in the main cash crops of maize and soybean. We have also investigated marketing and value-chain issues since these affect upland farmers in important ways. Our philosophy has been to bring expertise to each situation and adopt a co-learning approach with local farmers, government officials and NGOs.

Education and capacity-building of Cambodia collaborators has been an important part of the work. While our work is not yet finished we have found a genuine willingness by the Cambodian farmers to consider new ‘ways of doing things’ and be involved in assessing their own incentives to change. A variety of approaches are used in training and capacity building of the local researchers and officials. There seem to be substantial economic incentives to change some farming practices, but issues of farm input supply availability, markets and prices received for farm produce, transport costs and governance (provision of agricultural research and extension services) appear to constrain improved farm and regional outcomes.

Keywords: crop profit group, farmer participation, upland region, Cambodia
Environmental Education at Primary Schools for Sustainable Agriculture in Cambodia

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The degradation of natural environment has been advancing even in rural area due to the excessive use of agricultural chemicals applied in the fields. As most students in Phnom Penh and Kampong Cham of Cambodia become farmers after graduating from the primary schools, attention should be paid to the environmental education through guiding organic farming for sustainable agriculture at the primary schools.

So, environmental education has been implemented at several primary schools in Phnom Penh and Kampong Cham of Cambodia. The contents of environmental education implemented for 2 years from 2006 to 2007 were as follows; collecting and analyzing the cases of environmental education, establishing school garden as well as compost box, holding seminars for deeper perception on sustainable agriculture through composting and organic farming, and conducting questionnaire survey for evaluating the perception on organic agriculture and environment conservation at primary schools.

In addition to the contents of 2006 and 2007, the contest titled “Competition on radish cultivation” was conducted at 3 primary schools of Phnom Penh in 2008 to enhance students’ motivation toward sustainable agriculture. There were 4 groups in each of 2 schools and 8 groups in other 1 school. The member in each group was formed with 10 students. The competition was done among groups in each school. Students started to cultivate radish on November 2008. After taking time, their radish grown well made their garden colorful green. In order to judge the results of each group, the committee was established with NGO facilitators and school teachers. The points for judgment were based on students’ records, growth condition, maintenance of their ridge and collaboration among the students. According to the committee judgment, the winners received the certificate and the awards.

This was a case that students’ motivation toward sustainable agriculture was enhanced through the contest titled “Competition on radish cultivation”. Some unique approaches should be considered for higher acceptance of students toward sustainable agriculture in environmental education at primary schools.

Keywords: environmental education, primary schools, sustainable agriculture, Cambodia
Local Acceptability on Organic Farming in Kampong Cham Province, Cambodia

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Recently, in Kampong Cham Province of Cambodia, subsistence agriculture is being converted to commercial mono-culture, and the amounts of agricultural chemicals applied to farmlands are increasing every year. The applied chemicals in farmlands cause serious environment problems in downstream, such as eutrophication, unusual growth of aquatic plants, decrease in dissolved oxygen and accumulation of bottom sediments in the water resources. Also, there seem to be many cases in which people apply agricultural chemicals without understanding the impact on health and food safety. It is necessary to promote and enhance understanding of sustainable agriculture among local people including farmers. So, this study dealt with the evaluation of local farmers’ acceptability on organic agriculture based on the participatory level.

The extension activities, such as promoting sustainable agriculture through demonstrating how to make compost box and compost, leader training for their deeper perception on sustainable agriculture, and conducting workshops on sustainable agriculture through composting, were implemented in 2007. Also in 2008, following activities were implemented; introducing the farmers how to make pellet compost, initiating 4 model organic farms, leader training on making bio-pesticide, and conducting workshops on sustainable agriculture through applying pellet compost. In addition to extension activities, the surveys by interview or questionnaire for evaluating local farmers’ acceptability on organic agriculture were implemented occasionally.

According to the results of evaluating local farmers’ acceptability on organic agriculture based on the participatory level, it was considered that building local farmers’ confident through various extension activities is the most important key to increase local acceptability.

Keywords: organic farming, acceptability, local farmers, extension, Cambodia
The relation between the lifestyle and the participation attitude to the lecture of the food and agriculture education theory course (FAETC) was evaluated in this study. One of the important purposes of the food and agriculture education in the higher education of Japan is that the conscientization of students’ daily life and being connected the integration of knowledge, which normally scattered leaving, through the food and agriculture education theory course (FAETC).

In the present study then, the effect of the FAETC was investigated from the relation among student's of attending a lecture daily life, especially sleeping time and the breakfast intake custom, and the lecture participation attitude (adequacy of concentrated level = key word selection by students at each class).

The survey was conducted to the 3rd grade students of the Department of International Bio-business Studies including other departments and faculties’ undergraduate of Tokyo University of Agriculture from 2007 to 2009. In the survey, students fulfilled the sheet in the last minutes of the each lecture and it was submitted when ending. Sleeping time, the breakfast intake, and each selection key word was individually totaled, and those averages and the correlation etc. were calculated in the analyzing process.

The results of survey indicated that the students, who had a regular lifestyle as asleep and eating tends, showed higher in the lecture participation attitude and the positive content grasp adequacy. The one that the lifestyle was renewed to an irregular student autonomous and concentrated level rises appeared, too. Therefore, it is thought that there is a correlation at a lifestyle and concentrated level, the conscientization can be urged by keeping appealing for the presentation of a daily material. That is, it was thought that there is a big possibility in the FAETC for the conscientization of students in their daily life.

**Keywords**: lifestyle, participation, shokunou kyouiku, food and agriculture education
Potentials of Export Expansion on Food and Agricultural Products in Cambodia

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Cambodia has the great potentials of export expansion on food and agricultural products, making use of the rich natural resources. Agricultural trade will surely be playing an important role in gaining the foreign currency needed for economic development in Cambodia. This presentation aims at evidencing the potentials and possibilities on food and agricultural products on the basis of results from orally interviewed by stakeholders concerned with food value chain in Cambodia.

The interview survey has been conducted since 2006 focusing on the discussion with farmers, food processing industry, food marketing traders, logistics, exporter, or governmental officers. Following outcomes were summarized on the basis of the interview survey.
1. Cambodia is rice based country. Higher qualitative rice has great potentials for export expansion.
2. It was identified that beans and oil seed crops would be the promising ones for the nearest future.
3. It was identified that vegetables and fruits would be import substitution ones. They will be significantly exportable products especially with providing value addition for them.

In conclusion, although there are high potentials and possibilities on the export expansion of food and agricultural products in Cambodia, the process of value addition should be advanced with applying sophisticated technologies as well as food safety control. Additionally, this process may increase the opportunity of job and income generation.

Keywords: potential, export expansion, food and agricultural products, Cambodia
Cattle Feeding and Management Practices of Smallholder Farmers in Kampong Cham Province, Cambodia

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Almost all cattle in Cambodia are produced by smallholder farmers. The cattle are raised in an extensive way for draught power and wealth accumulation purpose. The feed availability is a major challenge for farmers associated with the poor management which limited the cattle productivity. This study reported a survey which was conducted to describe the cattle feeding and management practices of small-scale farmers in Cambodia. 60 farmers raising cattle in Kang Meas and Tbong Khmum district in Kampong Cham province were randomly selected for an interview in 2008.

The interviewed farmers raised 4-5 cattle per household on average. Most of them had the cows aged older than 3 years which were mainly kept for breeding. More than 80% of cattle in Kang Meas were crossbred, but about 40% of cattle in Tbong Khmum were local breed. Very few farmers practiced weaning and no one predicted the date for their cows to calve a calf. However, most of them selected a bull in their village for mating the cows. No artificial insemination was practiced in the village. The majority of them vaccinated their cattle to prevent the hemorrhagic septicemia while very few de-wormed their cattle. The cattle feeds were mainly based on grazing in dry season and rainy season. During flooding season, farmers in both districts relied on cut-and-carry native grasses and crop residues. Lastly, 60-70% of farmers participated in selling cattle while only 10-20% of them bought cattle during the last one year.

In conclusion, the cattle production of smallholder farmers was accessed as very low in terms of management and feeding. The farmers still raised their cattle in traditional way with low health care intervention. The better housing of cattle with proper health care and improved feeding system is recommended to farmers to increase their cattle production.

Keywords: cattle feeding, management, smallholder farmers, production, Cambodia
Innovations in Fisheries Co-management
- Experiences in linking State, Civil Society and Villager Led Research

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As the reform of Cambodian fisheries progresses, substantial focus has been made on the roles of local communities to manage local resources and their use. Through this change both the environment in which fishing occurs and the local institutions engaging in resource management have been reshaping. While Community Fisheries (CFs) established as a part of the reform are still on the long road to managing their respective allocated resources effectively, networked and nested institutional arrangements are recommended as an essential institutional innovation for successful natural resource management, particularly for greater coordination of activities of contiguous CFs as they spread and the fishing grounds between them.

The paper builds on the lesson local people led fisheries research in Stung Treng province, Cambodia, and draws on the experiences from current work toward a co-management of deep pools that are important dry season fish refuges on the Mekong in the Northeast Cambodia. It begins with a synthesis of how local villagers share and advocate their research findings and then discuss on how and what different players including the Fisheries Administration (FiA), the local authorities, Community Fisheries (CFs), village researcher groups, non-governmental organization, and other stakeholders, negotiate to forge a joint effort for resources co-management based on collective understandings from both scientific and local knowledge. The paper also illustrates the initial feedbacks and responses from the joint deliberations, and how management objectives and regimes will be reconciled. While the activity is still on-going, the paper will conclude with a discussion on what implications process and outcome attained at this stage would have on designation, management regime and use of resources.

**Keywords:** co-management, fisheries, community fisheries, local knowledge
Assessing Poverty Outreach of Microfinance Institutions in Cambodia
- A Case Study of AMK

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Microfinance industry works to balance social and financial benefit, which is viewed as an effective way of helping the poor. The industry, however, faces the challenge to measure the social bottom line, especially the depth of poverty outreach which refers to how poor are the clients served. This article aims to analyze for Angkor Mikroheranhvatho Kampuchea (AMK). This article assesses the depth of outreach through two main measures: the Wellbeing Score and Daily Food Expenditure per capita. The analysis is based on data from field survey in 2009 with 810 samples [648 new clients (504 group clients and 144 individual clients) and 162 non-clients] randomly selected in 18 provinces in Cambodia.

The results of AMK’s depth of poverty outreach for group clients based on the wellbeing score indicate that AMK reaches more poor and medium level households than what is found in the control group of non-clients, but less better-off clients. As for individual clients, AMK reaches a larger share of the medium households, less poor households and a slightly smaller share of the better-off households than what is found in the general population. The results based on the number of clients spending in food below the Cambodian Food Poverty Line confirm that indeed AMK clients are poor with 56% of clients (group and individual) below the line. The study concludes that AMK achieves the social bottom line in term of poverty outreach because its clients are more represented in the categories of the poor and medium level households, and the percentage of clients below food poverty line is high at 56%, higher than what found in the general population.

Keywords: assessment, poverty outreach, microfinance, AMK, Cambodia
**People’s Livelihoods in the Suburbs**  
- *A Case Study at a Community of Ho Chi Minh City*

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The study focuses on the analysis of the effects of urban growth and land tenure policies on access to the land and livelihoods of the people. In the process of urbanization, suburbanization, and changes in land tenure status, practical evidence shows that the households’ situation has improved. The problem, however, is whether everybody is benefiting equally. Who are the “winners” and “losers” in this system? What groups of people tend to win more? What are the negative socioeconomic impacts of the abovementioned policies? In order to understand the problem, the following questions need to be answered: How do policies impact on the livelihoods of the households? How do peoples in the community have change their livelihoods to adapt to the new circumstances.

The study employed various participatory research methods, both quantitative and qualitative. Semi-structural interviews, In-depth interviews, Focus-group discussion, Participant observation, Secondary data were used to collect the data.

The results indicated that the most successful households are those that are characterized by multi-activity and risk-spreading. This is achieved by exploiting rural and urban opportunities simultaneously. The least successful and poorer households are generally those with non-diversified income-earning activities and/or which do not attempt to maximize the utilization of rural and urban resources. It seems that farmers are not well-prepared for the transition from rural to urban. Lack of skills and formal training prevent them from getting opportunities to adjust to rapid changes. Thus, we can now observe a new group of people who have fallen into poverty.

Tenure transformation in the suburban areas due to rapid urbanization has created more hardships, in social and economic terms, for the most vulnerable in society. Given the limited availability of land, farmers in the commune generally have three means of maintaining and improving their livelihoods. First, they can increase the use of agricultural inputs. Second, they can migrate to areas where agricultural land is available or where non-farm employment offers higher wages. Third, they can establish themselves in a local off-farm occupation. Each of these strategies can be carried out alone or in combination.

**Keywords:** urbanization, livelihood, suburbs, skills, Ho Chi Minh
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Organic Vegetable Farming Leading Environmental and Rural Development - The Case Study in Chiang Mai Province, Thailand

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Organic farming is one of main patterns of sustainable agricultural system for small farmers in Thailand, which be promoting by the government. The main idea of sustainable agricultural manner refers food security, social welfare, and natural resources and environmental management as a way to develop the rural sector in sustainable. Thai farmers strongly believe that organic farming can provide economic feasibility due to the high prices of their products and healthy life, while reducing the burden on the environment. Based on a questionnaire survey of 142 vegetable growers under different production systems in Chiang Mai Province in 2008, this paper aims to clarify organic farming is a feasible form of sustainable rural development under small farm size conditions. Organic farming leading environmental and rural development is analyzed in terms of production efficiency, farm income, and environmental and social impact in comparison with other production systems.

There were four types of farming system: organic, chemical pesticide free, safe use, and conventional farming systems in Mae Rim District, Chiang Mai Province. The organic farming system was economically the most feasible due to high prices of produce; however, it would need further improvement in order to increase yields and production efficiency. The benefit-cost ratio (B/C ratio) of organic farming system was greater than one, especially the B/C ratio of organic yard long bean was the highest. In organic kale, labor and seed were the most important factors in improvement of organic kale production, while the highest efficiency of resource use was seen for labor, indicating that the increased use of labor would lead to higher income for organic farms. The conventional kale production appeared to have the highest negative environmental and social impact, while the lowest was attained by organic farming. Only in the case of organic production, the average cost decreased due to the reduced negative impact and organic growers could raise farm income per ha per year to 7,150 USD. These results show that organic farming could provide positive environmental and social impacts, and encourage the rural development in a sustainable manner.

Keywords: organic vegetable, environment, rural development, income, Thailand
Yam Tubers (Dioscoreaceae spp.) from Thailand
- New Alternative for Starch Staple Food

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Yam Tubers were classified in the Family Dioscoreaceae which are starch staple foods. Now are main source of starch supply in Africa. The original from Southeast Asia are D. alata and D. esculenta. Yam tubers were distributed for all region parts of Thailand. Aiming of this research to study in some physical-chemical properties of starch obtained from three type of yam tubers from two species: water yam (mun jao diang: jd and mun lued: ld) and lesser yam (mun mue seu: ms) as alternative for food industry. Starch was extracted from fresh tubers by wet milling process and purification. Products were compared among three type of yam tubers, the yields of starch were about 17.01 - 41.73 % for jd and ms, but ld was quite different in starch content at 95 - 99% (dry weight) estimated by enzymetric method. The chemical properties were not quite different, but the structural starch granule by image analysis and morphological approach by scanning electron microscope (SEM) showed the shape of D. alata were trigonally rounded with average size was 20 – 26, also that in D. esculenta were polygonally with average size 4.7. It was considered that some of starch granule could be destroyed by milling process. For viscosity and some functional properties were not remarkably different for all of yams starch.

Keywords: yam tubers, Dioscoreaceae spp., Dioscorea alata, Dioscorea esculenta, starch staple food, alternative
Satisfaction of Human Needs as a Tool for the Evaluation of Sustainability through Indicators

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Inside the current worldwide framework of climate change, economic globalization and population growth, irrigation agriculture faces a series of problems which have to be approached as a challenge to our sustainability. To speak about sustainability in irrigation it must be stated that irrigation agriculture is a system of production of goods with the objective of satisfying human needs. From this definition, the concept of sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs achieves full meaning.

Developing a methodology of evaluation of sustainability, focused as a checking of the level of satisfaction of human needs of local population and of the variation of such level of satisfaction through time, may allow for a more complete and true vision of reality than a mere economic evaluation. It can also provide more comparable and reliable data than other methods of evaluation of sustainability in which economic, social and environmental aspects are studied in a less structured way. A conceptual framework which includes aspects of eco-efficiency, endogenous development, caution and equity principles, social empowering and self-control of consumption, and which, for agricultural environments, tries to focus the understanding of agroecosystems inside an agroecological perspective, offers solid chances to elaborate a methodology of evaluation of sustainability in irrigation based on the satisfaction of human needs.

Keywords: sustainability, irrigation, satisfaction, human needs
Estimation of Seasonal Direct-Use Value of Cheung Ek Peri-Urban Lake, Phnom Penh, Cambodia

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Cheung Ek Lake receives 80% of Phnom Penh’s urban wastewater. While most of the lakes around Phnom Penh are being reclaimed for urban development, surveys were undertaken to analyze one part of the overall economic value of the lake, namely the direct-use value which could serve for policy-makers’ future considerations. In the dry season, the direct-use value could be assessed by summing up the total income of all activities performed on the lake. The income has been calculated using a bottom-up approach based on a stratified sampling and on the in-depth interview of 192 households using structured questionnaires for the understanding of each household’s activity.

The primary activities performed on the lake are: water spinach, water mimosa, and rice cultivation, fishing, and duck raising. Over a six months period, the farmer receives an average profit of 4,168 USD/ha from water mimosa cultivation, 1,553 USD/ha from water spinach cultivation, 512 USD from fishing, 506 USD/ha from dry season rice cultivation, and 157 USD/100 heads from duck raising. After multiplication by the total surface of plants using remote sensing and number of household and duck using direct investigation, the direct-use value can be estimated at more than 1 million USD, of which water spinach production contributes 65%, fishing 20%, water mimosa production 13%, duck raising 1%, and dry season rice production 0.7%.

The study suggests that almost a thousand of direct-beneficiaries can generate part of their income from agriculture or fishery related activities performed on the lake. However, the research targeted one part of direct-use value of the lake and thus largely underestimated the overall value of the lake. Another component of the direct-use value, water purification, and the indirect-use value of the lake which is of high important for future economic potential must be taken into account by further research.

Keywords: direct-use value, Cheung Ek Lake, water spinach, Phnom Penh
Negative Impact of Forest Land Use Change on Household Income, Kratie, Cambodia

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Land use pattern in the upland area, Kratie province consists of forest, grazing, shrub and farming land. Due to economic development and demographic pressure, the use, access and control of the forest land have changed significantly. The main objectives are (1) to analyze the impact of the change in land-use on use and extraction of Non Timber Forest Products and (2) to analyze the impact of the change in land-use on livelihood of each type. Structured questionnaires were used on 75 respondents stratified into four sub-groups: resin tapper, former tapper, never tapped and immigrant. Three kinds of forest changes were noticed in the study area. Firstly, forest land was converted to plantation by economic land concession. Secondly, forest was converted to Chamkar and rice growing by farmers. Finally, forest and resin trees of households were destroyed by illegal logging. Commune statistics (2008) showed that 41% of total area was under economic land concession. Furthermore, the average area of Chamkar has been enlarged from 0.44 to 1.30 hectare per households per period of time.

The study also shows a problem with resin trees which decreased from more than 160 to only 20 trees per household. Furthermore, the number of resin of tapper was decreased from more than 360 to only 130 trees per household. The income of former tapper decreased from approximately 35% (1000 $/year) to 0.64% (20 $/year). The result shows significant change on the income of tapper from 42.9% (1200 $/year) to 34.9% (813 $/year) even the price of resin increased doubled since 2004-2009. In conclusion, changing in forest land use strongly affected household livelihoods.

Keywords: deforestation, land use change, household income, Kratie
Market Channel and Trade of Fermented Small-Sized Fish Paste in Cambodia

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Fermented small-sized fish paste is considered to be one of the main food sources for Cambodians, especially for the poor. However, according to the former studies, most small-sized fish are used as direct feed for aquaculture or dried for animal feed. This study was conducted in order to identify market channels and trade of the fermented small-sized fish paste. Phnom Penh city, Kandal, Kampong Chhnang, Battambang, and Siem Reap provinces were selected as the study areas. Samples differently and typically categorized were interviewed. The total numbers of samples are 150.

The study revealed that fermented small-sized fish paste is marketed and traded in many different ways. Three main sources of product should be considered when analyzing total volume of annual production. The total production of the fermented fish paste in 2007-2008 is around 6,659.466 tons of which 50.18% are domestically consumed, and 49.82% are exported to Thailand and Vietnam. Kampong Chhnang province bears the largest amount of the fermented fish paste. About 58.82% of the fermented fish paste bought by middlemen comes from fishermen; 92.75% bought by exporters come from middlemen; 73.50% bought by wholesalers is from middlemen; 43.13% bought by retailers is from processors. When sold, 63.83% is sold from processors to middlemen; 65.14% from middlemen to exporters; 88.74% from exporters to middlemen; 33.97% from wholesalers to provincial wholesalers/retailers. The fermented fish paste is mostly not classified when traded in markets. Total amount processed and traded by all stakeholders, except wholesalers, continuously increases during 2000 to 2008, so does its price.

In conclusion, over half amount of the fermented fish paste are domestically consumed. It is marketed and traded differently depending on trading sites, stakeholders' characteristics, and fish species containing in the fermented fish paste.

Keywords: market channel, trade, fermented small-sized fish paste, Cambodia
Contribution of Kampong Preak Fish Sanctuary (Tonle Sap Lake) to Livelihoods in Two Adjacent Floating Villages

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This study focused on the contribution of natural resources (fish, wildlife, vegetation, flooded forest, etc) to the livelihoods of communities living in two floating villages (Anlong Raing and Kampong Preak) located near Kampong Preak fish sanctuary, KroKor district, Pursat Province. The approach was based on a combination of Rapid Rural Assessment (RRA) and economic assessment methods. Data was collected from 60 households. Stratified random sampling was used to interview rich, medium and poor households. Quantitative information was complemented by interviews of key informants and of village chiefs. Analysis focused on i) quantitative data, and ii) perceptions of interviewees about the contribution of natural resources and of the fish sanctuary to their livelihoods.

This study showed that the fish catch is an important element of income. The living standards of villagers varied, depending on fish production and aquatic plant collection. Labor, aquaculture, pig farming and wildlife catching were the other sources of income in the two floating villages. During six months of fishing season, rich households can catch up to 8020 kg of fish worth USD 1938 while medium households can catch 1950 kg of fish (USD 778) and poor households can catch 1426 kg of fish worth in average USD 422.

The fish sanctuary contributed to household consumption and income generation in all households. Fish, snake, water bird, turtle, edible wild plant and fire wood are most important for daily subsistence of poor households and were the main sources of income for this group. People in rich households get more benefits from natural resources because they have more capital to invest on fishing equipment and to bribe law enforcers. The local authorities must be strict in measure and enforcement to conserve or protect the fish sanctuary by reducing the fishing illegal activities and replanting the flooded forest around fish sanctuary.

Keywords: fish sanctuary, livelihoods, floating villages, Cambodia
Spatial Analysis of Human Activities Performed in Cheung Ek Inundated Lake, Cambodia

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Cheung Ek is an important lake for local community’s livelihoods through different activities, which acts as a wetland area to control flood waters and remove pollutants from Phnom Penh city. However, industrialization, urbanization and uncontrolled human occupation on the bank of the lake in previous years has decreased the lake's surface and caused the lake become incapable to assure the evacuation and retention of storm water in the condition of heavy rain.

GPS mapping were undertaken to analyze the lake border, water spinach and water mimosa surface and other human activities while survey were conducted to understand the method of cultivation and yield estimation of main aquatic vegetables.

The surface of Cheung Ek Lake in dry season is 992 ha, occupied more than 50% by different human activities: 429 ha of water spinach surface, 32 ha of water mimosa surface, 13.5 ha of dry season rice field, 10-20 ha of fishing activities and around 10 ha of duck raising. In Cheung Ek Lake, water spinach and water mimosa are grown in rows secured by a string between the poles to prevent the crop from floating away. During the dry season, a water spinach cultivator can obtain an average yield of 16-17 ton/ha for a six-months production cycle while a water mimosa producer obtain on an average of 15.5-16 ton with the production area of 5000m² during five months of production cycle.

In conclusion, during dry season, the lake provides from 6864-7293 ton of water spinach and 992-1024 ton of water mimosa for human consumption. However, aquatic vegetable production is also facing with many problems particularly with insect damage and disease outbreaks during the production period.

Keywords: spatial analysis, GPS, aquatic vegetable, inundated lake, Cambodia
Assessing Clients’ Satisfaction of Microfinance Institutions in Cambodia - A Case Study of AMK

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Microfinance is widely advocated as a powerful tool to reduce poverty and improve social inclusion. It can assist the poor by reducing their vulnerability and avoiding economic shock. While scale and outreach have been critical indicators of microfinance performance, there hasn’t been much investment in measuring whether clients are satisfied with the microfinance products and services they have been accessing.

For this article presents findings of a study by Angkor Mikroheranhvatho Kampuchea (AMK) which is measuring client satisfaction with microfinance product and services. While the overall aim is to access whether clients are satisfied or dissatisfied with microfinance products and services, the study also explores the loan use (in comparison with other competitors). Is microfinance widely accepted by the clients? Do microfinance products provide good coverage at affordable interest rates? Do the delivery mechanisms effectively the clients needed? These are among the key findings addressed in this study. The study was designed be qualitative by in-depth interviewed and extracted information from March to May 2009 total covered 648 new AMK clients in 18 provinces.

The findings provide the clients’ perception of microfinance product and services, in generally clients are satisfied with AMK more than 85 percent of client at least gave one reason for satisfaction feedback. Approximately, 8 percent to 17 percent had at least one negative comment on microfinance product and services. Low interest, providing loan as needed and give loan at doorstep are a crucial aspect of microfinance AMKs’ competitive advantage, among all clients categories the poor were most satisfied with low interest rate of microfinance. The study also reported that the great majority of client has used at least part of their loans for productive purpose, mostly in farm-related activities (agriculture and livestock). Notably the study gives strong signals for improving product development and service, more than that try to retain as many clients as possible.

Keywords: assessment, clients’ satisfaction, microfinance, AMK, Cambodia
Examining the Efficacy of Micro-Credit Programs among the Very Poor

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Since the creation of the Grameen Bank, micro-credit has exploded as a tool for reducing poverty. However, questions remain regarding whether the very poor can participate and be positively affected by such programs, as lack of credit and technical skills create barriers.

Research on this topic was conducted in a micro-credit program in the Mekong Delta of Vietnam. The program utilized micro-credit loans to reduce poverty by expanding targeted households’ income generating activities. The program also provided technical support and strove to enhance participants’ social connections, with the ultimate goal of preparing participants to receive government loans post-program involvement.

The poorest 21 families involved were targeted for this study. The primary objectives were to: 1) determine the financial impact of the program on participants’ incomes; 2) examine the importance of technical education and social networks; 3) discover possible barriers to success in program design; 4) preliminarily investigate whether extreme poverty was a continual negative factor for involvement. Face to face interviews with participants and key informants was the primary research method.

Research findings demonstrated a positive increase in participant’s income and a 100 percent loan and interest repayment rate. Technical and financial management skills were enhanced, and both bridged and bonded social networks were expanded. Research concluded that the education strategies implemented were an essential program component and that the group structure of granting and monitoring loans had a significant effect on repayment rates and confidence levels of participants.

Although poverty levels presented some initial barriers to participation, most effects were negated by the educational interventions. Thus, this research raises important findings about the structure of micro-credit programs aimed toward extremely marginalized people and draws conclusions regarding the involvement of, and benefits for, the very poor in micro-credit programs.

Keywords: micro-credit, efficacy, poverty, Vietnam
Coffee is one of the most traded commodities in the international market. Because of the high return of income, many countries have promoted the production of coffee as a cash crop. In Nepal, the government in collaboration with international development agencies also promoted the cultivation of coffee for soil conservation as well as an income generation project for small farmers since early 1970s. Today, approximately 1,396 hectares are under the coffee crop in Nepal.

Coffee growers in the developing countries have been suffering from dramatic changes of coffee prices. In order to support farmers and to promote environmental conservation, governments and non-profit organizations have initiated organic and fair trade certification to promote coffee production through price premiums. However, organic certification requires high costs, which is often too costly to small farmers in the developing countries. Nepalese coffee sector is also facing this dilemma of applying international organic certification for export market.

This study was conducted focusing on the following objectives: 1) to study the current situation of coffee production; 2) to analyze coffee supply chain management; 3) to develop policy recommendations for future production and coffee supply chain management. Face-to-face interviews were conducted with coffee farmers and key informants and secondary data were utilized.

Findings showed a significant increase in organic coffee production in Nepal. However, it is necessary to improve the quality of coffee by growing coffee trees under shade, irrigating plants during dry season, and using wet-processing method as well as improving the soil quality. This study also shows the possibility of alternative trade by using the example of Alter Trade Japan Company, which directly connects producers and consumers without certification and standard system, and it examines coffee trade, which truly benefits and brings the empowerment to small farmers.

Keywords: organic coffee, small farmers, livelihood, supply chain, Nepal
Sustainable Development of Mid-Hill Farming System in Nepal - Cases of Kavre, Nuwakot and Lalitpur Districts

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This paper focuses on the sustainability of the traditional mid-hill farming system performed on slope and terraces, which is a location-specific and environment-adaptive system based on three components crops, livestock and forestry. Sustainability cannot be attended unless productivity concerns are adequately addressed. Improving farm income through proper balance of three components is a part of sustainability. Therefore, this paper focuses on the economic performance of major farming components. Based on data of three mid-hill villages; Kaule in Nuwakot, Khalchowk in Kavre and Bistagaun in Lalitpur districts, collected through household questionnaire survey, attempts to (1) quantify the degree of physical interactions among three components, (2) examine the strength of weakness of those interactions, (3) clarify the economics of the three components, and (4) identify the optimum combination of the three components.

Six major interactions were identified. The strongest of the six were from livestock to forest and vice versa in terms of quantity and quality, followed by the interaction among crops and livestock. Among three components, crop production gave the largest incomes to Bistagaun and Kaule farmers but for Khalchowk farmers’ gross and net incomes were largest from livestock followed by forestry or tree products. Indeed, heavy use of inputs to crops yields negative income in Khalchowk.

The optimum combination for the small farm was to operate 0.53 ha of land requires 0.53 draft animal, and 0.76 ha of forest and 1.7 trees on the farm yard. This yielded a maximum net income of 86,163 rupees, much higher than current income. For the large farm, the optimal combination was to operate 1.21 ha of land requires 1.2 draft animals and 0.21 ha of forest. Maximal net income on the large farm was 93,539 rupees, but the gap between small and large farm incomes narrowed under optimal cropping patterns.

**Keywords:** sustainable development, mid-hill farming system, Nepal
Local Awareness on Burning Crop Residues in Wenshuixian of Shanxi, China

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In China, about 700 million tons of crop residues are being produced every year. Burning crop residues is a traditional farming practice and considered as the easiest alternative way on treating the residues from the farm fields. Various effects from burning crop residues bring intention on environmental awareness. So, this study dealt with the investigation on local awareness on burning crop residues in Wenshuixian of Shanxi, China.

In order to make out the actual situation of burning practices, questionnaire survey was conducted in Wenshuixian, Shanxi of China to evaluate knowledge and awareness of the local farmers. Based on the results of questionnaire survey, the burning crop residues have been initiated since 30 years ago. However, it was observed that the number of farmers conducting the burning practices is gradually decreasing due to the increase in their awareness on environmental degradation by the burning crop residues. Also, the results indicated that 90% of the local farmers pointed out the burning crop residues caused air pollution and 80% responded it degraded soil quality. On the other hand, farmers are not succeeded in emerging the burning practices of crop residues due to its convenient and time saving advantages.

It was concluded that appropriate techniques on how to utilize the crop residues to mitigate the burning practices should be promoted in Wenshuixian of Shanxi, China.

Keywords: burning practices, local awareness, environment, Shanxi China
Incentives of Local Farmers toward Organic Fertilizer Application in Nan Province of Thailand

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In recent year, many of agricultural and environmental problems occur due to high amounts of agricultural chemical or pesticide applied. The most important step for reducing soil degradation or water pollution is to mitigate nutrient losses from agriculture fields where used to work as non-point sources. For decreasing the amounts of agricultural chemicals, organic fertilizer has been proposed as it may contribute to reduce the expense of agricultural chemicals and to be safe for human health and natural environment. However, it is important to make farmers understand the background of the application of organic fertilizers, such as its benefit or technology, through the demonstration or the training.

The studies were conducted to evaluate granular compost application comparing with chemical fertilizer or conventional compost application from viewpoints of reducing soil and nutrient losses under natural rainfall and of plant growth for 2 cycles of cultivation in agricultural field. The experimental results showed that in the natural rainfall having 14 to 38 mm/hr, the losses of soil, total nitrogen and organic matter from the plot applied granular compost were significantly lower than those from the plot applied chemical fertilizer or conventional compost. Additionally, the 1st cultivation showed that plant length and live weight of the ridge broadcasted granular compost after planting were higher as same as the ridge applied chemical fertilizer. However for the 2nd crop, plant length and live weight of the ridges applied granular compost before or after planting were the highest among all ridges. It means granular compost application is the effective way for decreasing the amounts of soil and nutrient losses from agricultural fields, and for making plants grow efficiency.

Keywords: organic fertilizer, granular compost, soil loss, nutrient loss, plant growth
Earthworm Distribution under Different Land Use Systems in Northeast of Thailand - Beneficial for Land Resource Reclamation

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The aims of this study were to study the influence of land use systems on the earthworm distribution in Northeast of Thailand. The experimental systems include natural forest, eucalyptus plantation, an organic agricultural and a conventional agricultural system. The effects of land use systems and their management on the distribution and characteristics of earthworm, Pheretima sp. on related soil properties were investigated in rainy season (August-September 2008) and dry season (December 2008-February 2009) during year 2008-2009 in Bann None Daung Mun, Tumbon Sa-Ead, Amphur Meang, Khon Kaen, Thailand. Earthworm populations varied and significantly difference among systems (p<0.05). They were highest in the natural forest followed by an organic agricultural and lower in a conventional agricultural system and lowest in the eucalyptus plantation in rainy season. The same result found in dry season but organic agriculture system had higher number of casts more than in the forest. The same trend was found with the earthworm cast’s height and the earthworm cast’s width.

The result found that the earthworm cast’s width in the eucalyptus plantation were lowest in rainy season but no significant different in the earthworm cast’s width in dry season between each land uses except the eucalyptus plantation. These results suggest that land-use types are strong drivers of the abundance and characteristics of earthworm cast in Thai soil ecosystems. The results of soil quality analysis showed that the biological soil quality as the soil respirations in soil samples from each land use were not significantly different (p<0.05) but it showed that the soil respiration was high in the organic agriculture system and lowest in the eucalyptus plantation. The soil respirations in earthworm’s cast were higher than in soil in rainy season. The results showed that the soil properties of earthworm cast were difference in each land use systems. As for chemical properties, the results found that the soil quality in the earthworm’s cast had higher EC, organic matter, CEC, Total nitrogen, available phosphorus, and calcium and magnesium than in soil especially the highest available phosphorus.

Keywords: earthworm, land use systems, land resource reclamation
Comparison of Microbial Diversity of Paddy Soils in Sustainable Organic Farming

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Agricultural managements significantly influence on soil microbiological properties, such as microbial biomass carbon, microbial biomass nitrogen and respiration rate. This study is aimed to develop and make use of microbial diversity in rice soil as indicator of soil quality for sustainable organic rice farming. The experiment was carried out using the existing rice field (Kao Dok Mali 105 variety) in Surin Rice Research Center, Thailand. Four plots, of rice received different management practices for over 11 years, were investigated under this study. They include: (1) conventional farming (CF) with normal rate of chemical fertilizer applied, (2, 3) two plots of organics: one with green manure (GM) and the other with rice straw (RS) and (4) control plot (CT) without external source of plant nutrients. Soil microbial communities were determined by culture and molecular methods, such as total plate counts, community level physiological profiling (CLPP) obtained with BIOLOG Ecoplate™, and PCR-amplified (16S rDNA) and analysed by denaturing gradient gel electrophoresis (DGGE).

Two-way ANOVA of the results revealed that total plate counts were significantly (P<0.05) affected by the four different management practices. However, GM plot (2.3±1.61x10⁶ CFU g⁻¹ of dry soil) and CF plot (1.8±1.33x10⁶ CFU g⁻¹ of dry soil) were not significantly different (P>0.05). Likewise soil management practices have influenced the microbial diversity; both in functional and genetic diversity in those rice plots studied. The BIOLOG Ecoplate™ study is employed to consider the functional diversity of bacterial communities. With statistical analysis (ANOVA) performed using Shannon-Weaver diversity index (H') and substrate richness (S) from potential substrate utilization patterns as the input data, GM treatment proved to increase the microbial diversity. Genetic community structure showed that the number of bands were similar among all treatments. The results suggested that microbial communities with those bands were stable and not affected by different management practices.

Keywords: microbial diversity, organic farming, paddy soils
Diversity of the Actinomycetes Community Colonising Rice Straw Residues in Cultured Soil Undergoing Various Crop Rotation Systems in the Mekong Delta of Vietnam

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Actinomycetes, phylogenetically defined as a number of taxa within the high-GC subdivision of the gram-positive phylum, are involved in important processes in a wide range of habitats, especially for decomposing organic materials. In this study, we examined the impact of crop rotation on the actinomycetes community colonizing rice straw residues in soil over a period of three field seasons using Denaturing Gradient Gel Electrophoresis (DGGE) fingerprinting analysis based on the V3 region of 16S rRNA gene and sequence analysis of actinomycetes 16S rRNA gene clone libraries from selected samples. The studied yearly crop rotation systems were rice-rice-rice (CRS1), rice-rice-baby corn (CRS2), rice-rice-mungbean (CRS3) and baby corn-rice-mungbean (CRS4). The cropping systems were applied on different experimental plots of the same field location. Litter bags containing rice stems were inserted into the soil and recollected at different time and points for analysis and comparison of the structure of the actinomycetes community colonizing the rice straw.

The results showed that the actinomycetes community colonizing rice straw residues were significantly different in composition in the baby corn-rice-mungbean rotation system (CRS4) compared to those in the 3 other systems during the growth of the first crop and during the growth of the second crop. In contrast, during the cultivation of the third crop, actinomycetes communities were significantly different in rice-rice-rice (CRS1) compared to those in the 3 other systems. The analysis of the 16S rRNA gene libraries constructed from selected samples of rotation systems CRS1 and CRS4 during growth of the first two crops confirmed the DGGE results. Moreover, the diversity of actinomycetes tended to be highest in the CRS4 system and lowest in the CRS1 system. This research shows that different crop rotations have distinctive effects on diversity of actinomycetes colonizing rice straw residue.

Keywords: actinomycetes community, diversity, crop rotation, Mekong delta
The changes in environmental conditions impact upon human, animal and ecological world as well. The impacts are interrelated, as changes in ecological conditions affect the availability of resources and threaten biodiversity. The objective of the study is to explore livelihoods strategies adopted by people in dealing with environmental degradation, whether the communities are able to maintain their livelihoods, do the strategies has contributed to resilience of the social ecological system as a whole. In order to fulfill this aim, we consider a case study of a lake ecosystem which most of the inhabitants rely on the lake resources to support their livelihoods. The study is based on secondary and primary data. Secondary data are derived from reviewing government documents. Primary data mainly is collected through key informants interview, focus group discussion, household’s survey and participant observation. The communities surrounding Singkarak Lake face many disturbances including fishing communities who are struggling with continuous decline of fish population and degradation of its habitat due water pollution and fluctuation of lake level. Furthermore, another group, farmers, also suffers from decreasing and fluctuating lake level. Farmers use traditional waterwheel made of bamboo to irrigate their rice fields, however due to decreasing lake level, they cannot get enough water for irrigation. Both groups of lake dwellers employ different livelihoods strategy to cope with the changes and maintain their livelihoods resilience. Income diversification is commonly practiced, most of fishermen diversify their livelihoods by sending family member to work in the city and practicing fish processing at households level.

Farmers tend to do more intense traditional illegal mining activities along the Ombilin River. The mining activity has caused severe degradation on the river and its surrounding area. It can be concluded that Singkarak Lake side’s dwellers can cope with the changes and maintain their livelihoods through income diversification. On the other hands, those strategies have caused severe environmental impact because people are extracting other resources and abandon conservation of the Lake.

**Keywords**: dynamics of livelihoods, environmental degradation, Singkarak Lake
Fluoride Water Pollution in Central India

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The complex environmental issues i.e. industrial and transport effluent emissions, mixing of industrial and municipal sewage and over use of ground water cause several water borne diseases in India. Many states (>60%) of India is suffering with fluoride osis problem due to the consumption of fluoride contaminated water. One hundred fifteen ground water samples from various sketches of central India, Chhattisgarh state in the post-monsoon period, 2008 was collected for mapping of F- levels. The F- content (n =115) in the ground water was ranged from 0.7 - 17.3 mg l\(^{-1}\) with mean value of 2.9 ± 0.5 mg l\(^{-1}\). Most of these waters became red-orange when exposed to the air due to hydrolysis of metals i.e. Fe, Mn, etc. present at excessive levels. Among them, the Tamnar area (\(+22^\circ 4' 58.80''\), \(+83^\circ 25' 58.80''\)) is severely affected with fluoride contamination of the environment and selected for the detailed investigation. The variations, correlation, and sources of the F- content in the ground water are proposed. The co-existence of other toxic metals with F- in the ground water is discussed.

Keywords: fluoride water pollution, ground water, environment, Central India
Influences of Riparian Land Use on Nitrogen Concentration of River Water in Agricultural and Forest Watersheds of Northeastern Hokkaido, Japan

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This study examines the relationship between nitrogen concentration in river water and agricultural land use in a large-scale upland farming region, with particular emphasis on the influences of riparian land use in agricultural watersheds on the nitrogen concentration in river water. In 21 watersheds in Northeastern Hokkaido, nitrogen concentration was surveyed during normal river flow. Water quality measurement items included T-N and NO$_3$-N. Upland and grassland accounted for 1% to 88% of each watershed, and forestland for 7% to 96%. The survey was done six times during the summer and autumn of 2006 and 2007.

The survey found a close correlation between the percent of upland and grassland in each watershed and nitrogen concentration in the river water. Use of land for agriculture was shown to elevate the nitrogen concentration in river water. Next, using the buffering function of ArcGIS software, we set three buffer zones demarcated from the channel centerline outward: BZ20, BZ60, and BZ100. The subscripts indicate the width of the zone in meters, with the riverbank as 0 m. The ratio of percent of forestland in BZ20 to the percent of upland and grassland area in the watershed was defined as the Land Use Index (LUI), and its relation with nitrogen concentration was investigated.

The investigation revealed a strong negative correlation between LUI and T-N concentration, a correlation that could be approximated by linear regression. From the linear regression formula, we can estimate the minimum LUI necessary for reducing the T-N concentration in rivers to 1 mg/L or less. To keep the T-N concentration of rivers in the study region at 1 mg/L or less, it was determined that an LUI of at least 0.07 should be maintained. This means that forested area equivalent to 7% of the upland grassland needs to be maintained in the riparian land.

We conclude that LUI is strongly associated with the nitrogen concentration of river water. This suggests that even when upland area accounts for much of a watershed, establishment of much riparian forest can reduce the nitrogen concentration in a river.

Keywords: riparian land use, nitrogen concentration, river water, watersheds, Hokkaido
Development of the Indigenous Chironomid Species as Ecotoxicology Test-Tool for Water Quality Management in Thailand

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In Thailand, heavy metals contaminated in aquatic ecosystem particularly in overlay water and sediment has a big concern because it affect on water quality and toxicity on aquatic organism. The aim of this study was to develop the ecotoxicology standard test organism and test protocols for measuring acute and chronic toxicity test using Midge, Chironomus striatipennis Kieffer which is an important indigenous freshwater invertebrate in Thailand. Acute effects of cadmium chloride and lead nitrate on midge larvae were investigated by static bioassay under laboratory conditions. The observed mortality data of the acute test for median lethal concentration 48-h LC$_{50}$ of cadmium chloride on first, second, third and fourth instars of midge larvae were 25.10 (14.61 - 40.67), 201.30 (60.05 - 367.03), 579.31 (536.74 - 620.07) and 641.12 (564.30 - 717.21) mg/L, respectively. The 48-h LC$_{50}$ of lead nitrate on first, second, third and fourth instars of midge larvae were 99.89 (14.68 - 209.13), 55.49 (265.69 - 896.62), 1,539 (1,201 - 1,874) and 3791.10 (2,890 - 4,405) mg/L, respectively.

The results disclosed cadmium chloride and lead nitrate had high toxicity to the first instar larvae followed by second, third, and fourth instar larvae, respectively. Sublethal effects of cadmium chloride and lead nitrate on midge were studied. It was found that cadmium chloride and lead nitrate had effects on the growth of midge, body length of larvae, period in the development of larvae, dry weight, emergence of adult and the number of female and male adult. The result from this study would be useful as developing a biomonitoring tool for heavy metal contaminated assessment in freshwater ecosystem and water quality management in Thailand.

Keywords: ecotoxicology test, heavy metal, chironomid, cadmium, lead, freshwater management
Seagrass Diversity and Distribution in Coastal Area of Kampot Province, Cambodia

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The species diversity and distribution in the coastal area of Kampot Province, Cambodia were evaluated. Observation of general environment conditions which support seagrass growth is included. The samples were taken from 960 points within the seagrass area and quadrat method was used.

Eleven seagrass species were reported. They were: Halodule uninervis, Cymodocea rotundata, Helophilla decipiens, Syringodium isoetifolium, Enhalus acoroides, Thalassia hemprichii, Halophila ovalis, Cymodocea Serrulata, Halophila beccarii, Halophila minor and Halodule pinifolia. Of the twelve species, Halodule uninervis was the most dominant one and widely distributed along the coastline of Kampot.

Based on survey and data analysis, less number of seagrass species occurred in the shallower water (0.1-1 meters) and deeper water (4-7 meters), whereas more species occurred in the water depth of 1-3 meters. Four species; Halodule uninervis, Cymodocea rotundata, Helophilla decipiens, Syringodium isoetifolium widely distribute everywhere. The seagrass coverage in the area is correlated with water depth. The higher seagrass coverage was found in the shallow water whereas the lower seagrass coverage was found in the deeper water.

Among ASEAN countries 16 species exit in the Philippines (Fortes, 1989) and as the greatest number of seagrass species amongst the ASEAN countries, 4 species in Brunei, 12 species in Indonesia, 9 species in Malaysia, 12 species in Thailand (Fortes, 1990), Based the above finding the evaluation would be made that Cambodia is a rich country in seagrass diversity.

Keywords: seagrass, diversity, seagrass distribution, seagrass coverage, Cambodia
Studying on Pig Manure Treatment in order to Minimize Environmental Pollution and Use Bioenergy

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The research was carried out on a pig farm in Hung Yen Province from October 2008 to August 2009. The farm had 36 sows, selling about 1.5 tons of weaned piglets and 33 tons of live weight pigs per year. For the piglets (from weaning to 15 kg) which consume about 0.42 kg of feed/ head/day, they produce 0.25 kg of solid waste in average per day and the coefficient of the solid waste/feed consumed is 0.59. Pigs from 15 to 30 kg consumed about 0.76 kg of feed/head/day, and the coefficient of the solid waste/feed consumed is 0.61. Growing pigs consumed 1.64 kg of feed per day and the coefficient of solid waste/feed is 0.49. This coefficient in finishing pigs (>60 kg) is 0.46 and the consumed feed is 2.3 kg. For the sows, this coefficient is 0.43 for all different periods (gestation and lactation). After 24 hours, in winter the biogas will be produced about 4.16 m$^3$/day in the biodigester of 24 m$^3$, it is much less than in summer (9.06 m$^3$/day). To create one kW electricity, we need 0.92 m$^3$ of biogas. The pig manure treatment by biodigestor was decreased considerably some polluting compositions such as BOD 5 concentrations down to 4.37 times, the COD concentration -5.9 times, the dissolved sulphide concentrations - 8.44 times, the concentration of heavy metals Cu$^{2+}$ - 2.09 times, Zn$^{2+}$ - 1.59 times, the Cl$^-$ concentration - 1.41 times, NH$_4$N - 2.07 times.

Keywords: biogas, liquid waste, solid waste, pig manure
Assessment of Solid Waste Management in Ecovillages  
- Case Study of Konohana Family in Japan

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Inadequate management of solid waste causes environmental and social problems that can be minimized by realizing sustainable practices in communities. In Japan, some communities are taking active role in efforts to achieve sustainability on regional scale. In Shizuoka Prefecture of Japan, a community called Konohana Family is challenging to be a sustainable community, where 55 members live together as a big family; and an ecovillage approach is followed. Ecovillage principles aim to combine social–cultural environment with a low–impact lifestyle. During July, 2009, the preliminary diagnostic and management of solid wastes in Konohana ecovillage were evaluated.

The Konohana Family was founded in 1993 as an organic agricultural community who has inspired in achieving a deep human connection to nature, until they started to grasp ecovillage principles leaned from the Ecovillage Design Education Program promoted by the Global Ecovillage Network. However, visual inspection showed four strengths: the social is health and healing; the economic is right livelihood; the ecological is the organic food production; and the worldview is spiritual. However, specific research topics, such as solid waste management, were not conducted. Thus, this research studies to what extent Konohana ecovillage achieves a sustainable solid waste management. Preliminary diagnostic shows that organic wastes are completely recycled; and to manage inorganic wastes, Konohana ecovillage is not only dealing with reduce their solid wastes generated, but also they receive wastes from neighbors as donation (e.g. clothes, toys, dishes, and so on); and those materials are mainly reused by their members. Future plans consider the option of implementing a Green Clothing Boutique to promote local actions to reuse wastes. Considering the general conditions of solid wastes Konohana community, it is possible that their members are addressing sustainability. However, to identify its achievement, the system thinking concept will be adopted in this research. In conclusion, the solid waste management in ecovillages is being conceived according to a strong sustainable vision, minimizing possible social and environmental impacts. However, long-term studies are necessary to monitor the sustainability at Konohana Family.

**Keywords:** solid waste, management, assessment, Konohana Family, Shizuoka, Japan
**Tree Leaves as Bioindicator for Particulate Elemental Pollution**

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Heavy metal pollution is severe at coal burning site in India. Some tree leaves were reported as simple and versatile tool for detecting metallic air pollution. Therefore, in the present work, the common tree leaves are proposed as indicator for metallic air pollution in the most industrialized zone of the country, Korba city. Heavy metal concentration, such as As, Cr, Mn, Fe, Cu, Zn, Cd, Pb or Hg, in five commonly growing tree leaves (i.e. Eucalyptus, Butea monosperma, Ficus religiosa, Tectona grandis and Azadirachta indica), surface soil or aerosol was evaluated in Korba city, central India.

The sum of total contents of eight heavy metals in the soil and tree leaves was ranged from 1.8 - 4.6 and 0.07 - 0.23% (DW) with mean value of 3.5±0.9 and 0.12±0.05% (DW), respectively. The mean content of the PM10 associated metals such as As, Cr, Mn, Fe, Cu, Zn, Cd, Pb and Hg in the air was 134, 220, 1,080, 21,560, 3,470, 1,750, 29, 1,830 and 103 ng m$^{-3}$, respectively. The data indicated that the enrichment factor (ratio of metal content in leaf to soil) was ≥ 1.8 for metals of As, Cu and Zn in Azadirachta indica leaves. These data showed that the Azadirachta indica may be considered as a heavy metal pollution bioindicator.

**Keywords:** tree leaves, bioindicator, particulate elemental pollution, Korba
Vermicompost: Tool for Agro-industrial Waste Management and Sustainable Agriculture

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Agro-industrial waste is one of the big issues and difficult to manage due to Thailand is an agricultural country. There is a need for the safe, ecological sound, economically viable and socially acceptable technology. The aim of this study was to use vermicompost to manage agro-industrial waste. The feasibility study experiment of using vermicompost to reduce the cadmium contaminated in some typical Thai soil Nampong (Sandy) and Phimai (Clay) soil series were conducted by spike soil with various concentrations of Cd (0, 5, 50 mg/kg of Cd) as CdCl$_2$. The physical and chemical properties of soil were analyzed before and after compost and vermicompost.

The results found that vermicompost reduce the cadmium contamination. Earthworm activity significantly increased the availability of soil pH, P, K, Na, Mg, Ca, and decreased organic carbon, Cd contamination in soil. The production of earthworm was increased followed by the increasing of agro-industrial waste. Therefore, vermicompost is an answer and suitable method for agro-industrial waste management that can use the local and available materials by a healthy quality and less impact of environment for decreasing global warming and increasing organic matter content and available nutrient to plant and microorganism in soil ecosystem and can survive in the environment contaminated with heavy metals. The vermicompost could be suitable tool for agro-industrial waste management and source of nutrients for plant production in sustainable agriculture.

**Keywords:** vermicompost, agro-industrial waste, sustainable agriculture
Environmental Risk Assessment of Agrochemical Packaging Waste in Northeast, Thailand using Modeling and GIS

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The aim of this study was to monitor environmental risk assessment of agrochemical packaging waste in Northeast, Thailand by using modeling and Geographic Information System (GIS). The route of agrochemical packaging waste was monitored by interviewing farmer using questionnaire and the effects of diffuse pollution from agrochemical waste in soil and water were studied. The result found that the ranging of pesticide use from highest to lowest in Northeast of Thailand were organophosphate, pyrethroid, carbamate, organochlorine, thiocarbamate, paraquat, and others, respectively. Therefore, mathematic model and Geographic Information System (GIS) were used as tools to perform site-specific risk assessment by integrating land use, soil properties, metrological data, rate of application, chemical properties of pesticide and toxicological data for aquatic and soil organisms. The outcome of this study is useful for agrochemical waste management and reduces the diffuse pollution of agrochemical waste to environment.

Keywords: modeling, geographic information system, environmental risk assessment, agrochemical packaging waste
Soil Biota Activities Relation with Soil Characteristics in the Improved Salt-Affected Area by Tree Plantation

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Salt affected soil is a serious problem in Thailand, in the Northeast Plateau where salt bearing rocks are common. Excessive amounts of salts have a range of adverse effects on the physical and chemical properties of soil microbiological processes and plant growth. However, soil biological aspect of saline environment has been less studied.

Tree plantation has been introduced to improve salt-affected area. Monitoring of the changes by study the soil biota activities relation with physical and chemical soil characteristics are importance. The aim of this study was to monitor the change of soil biota activity relation with the soil properties in the improved salt-affected area by tree plantation at Amphur Borabue, Mahasarakam Province. The study area was divided into 3 zones followed by the plant community found in each area which correlated with the flooding situation and soil salinity. The soil physical, chemical and biological characteristics in soil sample were analyzed. The results showed that soil biota activity after tree plantation was higher than before. Soil respiration before and after tree plantation were 12.13 and 71.50 mg CO$_2$/day, respectively. The EC, Na, CEC values were reduced and pH, OM, and N were increase after tree plantation. The result would be useful for sustainable land resources improvement and rehabilitation.

Keywords: salinity, soil biota, salt affected area, soil respiration, soil characteristics
**The Influence of Eucalyptus Plantation on the Soil Ecosystem under Different Soil Series in Northeast, Thailand**

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Eucalyptus has been introduced to the farmer and extensively grown in Thailand for paper pulp production and give high income to farmer. However, the long term impact on soil ecosystem has been less studied. Therefore, the aim of this study was to investigate the influence of eucalyptus plantation on the soil ecosystem under different soil series in Northeast, Thailand. The biological, physical and chemical properties of soil in Eucalyptus plantation (more than 3 years) were analyzed and compared with the dry dipterocarp forest nearby. Moreover, impacts of eucalyptus on soil biota (Earthworm) under different soil series (Pimai and Nampong soil series) were evaluated in the laboratory.

The results indicated that microbial activity and microbial biomass nitrogen as soil respiration in Eucalyptus plantation were less than in the dry dipterocarp forest significance from 3.950 to 5.916 mg C/m²/day for microbial activity and then 15.811 and 108.620 µg N/g Soil (p<0.01) for microbial biomass nitrogen, respectively but microbial biomass carbon was not significantly difference (p>0.05). For the 50% avoidance of the earthworm to eucalyptus leave in Pimai (Pm) and Nampong (Ng) soil series were 17.35 and 19.44 g/kg soil, respectively. The result showed that eucalyptus plantation has adverse effect on soil microbial activity in soil ecosystem and differ in each soil series. The result of this study will be useful for involved organizations for decision making and land use management. The impact of eucalyptus plantation should be considering of site specific location and find out the suitable place to grow eucalyptus.

**Keywords:** eucalyptus, soil characteristics, soil ecosystem
Local Trans-Boundary and Inter-Sectoral Water Pollution Management - A Case Study of an Action Research in Ratchaburi Province, Thailand

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Local trans-boundary and inter-sectoral water pollution is one of the most serious problems affecting many contiguous rural-urban areas in Thailand today. Effective management of pollution in canals in these places is commonly confronted with major obstacles posed by pre-existing problems of conflicting uses between industries, non-farming and farming sectors of local water system; low conservation awareness of communities and small and medium farm owners along the canal; administrative and territorial separatism of districts and sub-districts governments; distinct mandates between functional agencies dealing with various aspects of water quality and allocation; and environmental regulation. This paper presents a case study of a development initiative of CIDA-AIT to address these difficulties and challenges in Bang-Pa canal in Rathchaburi Province in Thailand through an action research project. It involved mobilization youth and women groups, seven Tambon (sub-district) Administrative Organizations (TAOs); and local governments (i.e. Regional Environmental Office, Agricultural Office, and Livestock Office) plus a local school and piggery farm owners. The action research has components of networking, training workshops, stakeholders’ dialogue and appropriate technology.

Through participatory research and use of biosensors it was able to monitor and clarify immediate sources and responsibilities in water canal pollution, raised awareness and initiated collective actions of concerned communities. Through an on-site wastewater treatment technology for a small piggery farm, it has demonstrated a viable technology option for pig owners. Local authorities in the province have responded positively and have committed to officially continue with aspects of the project and give it strong policy support. Momentum for multi-stakeholders’ dialogue has thus been generated as an important problem solving approach. The project though faces other problems related to sustainability even as it has undoubtedly served its purpose in deepening understanding of and catalizing positive local actions to address to complexities and challenges of local trans-boundary and inter-sectoral pollution management in water canals.

Keywords: local trans-boundary, inter-sectoral, water pollution management, Ratchaburi
Characteristics of E. coli Loss under Different Fertilization of Manure

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Approximately 90 million tons of dung is being produced annually from cattle farms all over Japan. Considering the proper treatment of this waste product, applying manure to farmlands has been focused from a viewpoint of popularizing organic agriculture. However, pathogenic bacteria known as E. coli may possibly be released from the immature fermented manure that was applied in farmlands.

In this study, model experiments were conducted employing slope plots under artificial rainfall simulator to investigate the E. coli loss. The slope plots were filled with soil and then applied 3 types of manure such as cow dung, manure fermented for 2 weeks and 12 weeks. In addition, two methods of application were proposed such as broadcasting method and incorporating method to differentiate the loss of E. coli from farmlands applied manure.

The experimental results showed that there was slightly difference in the amount of E. coli loss from two methods of broadcasting method and incorporating method. The difference was observed for E. coli loss through percolation from the plot applied manure fermented for 12 weeks. E. coli loss was not observed from the plot with broadcasting method, but observed from the plot with incorporating method. However in both methods, surface runoff showed higher amount of E. coli loss compared to percolation. In addition, there was a tendency that the loss of E. coli decreased with fermentation stage of cow dung.

Therefore, it was concluded that the loss of E. coli, being affected by the fermentation stage of manure, was remarkably influenced by surface runoff in both broadcasting and incorporating methods.

Keywords: E. coli loss, fermentation, fertilization, broadcasting, incorporation, manure


Soil Erosion Control by Coconut Husk Buffer Strip
- A Situational Strategic Approach in Bohol Island, Philippines

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Agricultural activities on slopes, exploitation in some parts of mountainous areas for subsistence agricultural purposes are some of the factors that soil erosion continuously occur in the island of Bohol, Philippines. Along with the high precipitation in the interior mountainous areas in the island, upland fields and other less vegetated areas on slopes are susceptible to soil erosion that leads runoff to downstream waters causing eutrophication and sedimentation. In connection with, a strategic measure has been focused with the use of coconut husk to mitigate the effects of soil erosion.

To observe the capability of the coconut husk as a buffer strip to trap soil and nutrient losses, a modeling experiment was conducted by using slope model plots under an artificial rainfall simulator. Three stainless slope model plots were prepared and filled-up with clayey soil from Bohol, Philippines. Coconut husk buffer strips were installed at the lower end of the two plots leaving one plot without buffer strip as a controlled plot.

Based on the experimental results, 98% of the eroded soil particles from 106 µm in diameter to larger sizes were trapped by the coconut husk buffer and at least 27% on the diameters below 106 µm. However, nutrient losses from the husk buffered plots tended to be higher than the losses from the controlled plot. It was observed that the load of nitrogen from the husk buffered plots through the surface discharge and percolation was 1.25 and 2.62 times higher than that from the controlled plot. Also, 5.18 times higher of phosphorus in the percolation compared to the controlled plot.

In conclusion, the coconut husk buffer is effective to trap soil losses however the buffer medium may contain and emit nutrients which apparently caused the increase of nutrient losses from the buffered plots. Therefore, it was suggested that pretreatment of the material is required before installing as an erosion buffer medium. In connection with, further studies are going to advance on how to treat the material and to find alternatives on how to utilize the constituent nutrients in the coconut husk.

**Keywords:** coconut husk, buffer strip, trapping capability, soil and nutrient losses
Removal of Nitrate Nitrogen in Activated Carbon with Calcium Treatment

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As chemical fertilizers have been applied to farmlands beyond the environmental capacity, leaching of nitrate nitrogen (NO$_3$-N) have been causing severe problems, such as groundwater contamination or eutrophication in water systems in watersheds. Also, high concentration of nitrate nitrogen in groundwater happens to affect human health, especially for fetus. So, this study dealt with the strategy on removal of nitrate nitrogen from farmlands through the column experiment using charcoal granules with calcium chloride (CaCl) treatment.

In the experiments, 2 types of charcoals were prepared; one was charcoal granules with calcium chloride (CaCl) treatment and the other charcoal granules without the treatment. The experiments were conducted to corroborate the removal of nitrate nitrogen between 2 types of charcoal granules, and to quantify the amounts of charcoal granules added for certain amounts of nitrate nitrogen removal. Glass beads, around 1.1 mm in diameter, were used as an alternative soil and incorporated with the charcoal granules of 10, 20 and 30% by volumetric basis.

Based on the experimental results, the charcoal granules with calcium chloride (CaCl) treatment showed 1.10 times higher in removal of nitrate nitrogen compared to charcoal granules without the treatment.

Keywords: nitrate nitrogen removal, activated carbon, calcium chloride, treatment
Indigenous Community Forest Management in Northeast Thailand - Biodiversity Conservation through Rural Development

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Deforestation which causes the forest area decreasing and lead to the global environmental change through biodiversity loss and emissions of greenhouse gases is one of the important environmental problems face by developing countries like Thailand. Forest management is an important biodiversity conservation and carbon mitigation strategy.

The aim of this study was to investigate the suitable strategy for forest management in local community in Northeast of Thailand basing on the community participation. Plant biodiversity in Khon Kaen local community forest (200 Rai (= 32 ha)) was surveyed during 2008-2009, Focus Group Interview and SWOT analysis was used as a tool to find out the sustainable strategy for forest management. The result found that forest biodiversity was rich. Eighty plant species were found in this area. Indigenous community forest management such as traditional, cultural, local commitment and believe is the suitable forest management. The outcome of this project in long term will be beneficial for biodiversity conservation, carbon mitigation and sustainable rural development.

Keywords: indigenous community forest management, biodiversity conservation, carbon mitigation, rural development
Soil Quality Assessment for Coffee Production in Pakxong District, Champasak Province of Lao People’s Democratic Republic

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Quality assessment of coffee cultivated soils in Pakxong district Champasak Province of Lao People’s Democratic Republic studied by using soil samples representing coffee cultivated soils in 9 villages of Pakxong district such as Lak 35, Lak 40, Nongbone, Lak 43, Kapheu, Nonglouang, Phoumaknao, Phou oy and Phoumako. The study includes survey methods on soil profile description and explore the area with environmental samples. The collected soil samples were analyzed on physical and chemical properties to evaluate different soil properties related to the requirement of coffee. The main objective of the study was to assess the potential of land suitable for coffee. Assessment of the fertile soil in the coffee plantation showed that most soils are moderately fertile and assessment of potential soil by soil quality assessment found that most areas are medium appropriate for coffee but some areas are slightly right and some areas are more appropriate. However, guidelines for proper soil management are held the amount of organic matter in soil and soil should be well managed and continued for maintain or improve soil potential.

Keywords: coffee cultivated soil, soil quality assessment, soil fertility
Indigenous Practices of Soil and Water Conservation for Sustainable Hill Agriculture and Improving Livelihood Security

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Soil and water are the two important natural resources, which are the backbone of the Indian Agriculture. In the foothill region of N-W Himalayan region of India, these two resources are limiting the crop production because of reduction in soil fertility and productivity, due to massive soil erosion. The most critical management challenge is how to deal with poor distribution of rainwater leading to short periods of too much water and flooding, and long periods of too little water. The farmers are socio-economically poor and there is great challenge for developmental activities including nutrient management and soil moisture conservation. Checking of soil erosion is one of great challenge for sustainable crop production. Farmers in the area had developed an innovative technology of soil and water conservation and crop production, which has helped him to sustain so far. In order to manage land, water and vegetation, technical knowledge suitable to the specific conditions of a region was required. Indigenously adopted traditional knowledge of practices which vary from place to place in the sub-hill region are stepping stones for development of any improved technology for soil and water conservation and crop production. Indigenous practices for soil and water conservation such as field bunding, pre-monsoon ploughing, filter strips, earthing-up in maize, mulching, compression of soil in sugarcane are effective in preventing soil loss, conserving in-situ moisture and soil fertility restoration.

The experience of some indigenous farming systems in North-east hills of India, involving efficient use of water under stress conditions, has shown that food production can be increased by 2.0 to 3.0 folds if the available water is utilized properly. The mention may be made of ‘Bamboo Drip Irrigation’ system, and Zabo (means impounding of water) system. The availability of irrigation water and the corresponding yields in different states of India when compared with north-east region shows significance of water.

Keywords: indigenous practice, soil and water conservation, sustainable hill agriculture
**Sustainable Soil Management and Crop Production through Conservation Tillage**

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Conservation tillage systems offer numerous benefits than intensive tillage systems. Sustainable soil management is possible through conservation tillage practices such as zero tillage or minimum tillage. Conservation tillage has positive effects on soil chemical, physical and biological properties compared to conventional soil preparation. Also, reduced tillage or conservation tillage has the remarkable benefits not only for increasing soil aggregation or organic matter content but also for reducing soil erodibility. Soil moisture holding capacity generally increases under reduced tillage. Also, conservation tillage contributes to make higher in nutrient availability, cation exchange capacity, and microbial population compared to conventional tillage.

Conservation tillage could offset as much as 16 % of world-wide fossil fuel emissions and can slow or prevent the loss of organic C in the soil. Reduced tillage systems also play an important role in energy saving. This method of tillage provides an opportunity to farmers to plant wheat at least 7-10 days earlier. This allows more time for crop growth and thus a yield premium of 1-2% per day depending upon the region because time sowing has a significant effect on productivity of wheat. Use of conservation tillage methods to establish wheat after rice enables farmers to sow and harvest wheat earlier than normal, allowing them to introduce an additional crop into their annual rotation. Sowing of wheat after rice in the Indo-Gangetic plains of India under conventional tillage involves pre-sowing irrigation, intensive land preparation and finally seeding on fine tilth soil which consume enormous time, labour, irrigation water and energy, which in turn results in delayed sowing of wheat, poor plant growth and crop yields.

**Keywords:** sustainable soil management, crop production, conservation tillage
Strategy for Soil Fertility Management in Rainfed Lowland Rice in Cambodia

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Rice (Oryza Sativa L) is a staple food of Cambodian population and accounts for 68-70 percent of daily calorie intake. Rainfed lowland rice ecosystems are often hampered by drought, submergence and soil problems (Acid Sulphate) that associated with low productivity and with a high incidence of poverty. These ecosystems have many factors and constraints rice production such as soil quality and soil problems, flood and drought, water problems, pest and diseases and crop management of farmers, etc.

To cope with the problems, a study was conducted to identify the best practices in soil fertility management and conservation on sandy soil for improving rice yield and cost effectives of rainfed lowland rice production systems in order to contribute to the improvement of food security and income generation of rural farmers. Three research experiments are conducted in rainfed lowland rice agro-ecosystems in Champei commune, Bati district of Takeo province during mid 2006 to mid 2009: (i) assessment of agro-ecosystem analysis and rice agro-ecosystems, (ii) study on interaction of NPK fertilizers and compost on rice yield cost-effectives of interaction of NPK fertilizers and compost in sandy soil of rainfed lowland rice of rainfed lowland production systems and (iii) conduct adaptive research in farmer fields (on-farm research) on interaction of NPK fertilizers and compost in sandy soil of rainfed lowland rice ecosystems.

The results clearly indicated that: (i) the factors and parameters impact on rice productivity and yield are poor soil fertility (sandy loam soil) and management of soil fertility and (ii) two options of best practices were identified for improving soil fertility management and rice yield i.e., a. for farmers raising a limited number of cattle (1-2 cattle) and limited access to compost fertilizers should use N25 P13 K15 or Urea: 44 kg, DAP: 25 kg and KCl: 25 kg plus 5 tones of Compost per hectare and b. for farmers raising more cattle and produce plenty amount of compost fertilizers should use N25 P13 K15 or Urea: 44 kg, DAP: 25 kg and KCl: 25 kg plus 5 tones of compost per hectare.

Keywords: soil fertility, rainfed lowland, rice, productivity, Cambodia
Rice Soil Fertility Classification and Constraints the Mekong Delta

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In the Mekong delta, areas of intensive rice production have been rapidly enlarged. Soil fertility degradation in this system can be one of the most important factors contributing to the yield decline. Information on soil fertility and recommendations on improving soil constraints will provide basic data for proper soil management, land evaluation and land use planning. A Fertility Capability Classification (FCC) system, based on the work of Sanchez (2003), incorporates characteristics of soil morphology, soil physics, and soil chemistry.

Data from 300 soil profiles and 28 field experiments were collected from field surveys and other sources, showing that there were 25 rice soil fertility types, and the major soil constraints for rice cultivation can be listed as follows: low organic carbon content (o); high P fixation and high Fe toxicity potential (i); potential salinity (s-); low available P (p); high acidity and Al toxicity (a); the separation of actual acid sulfate soils (c, c-) and potential acid sulfate soils (f, f-).

Keywords: soil fertility type, FCC, soil fertility, constraints, degradation
**Chemical Properties and Sustainability of Rice Soil in Rice-Shrimp Farming in Mekong Delta**

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Rice-shrimp farming in the Mekong delta is a special cultural system in seasonally saline areas. Rice-shrimp farming may give highly profitable land use practice, in turn, soil and water environment may become degraded. The research was carried out at Kien Giang and Bac Lieu Provinces to evaluate water quality, soil physico-chemical properties, and rice yield of rice-shrimp farming system. The value ranges of pH of canal water and top soils were found at suitable for rice cultivation. ECe of rice fields varied with EC of irrigated water. Soil ECe was high at beginning of the rice crop (12 mS cm$^{-1}$) and remained high at harvest (8 mS cm$^{-1}$). These ECe values were not suitable for rice growth and therefore less suitability for rice production. The use of saline water to raise shrimp at Phuoc Long after many years has caused high soil ESP and SAR and the soils could be grouped as saline-sodic soil. Economic benefit from rice-shrimp farming system was 2.02 million VND/ha but mainly from rice, which equal to 80.7% and this benefit did not satisfy farmers’ expectation. There is the need to have field research to mitigate saline-sodic condition from rice-shrimp farming in the Mekong delta.

**Keywords:** rice-shrimp farming, ECe, field-water EC, ESP, SAR, saline-sodic soil
Piggery Farm Wastewater
- Alternative Solution for Agriculture and Soil Fertility

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The consequences of piggery farm are increasing public concern particularly, wastewater because of its high pollutant potential. Without the good wastewater treatment systems, it could lead to contaminate the natural water resources nearby. The number of the small and medium size of piggery farms could not afford the wastewater treatment cost. The wastewater management is needed. The objective of this study is to evaluate the water quality characteristics from the piggery farm in Northeast of Thailand and feasibility study of using wastewater from piggery farm for agriculture purpose.

The wastewater from influent, effluent from the system and wastewater before release to natural waterway were sampled and analyzed for water characteristics in term of pH, Temperature, Electrical Conductivity (EC), Total Kjeldahl Nitrogen (TKN), Phosphorus (P), Total Solids (TS), Total Suspended Solids (TSS), Total Dissolved Solid (TDS), Fat Oil&Grease (FOG), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) and other heavy metal contaminants such as Zinc (Zn), Lead (Pb), Cadmium (Cd) and Cupper (Cu). The results found that the wastewater had high potential to pollute the natural waterway. However, some water quality characteristics such as N and P may be the source of good nutrients for agriculture production and increasing soil fertility. Therefore, using piggery farm wastewater for agriculture may be one of alternative solution for soil fertility and wastewater management.

Keywords: piggery farm wastewater, agriculture, soil fertility
Effects of Stable Mulching on Plant Growth of Pearl Millet and Soil Moisture Condition

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Sub-Saharan Africa is one of the most hazardous regions, as desertification has been advancing there. In order to mitigate an environmental degradation for crop growing, this study aims to investigate the effectiveness of stable mulching in controlling the soil moisture evaporation.

The experiment was carried out at the greenhouse of Tokyo University of Agriculture, Japan. Pearl millet (Pennisetum glaucum (L.) R. Br.) was cultivated at each plot of 6.5 m length and 0.8 m width and soil moisture has been observed using a TDR soil moisture meter. Nine plots were divided into 3 groups based on the amounts of irrigation; one was irrigated at 3 to 6 mm/day (Standard plot), at 2 to 4 mm/day (2/3 water-saving plot) and at 1 to 2 mm/day (1/3 water-saving plot). Each group was constituted with 3 different treatments, mulching with pearl millet stalk residues, mixing soil with pearl millet stalk residues, and non-mulching. The irrigation amount of standard plots was same as that for upland rice in Japan, and the irrigation amounts of 2/3 or 1/3 water-saving plots were estimated on the basis of the precipitation in Sahel-Sudan climate zone or the Sahel climate zone, respectively.

The results indicated that plant growth in pearl millet above ground surface did not show significant difference among the plots of different irrigation amounts. Pearl millet even in the 2/3 or 1/3 water-saving plots grew as well as that in the standard plot. However, there was a tendency for the number of tiller in the plots of mulching or mixing with pearl millet stalk residues to be more than that of non-mulching. In addition, the trend of increasing number of tiller in the plots applied mulching or mixing with pearl millet stalk residues did not have a remarkable difference with amounts of irrigation. It means that mulching or mixing with pearl millet stalk residues is more effective for plant growth comparing to non-mulching even in the condition of Sahel climate zone.

Keywords: stable mulching, plant growth, soil moisture, pearl millet, Sub-Saharan Africa
Management of Manure Taking into Account of E.coli Loss from Farmland

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Large amounts of livestock excrement are being produced in Japan. Up to the present, most of excrement are being utilized and considered as one of the good sources for soil condition of farmlands. However, there were reports that the manure, which is fermented insufficiently, includes pathogen such as E.coli that threatens the environment and human health. Thus, a proper management of the excrement before applying to farmlands becomes an important issue. In addition, E.coli can be easily transported by surface runoff along with the soil sediments and may percolate into the groundwater in farmlands where manure was applied. So, the loss of E.coli from farmlands and the survival condition of E.coli in manure are big issues from viewpoints of environmental conservation and public health. Therefore, research interests have been paid to the loss of E.coli from farmlands taking into account of surviving limit of E.coli in manure.

Model experiments were conducted employing slope plots under artificial rainfall simulator to investigate the E.coli loss from farmlands. Since it was indicated that cow dung includes E.coli more than other animal excrement, manure from cow dung was used in this study. The slope plots were filled with soil and then applied 3 types of manure, cow dung, manure fermented for 2 weeks and 8 weeks. Based on the experimental results, it was indicated that the E.coli loss increased with the amounts of sediment loss. This tendency was observed not only the plot applied cow dung but also the plots applied manure fermented for 2 weeks or 8 weeks. It was obvious that E.coli lost from even the manure which was fermented for 8 weeks. So, attention should be paid more to manage manure before applying to farmlands.

In addition, to manage manure properly, several experiments to investigate the factor of E.coli surviving limit in manure were carried out. It was observed that E.coli vanished at the temperature over 60 degrees Celsius under constant water content. Furthermore, there was no correlation between survival of E.coli and water content of manure in the range from 10% to 80%. So, it was clear that temperature was the most effective factor for E.coli to vanish. Further study is expected for establish the strategy to vanish E.coli during the fermentation of manure.

Keywords: management of manure, fermentation, E.coli loss, environment
Ecological Risk Assessment of Using Swine Wastewater for Agriculture

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The environmental consequences of swine farming are increasing public concern particularly waste and waste water. Wastewater reuse for land application has been concerned for the environmental risk assessment. The aim of this study was to evaluate the diffuse pollution from swine farm, in terms of water quality parameters in effluent and copper contamination due to the application of swine waste water in different Thai soil series. The results found that wastewater effluence had an average BOD, COD, TDS, Total N, pH and EC= 467, 320, 3950, 0.048, 7.8, 4.5 respectively, an average copper concentration of 0.05-0.28 mg/L. Copper contamination in two Thai soil series (Roi ed (Re) and Nampong (Ng) soil series) after applied the swine wastewater were analyzed. The results showed that copper were found in Roi ed (Re) soil series higher than Nampong (Ng) soil series but in opposited with the copper concentration in leachate from two soil series. In conclusion, the land application of swine waste water effluence should be under consideration about the ecological risk and impact on soil ecosystem differs from each soil ecosystem.

Keywords: diffuse pollution, swine wastewater, copper, soil series
Using *Azolla pinnata* for Poultry Wastewater Treatment

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Waste water from animal farming especially from poultry industry has one of the sources of non-point source water pollution in Thailand. Plants can be an interesting tool for in situ remediation of waste waters. Water fern (*Azolla pinnata)* has been used assessed for nitrogen and phosphorus removal from waste water and can be good for increase soil fertility. The objectives of this study were to use *Azolla pinnata* for poultry industry wastewater treatment and potential use of *Azolla pinnata* biomass for increasing fertility of soil resource. The results found that *Azolla pinnata* can reduce BOD of wastewater from slaughter to 41% and produce the biomass of *Azolla pinnata* 90, 167, 245% in 100, 50, 25% dilution of wastewater, respectively. This study demonstrated that *Azolla pinnata* can be taken into consideration as a tool for wastewater treatment from agriculture activities especially suitable wastewater treatment for small poultry farming.

**Keywords:** *Azolla pinnata*, phytoremediation, wastewater, poultry activities
Indigenous Agricultural Knowledge
- A Sample of Practicing in Northeast Thailand

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The Northeast is the largest region of Thailand with approximately one third of both the total land area and population of the country. However, the region showed the lowest per capita income. This was due to the region agricultural systems dominated by rainfed farming, poor soil quality and fluctuation in market demand and price for the agricultural production. In general, more than 50% of farm income earn from crop sector rather than livestock. Under a risky business, farmers have learned their environments which included physical, biological and socio-economic in site specific areas. Then, they adapted farming techniques which has been given the name “indigenous agricultural knowledge” to improve crop yield and household income.

This paper illustrates the overview of indigenous agricultural knowledge in Northeast Thailand which included land preparation, pre-germinated seeds, eliminated buds, detaching flowers, decreasing leaf areas, suppressing weeds, alleviation of insect and disease damage, improving soil quality, post-harvest techniques and multiple cropping. Indigenous agriculture knowledge has been systematically few recorded in written form and therefore are not readily accessible to agricultural researchers. Indigenous agricultural knowledge is an immensely valuable resource that provide farmer-to-farmer training or transfer technology.

Keywords: indigenous agricultural knowledge, farmer training, Northeast Thailand

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There has been little information available on nutrient and heavy metal inputs via animal manure (cattle, poultry and pigs) in IAA-farming systems in Thailand. In this study, the nutrient and heavy metal contents in IAA-farming systems were measured, so that metal budgets could be constructed and “typical” rates of the inputs to IAA-farming systems could be calculated. This recent study has been carried out during August 2007 to May 2008 to investigate IAA-farming systems in peri-urban area in Thailand. Small scale pig farms in the peri-urban Pathum Thani province near Bangkok were selected as they were considered a typical of up to a third of total pig farms of the country. The specific objective of this study was to quantify nutrients and heavy metals (N, P, K, Mg, Cu and Zn) fluxes in (i) the agricultural system with small scale pig farm and (ii) the downstream aquacultural system with piggery waste-fed fish pond. It was necessary to quantify the amount of nutrients released as a result of farming and to estimate the assimilative capacity of the surrounding environment. Nutrients input (feed) and releases as a result of pig manure have been sampled monthly in the fattening period (about 6-7 months) to provide information on the environment load in that period. As nutrients and heavy metal fluxes (N, P, K, Mg, Cu and Zn) in the IAA system were quantified, they could be used for farm management with a view to decreasing environmental impact of piggery and fish farms. Nutrient and heavy metal flux data could be used as a basis data for developing of a practical tool to estimate nutrient flux for an integrated agriculture aquaculture (IAA) system.

Keywords: IAA-farming systems, peri-urban area, piggery waste, heavy metal, environment impact
Influences of Land and Water Use on the Water Quality of Canal through Agricultural Area

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Shinotsu Canal through agricultural area contains high load of pollutants from catchments. Pollutants load from Shinotsu Canal influence on the water quality of the Ishikari River which consequently affects the aquatic biota of downstream. Therefore, this study was carried out to evaluate the influences of agricultural land and water using activities on the water quality of Shinotsu Canal. Shinotsu Canal is 25 km and contains 10,864 hectares catchment hence divided 10 sub-catchment (CA2~CA11). The proportions of major land uses such as paddy field, upland, forest and others categorized by supervised classification method by satellite data from each sub-catchment. Water samples were collected from 11 points (P1~P11) from upstream to downstream manually from May, 2006 to April, 2009. Concentration of SS was analyzed by suction filtration, NO$_3$-N was by ion-chromatographic method and total nitrogen (T-N), total phosphorus (T-P) & NH$_4$-N were by UV-spectrophotometric method, respectively.

Concentrations of SS, T-N and T-P were found the highest in paddling period (PP). The highest concentration of NO$_3$-N and NH$_4$-N were shown at snow melting period (SMP) and snow covered period, respectively. The linear regression analysis showed positive significant based on the correlation coefficient between accumulated paddy field area (APA) (APA$_i$ = $\Sigma$ PA$_i$ = PA$_2$+PA$_3$+ ------ +PA$_i$, where i=2~11) and SS ($r=0.94^{***}$), also accumulated upland area (AUA) and SS ($r=0.96^{**}$) at PP. T-P concentrations also existed similar significant as SS. T-N showed high correlation between APA ($r=0.94^{***}$) and AUA ($r=0.98^{***}$) at SMP. The changing rate of SS and land use indicated very prominent at PP. Concentrations of SS, T-N and T-P were higher in downstream (P11) than upstream (P1) at all periods except normal irrigation period in case of T-N. It can be concluded that land and water using for agriculture, seasonal characteristics of meteorology and management of fertilizer affected on the water quality of Shinotsu Canal.

Keywords: land and water use, water quality, agricultural area, Hokkaido
Adverse Effects of Elevated Ambient Ozone on Yield and Protein Loss of Three Thai Soybean Cultivars

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Various studies in the past have shown that high ozone concentration significantly decreased yield and nutrition in soybean, but there is little information in Thailand. Hence, an examination of aforementioned problem is required. So, the objective of this study is to know the different adverse effects of elevated ambient ozone concentration on yield and protein content of Thai soybean. The research experiment was conducted from December 2007 to March 2008 at Field Crops Research Center located in Phitsanulok, Thailand. Thai native soybean 3 cultivars such as Chiang Mai 60, Sorjor 5 and Srisumrong 1, were planted and covered with open top chamber (OTC) since seedling through maturing stage. The OTC with charcoal filtered and non-charcoal filtered were set to control the O₃ level at three different levels at ambient level (32 ppb), lower (12 ppb) and higher than ambient level (62 ppb).

The experimental results indicated that growth and yield loss at maturing stage obviously occurred significantly in all 3 cultivars under the level being higher than ambient O₃ concentration. In addition, the different reductions in number of seed per plant of Chiang Mai 60, Sorjor 5 and Srisumrong 1 at 37%, 28% and 33% respectively, when they exposed to 62 ppb O₃ compared to the lower ambient level. However, the significant reduction in plant height appeared only to one cultivar, Sorjor 5 at 14%. The similar result was obtained in protein content. Sorjor 5 cultivar showed the most sensitive to higher level of O₃ concentration in protein content reduction at 2.3% significantly, whereas the significant reduction with higher level of ozone were not found in Chiang Mai 60 and Srisumrong 1. Accordingly, this study was concluded that a long-term higher O₃ exposure caused different adverse effects in among 3 Thai soybean cultivars. Sorjor 5 showed higher in ozone-sensitive than the other cultivars.

Keywords: ozone; Thai soybean, open top chamber, yield, protein
Effective Heat Dissipation in Hot-Humid Climates  
- The Hypothesis Formulated by the Results in Swamp Buffaloes

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Most countries of Southeast Asia are included in hot-humid climates generally with high humidity and small diurnal change in air temperature throughout the year. These conditions are harsh for heat dissipation in large livestock ruminants accompanying with fermentation heat, because the conditions prevents evaporative heat loss (panting and sweating). Swamp buffaloes are distributed widely throughout this climatic zone as a large livestock ruminant, and traditionally provide power to plough farm fields. Also, the buffaloes are good for small farmers that are found a lot in this area, as these animals show a good digestibility to low quality roughage.

For animal production in hot-humid climates, crossbred cattle have been exploited as an efficient tool for blending the adaptability of tropical cattle accompanying with high sweating rate. But the effective heat dissipation is still a major problem in this area. Buffaloes easily sustain heat stress under solar radiation in comparison with tropical cattle, but quickly recover from the stress after moving into the shade or spraying with water. Therefore these adapted animals to this area must have the effective physiological system for heat dissipation under hot-humid conditions.

Several experiments had been done for comparing thermoregulatory responses between swamp buffaloes and cattle. Also some responses in hormones and blood parameters were also compared between two species. In hot conditions, the active heat transport through blood flow and water turnover were shown in buffaloes in comparison with temperate or tropical cattle. In hot-humid climates, there is usually high water availability with a large amount of precipitation. Therefore the effective heat dissipation in buffaloes may be carried out through water utilization rather than evaporative heat loss in this climate. The observed physiological system suggests the adapted heat dissipation in this climates as well as behavioral heat dissipations e.g. wallowing.

Keywords: swamp buffaloes, heat dissipation, hot-humid climates, Southeast Asia
Zinc Deficiency in Agricultural Systems and Its Implication to Human Health

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There are more than 3 billion world population are directly or indirectly affected with low zinc (Zn) supply to their food causing up to severe health problems, which is also linked to Zn deficiency in most agricultural soils world-wide. Agricultural technologies can be directed toward the improving nutritionally rich food systems, which plays very important role in public health. Food systems are therefore, important for better health of people, which now are failing to provide adequate quantities of essential nutrients particularly in many developing nations. Several studies have been done to understand the Zn dynamics on crop and plants. There have been much more efforts given to see agronomic, physiological and molecular aspects of Zn in plants and soils. It is however, equally important to look at the human consumption perspective for healthy population. Therefore, this review discusses the role of Zn on soil and crop in view of human nutrition.

Agricultural strategies could help to combat such problems in many ways such as breeding Zn efficient genotypes, application of different Zn fertilizers, using high Zn content seed for crop production; and seed priming to address the Zn deficiency problems. The content of Zn in grains and fruits can in some cases be increased through soil or foliar applications of Zn fertilizers. Increasing total level of Zn in plant foods could be achievable by increasing the concentration of compounds which promote their uptake (ascorbic acid), or by decreasing the concentration of compounds which inhibit their absorption (phytic acid or phenolic compounds) of Zn. Low cost and easy approaches such as seed priming is also a effective measures to load higher Zn in edible parts. Plant breeding and genetic engineering techniques have the greatest potential to increase Zn content in grains, roots and tubers to combat the Zn deficiency world-wide.

Keywords: zinc deficiency, agricultural systems, human health
Organic Rice Farming Systems in Cambodia
- Potential and Constraints of Smallholder Systems in Takeo Province

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Organic farming is recognized as one important system of agriculture and food production that is environmentally sustainable and can generate several positive impacts to rural society. However, organic rice farming movement is still limited in Cambodia since the illiteracy rate of Cambodia people is high especially in the rural areas and it is difficult to adapt the new technology for those farmers. So, the objectives of this research were to identify the management practices in organic rice farms and to find out major obstacles and opportunities for organic farming.

In the research area of Takeo Province, most of small-scale farmers are always confronting with the problems of unstable productivity in rice farming and too limited farm outputs to generate incomes or even foods for the consumption of farm household sufficiently throughout a year. The results indicate that farmers start joining the organic initiatives primarily to improve their incomes and reduce the cost of farming inputs. And after the participation, farmers have improved their income through the increased yields, premium pricing, and reduced expenditures on chemical fertilizers. Moreover, all farmers believed organic farming has improved their conditions of health and food quality, strengthen the family and community ties and secured their livelihoods.

Nevertheless, these benefits were not distributed equally amongst individuals or communities. Very poor and isolated farmers could not generally access benefits. The three main factors that determined the impacts of the organics initiatives on farmer empowerment were identified as: the individual’s endowment of resources, the strengths of the farmer groups, and the policies and facilitation of the supporting organizations. One important remark for the sustainability of organic farming in Cambodia is, nowadays, all the organic producer groups are working dependently in the projects of international and local NGOs and this remains the question of “Will these organic farming be continuously developed and sustained by themselves in the future after these projects finish?”. There is no exact answer but the requirement of attentions from all the sectors as well as to create the action plan together for the sustainable growth of organic farming in Cambodia.

Keywords: organic rice farming, potential and constraints, smallholder, Cambodia
The Present Condition and Problem of Agricultural Water Management in Northern Part of Taklamakan Desert

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Irrigation is indispensable to guarantee the agricultural production at arid region like the Tarim Basin. In this region, administrations and farmers have reclaimed wild land like gravel and sandy desert, and had attempted agricultural development by securing the water resources. But, there is a problem of the extremely irrational plan between agricultural land reclamation and water resource development, and is an acute shortage of water in this region as that result. Also, this condition has caused ecological damage. In this paper, problems about agricultural water use discussed by real conditions of the water resource utilities and farmers activities. Most of the data on water use and management were provided by the Xayar Water Resource Agency. Interviews with representative of the branch offices of the agency and farmers were conducted from 2003 to 2009. It was shown that water supply volume per unit of the farmland is tendency decreasing because of the relations between quantities of intake from the river and the cultivated area in the past ten years. And, it is clear that the water supply from the river has decreased greatly in the region where the water saving irrigation by groundwater pumping was introduced earlier. The water-saving irrigation is being introduced to resolve water shortage and create new water resources. Though it seems to be effective for saving water resources in such way, improper management cannot often performed effective irrigation in the even farmland where the water saving irrigation was introduced. Especially, consideration concerning the water management was different among landowners and farmers, and it became clear there are many problems to introduce the water saving irrigation to the entire region.

Keywords: agricultural water management, water saving irrigation, Taklamakan Desert
Impacts of Atmospheric Ozone on Yields and Lipid Content in Thai Soybean of Chiang Mai 60 Cultivar

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Tropospheric ozone is known to damage the agricultural crop yield of several countries in worldwide and Asia. Soybean is one of important economic crops and sensitive to atmospheric ozone but lack of data on the impacts of ozone on seed nutrition, especially lipid content of soybean seed. Hence, there is a need to study this issue in Thailand. The objectives of this study are to investigate the impacts of ozone on yield, nutrition values and lipid content in Thai soybean (Glycine max (L.) Merrill) of Chiang Mai 60 Cultivar.

Soybean was grown in the Phitsanulok research field during 2008-2009. Open-top chambers system were applied with 3 levels of ozone concentrations; at ambient level (32 ppb), lower (12 ppb) and higher than ambient level (62 ppb), and soybean plants were exposed to ozone for 7 h day\(^{-1}\) from seedling to maturing stage. Our results indicated that elevated ozone concentrations significantly reduced yield production in pod/plant by 36% when compared between low level (12 ppb) and high level (62 ppb) treatment. Consideration in nutrition quality in soybean seed, the significant negative results were also found in moisture, ash and fiber by 31%, 25% and 33%, respectively. In contrast with the mentioned results, we found the strong positive result in lipid content by increasing 17% in high level ozone treatment. The results indicated that the elevated ozone concentrations of atmospheric ozone suppressed yield and some nutrition in soybean seed but induce lipid content increasing.

Keywords: ozone, production yield, lipid content, Thai soybean; Chiang Mai 60 cultivar
Estimation of Elevated Air Temperature Effects at Different Growth Stages on Thai Soybean

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A large number of research reveal the increasing temperature related global warming situation have damaged worldwide agriculture crops. Hence, there is a need to know the effects of temperature rise on agricultural crop so that agriculture sector can prepare for any long-term change. We thus investigated the effects of elevated air temperature on growth and yield of Thai soybean, Chiang Mai60 cultivars. Field experiment was conducted with open top chamber system for controlling temperature at Naresuan University Research Field at Phitsanulok, Thailand during January - October 2009. Soybean was exposed to 3 levels of air temperature; lower than ambient air temperature (30-33 °C), ambient air temperature (33-36 °C) and higher than ambient air temperature (37-40 °C); for 5 hr day^{-1} from vegetative growth stage to reproductive growth stage.

We observed that high temperature applied at R1 stage(beginning bloom) significantly reduced Leaf Area Index (LAI) by 22%, while at the same growth stage, significant increase were found in Chl a and height by 47% and 12%, respectively. In addition, significant effects of elevated air temperature were not observed in LAI, Chl a, Chl b and carotenoid at V1-V3 and R3-R8 growth stage. In consideration of the continuous significant increase in height from beginning stage (v1) to beginning pod stage (R3), it was also found that the height parameter was clearly more positive sensitive to elevated air temperature than other parameters, and the highest increase was shown at V2 stage. However, significant effects did not appear in yield components (No. of pod /plant and No. of seed/plant) at full maturing stage (R8). Thus, the experimental results revealed that elevated air temperature could suppress biomass in leaf but stimulated height increase. However, this stimulation could not induce yield increase in Chiang Mai 60 cultivar.

Keywords: growth stage, yield, elevated air temperature, Thai soybean
Agro-forestry System in Salt Affected Area in Khon Kaen Province, Northeast of Thailand

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Salt affected soil is one of the severe environment problems in northeast of Thailand. The total area of northeast of Thailand is 16.928 million hectare while the salt affected soil covers 2.848 million hectare, in which rock salt called Mahasarakam layer is laying at 100 to 200 m deep from soil surface. This salt accumulation is causing various problems, not only in agricultural aspects but also in economical and social aspects in rural areas. Although the several organizations are trying to solve this salt accumulation problem with planting salt-tolerant trees or controlling groundwater level, local people are still suffering from salt accumulation which causes various agricultural problems and poverty of farmers. As salt accumulation was not severe when the land had been covered with woods around 1940s, agro-forestry, one of the alternative agriculture, is expected to reduce the degree of salt accumulation in the area. However, getting high acceptance of local farmers has been difficult as planting trees is less incentive for them. Thus, the integration of planting salt-tolerant trees with field crops may be more advantageous not only for local farmers and but also for rehabilitating salt affected soils. So, attention has been focused on how to set effective agro-forestry system in salted affected area, Thailand.

This study dealt with existing agro-forestry system in Khon Kaen Province, Thailand. While there are various practices in agro-forestry system, due to the salt accumulated soil condition, agro-forestry system in salt affected area had a lower variety than that in non-salt affected area. Based on the results of field investigation, trees in agro-forestry system was observed as patch forest, trees on paddy bund, trees plantation associated with animal husbandry, trees in home garden and trees in vegetable garden. The dominant trees found in each practice are Sindora siamensis, Shorea obtusa, Eucalyptus camaldulensis, Bambusa bambos and Mangifera indica, respectively. However, the density of trees in each agro-forestry system is not enough; effective agro-forestry system in salted affected area was proposed in this study.

Keywords: agro-forestry, salt affected area, rehabilitation, salt-tolerant tree, Thailand
Some Characteristics and Qualities of Pork from Semi-Bio Pig Production Farm in Thailand

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The objective of the experiment is to study the meat quality and some characteristic of pork using two different systems i.e. semi-bio raising system and general raising system. Pork was divided into five part (boston shoulder, loin, tenderloin, ham and bacon), Meat quality was determined in carcass quality and some characteristic: chemical and physical properties (pH, colors, cooking loss, drip loss and shear stress). The results indicated that characteristics of pig from the two systems did not vary among the system. Carcass quality content of lean carcasses was 52.96 and 52.68 (P > 0.05), respectively. Trends of some characteristics in any parts of pork pH (5.02 -5.10), colors (L* average 37.52-51.02 and a* average 10.07-15.77 depend on the parts of pork) cooking loss, drip loss (3.26-8.30%, 5.5-7.8% respectively depend on the parts of pork) and shear stress (4.5-38.06 Kgf. depend on the parts of pork) not quite different. Therefore, the semi-bio pig raising system has sufficient potential application for pork meat production industry.

Keywords: pork characteristics, qualities, semi-bio pig production, Thailand farms
Strategy for Drought Tolerance Using Plant Biotechnology in Rice

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Environmental stresses such as drought and salinity represent the major constraints to agricultural production worldwide. The adaptation of plants to these environmental stresses is made through physiological, molecular, cellular, and biochemical levels. In the past decades, significant progresses in scientific and technological advances have been made through studying the model plant *Arabidopsis*. Small plant stature, short life cycle, and small number of chromosomes with the availability of complete genomic sequences make *Arabidopsis* the most popular plant material for understanding the molecular biology. Several genes function as transcription factors (TF) in environmental stress response in *Arabidopsis* have been identified and characterized. These TFs play vital roles in the control of gene expression in response to environmental stresses. Among them, *AREB1* was identified and characterized as a member of transcription factors and its expression is significantly induced by environmental stresses such as drought and high salt. In this study, we have generated transgenic rice plants overexpressing *AREB1* and its derivatives to evaluate the tolerance to drought stress and the growth phenotypes of the transgenic rice plants. We will discuss the effect of the overexpression of *AREB1* gene in drought stress tolerance in rice.

**Keywords:** rice, *Arabidopsis*, environmental stresses, high salt, drought tolerance
Appropriate Technologies of Organic Agriculture in Cambodia

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Agriculture is the largest primary sector in Cambodia economy. It contributes 34.4 percent to the GDP in 2008. About 74 percent of workforce is engaged in agriculture. Presently in Cambodia, organic products are becoming more popular due to increasing in health and environmental concerns. Government and non-government organizations support to the farmers on organic agriculture, as well as to improve the sustainable agriculture.

The objective of this study is to investigate the appropriate technologies of organic agriculture which has been applied by farmers. Three agricultural provinces, Battambang, Kampong Cham and Takeo, were selected to study. 403 farmers were interviewed with questionnaire about the household information, chemical fertilizer and pesticide applications, perception of farmer on organic agriculture, and technology of organic agriculture.

The results of the study show that there are several appropriate technologies of organic agriculture in the surveyed villages such as: application of organic fertilizers, bio-pesticide, mulching with materials to cover soil surface, crop rotation, mixture of crops and agro-forestry. The most popular material as organic fertilizer that applied by farmers was animal manure. Only 10 percent of farmers produce and apply compost, and very few farmers make liquid fertilizer and grow green manure in their farmland. Regarding to bio-pesticide, the results of this study indicated that only 1.2 percent of farmers produced and applied it to their crops. Beside organic fertilizer and bio-pesticide, some local farmers also apply other methods of organic agriculture such as crop mulching, crop rotation, mixing crops and agro-forestry. For improving their agricultural products, farmers still apply chemicals, both fertilizer and pesticide. However, many of farmers want to reduce the amounts of chemicals applied, if there are other things being available to replace. It was concluded that in order to improve the sustainable agriculture, it is important to improve the technologies of farming practice for farmers.

Keywords: compost, organic agriculture, sustainable agriculture, Cambodia
Accepting System of Rice Intensification (SRI) by Farmers in Rainfed Area of Cambodia

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System of rice intensification (SRI) is an environment-friendly and sustainable rice farming practice developed in Madagascar in 1980s under irrigated condition. Unlike the Green Revolution technology which was widely applied in many developing countries in 1970s, SRI does not require additional chemical fertilizers or agrochemicals. Recently, SRI has been diffused not only in irrigated area but also in rainfed paddy in Cambodia. It is significant, if SRI is confirmed to be effective in rainfed area, where green revolution technology is ineffective.

Objective of the research is to illustrate the main reasons why Cambodian rainfed rice farmers accept SRI. Farming practice comparison test was conducted in the rainy season of year 2008 and 2009 by six volunteer farmers in three villages of Prey Nheat commune, Kong Pisei district, Kampong Speu province in Cambodia. Each of these farmers’ rainfed paddy plot was divided into two parts, SRI practices on one part and the traditional practice on the other. In year 2008, the farmers practiced some of the SRI principles but there was no significance difference between the yield of SRI and traditional ones. In year 2009, all the farmers continued the comparison test with more rigorous manners in SRI practice area. One of the remarkable results was that these farmers started to introduce some of the SRI principles in their own field outside comparison plot (non-comparison plot).

Keywords: system of rice intensification (SRI), rainfed, Cambodia
Social Land Policy for a Sustainable Rural Development in Cambodia

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On 1st of July 2009, Cambodian Prime Minister Hun Sen signed the “Declaration of the Royal Government on Land Policy”. According to this document, emphasize should be given to State Reform and land and environmental laws with their impacts on the use of non-renewable resources (like land, water, soil). The implementation of the Cambodian social land policy should start with the need to ensure access to land and to sustain well-balanced rural development and environment for a modern, prosperous Cambodia.

The legal framework for sustainable rural development and land policy includes the Constitution from 1993, and the Land Law from 2001, and Sub-decrees. Land policy can be interpreted as a central element of property policy. Property is protected under the Constitution and the Land Law from 2001. State public property must be interpreted as the property of all Cambodian people – and thus as social land policy – that serves the purposes of human beings live in the country as a public interest, in particular in rural areas. Having a land use planning system in the future, the Cambodian planning authorities are able to guide and to restrict the use of land property to foster sustainable rural development.

Social land policy needs a broader basis in Cambodia than today. State public property with the guarantee for private use, e.g. through land leasing and concessions, is absolutely sufficient, efficient and effective.

Social land policy is an interdisciplinary approach of Good Land Governance, land and constitutional law, land economy, spatial planning, and gender issues. This policy can also be a State driven concept for rural areas in other (developing) countries. It must be legally classified as a public interest that the eternal ground rent as the economic gain of the land use is skimmed-off and, in the next step, is distributed to all Cambodians in equal shares.

Keywords: social land policy, sustainable rural development, Cambodia
Effective Governance Policy - Key to Sustainable Development of Co-managed Teknaf Game Reserve in Bangladesh

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Forest Department of Bangladesh in this decade through its Nishorgo Support Project (2004-05 to 2008-09 fiscal years) piloted collaborative management in five Protected Forest Areas (PFAs) as opposed to the traditional management. Performing research was essential to assess whether real sharing of responsibilities occurred and effectiveness of changes brought by the paradigm change. This research was performed in Teknaf Game Reserve (TGR) as one of the pilot co-management sites. The main objective was to study whether traditional governance structure has changed effectively in TGR and to judge governance performance of the new structure. The framework for good governance principles of PAs (Graham et al., 2003) was used. The research was mainly an exploratory study. In-depth case study method was followed mainly through interviewing key informants along with field research method.

Research revealed the new co-management structure as an appendum in the department’s main organizational structure and the seaming was not flawless. Unwillingness to share responsibilities and decision making in key areas under the uncertainty of current legal basis for co-management is found as one important reason for suboptimal output in PFA co-management. This also resulted in weak managerial performance and slow progress in attaining all five good governance principles for PA. Also, mechanism of sharing governance situation and experiences at different institutional level was poor. Thus, extraction of resources was found ongoing. Moreover, no quick solution of alarming issues inside the PFA like land encroachment, operating brickfields, and Rohingya refugee issue seemed attainable through co-management. So, great environmental threats exist for future. Real empowerment of local stakeholders involved in co-management is required for sustainable management of the Game Reserve as well as other PFA and socio-economic improvement of rural people living inside and surrounding the reserve. Establishing a working framework incorporating good governance will significantly increase effectiveness of co-management approach.

Keywords: protected forest area, collaborative management, governance, Bangladesh
Insights from a Systems View
- How Modelling can inform Rural Development

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Participatory modelling is one of several techniques that can help communities to share and test ideas, and to agree on the “best bet” for improving the triple bottom line for individuals and for the community. Two case studies illustrate selected insights of the use of participatory modelling to inform communities, to explore scenarios, and to give them the confidence to make changes. The first case study deals with fuelwood and deforestation and illustrates how relatively simple models can guide policy-making to secure rural livelihoods and reduce deforestation. The second case study highlights how participatory modelling can inform communal decisions about shared rights to avoid ‘the tragedy of the commons’. Both case studies rely on simple transparent models constructed and modified by participants using an easy-to-use visual modelling package (Simile). These examples illustrate how a better shared understanding of a resource and its dynamics leads to better decisions and sustainable outcomes.

Keywords: system view, modelling, rural development
Effect of Land Use Change on Land Quality and Water Resources in Phatthalung Watershed, Thailand

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Land use change can cause positive and negative effects on land and water resources, the key resources for agricultural production. A watershed scale study was conducted to assess the effect of land use change on land and water quality using selected indicators in the Phatthalung watershed, Thailand. The changes of water quality and quantity in the study area were assessed by computing Water Quality Index (WQI) using some important water quality parameters, such as pH, suspended solid and plant nutrients. Water quantity was assessed through the soil moisture storage. The land quality was assessed by developing Land Quality Index (LQI) based on soil resource index, land degradation status index and water resource index. The quality of land from two different areas, i.e. where land use has changed, and where no change has occurred, was assessed through the selected indicators.

The LQI results showed that the score of soil resource and land degradation status index of no-change area was found higher than area where land use change occurred, whereas it was vice versa in case of water resource index. The computed WQI was decreasing during the study period. The highest WQI was 97.5 found in year 1997 and 2003 and the lowest was 80.0 found in recent years (2005 and 2006). The suspended solid (SS) was the major factor influencing WQI. The quantity of water was assessed through the soil moisture storage. Due to the area covered by paddy field has high capability to generate higher surface runoff compared to rubber plantation and forest area, hence, the moisture storage of soil under paddy field was lower than other areas. The estimated soil moisture storage of the study area showed positive results because number of month of water surplus was increased from one month in a year in 1976 to 4 months in 2006 because of the reduction in paddy field area.

Keywords: land use change, land quality, water resources, Phatthalung Watershed, Thailand
**Upstream Irrigation Development and its Impacts on Deltaic Landscape and Local Livelihood - A Case of Indus Delta from Sindh Province in Pakistan**

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Over the period of last 80 years, massive irrigation development in Pakistan and subsequent disturbance in the natural course of Indus River has led to significant changes in landscape of the Indus delta. Thousands of hectares of precious agricultural land have been engulfed by the Sea. However, the pace of these changes has been reported considerably faster during last two decades. Following this, a survey using household level questionnaires, FGDs and interviews was carried out between April-July, 2009 to study that how landscape changes have affected the local livelihoods and social fabric in the delta.

The findings reveal that all three major occupational groups - rice cultivator, herders and fishermen - in the delta have experienced disturbing changes in their livelihoods. Former rice cultivator and herder tribes have diverted to fishing, resulting the overcrowding on marine fishery. Subsequently various harmful fishing practices are in vogue exerting severe pressure on resources and making local livelihoods increasingly vulnerable. Increased competition for limited resources has significantly affected the social fabric in the delta as different social groups do not observe similar degrees of harmony as enjoyed in the past. The case of Indus Delta is the stark example of narrow-focus ‘development’, and it’s environmental and social impacts and has implications for policymakers and development planners. Finally some recommendations are pinpointed on the issue.

**Keywords:** irrigation development, deltaic landscape, local livelihood, Indus delta
GIS-FMADM for Land Use Management at Mamasa River Basin
South Sulawesi Indonesia

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Mamasa River basin is situated in South Sulawesi, Indonesia. In the recent years, the function of Mamasa River basin cannot be implemented optimally in maintaining sustainability hydrologic function of Garugu dam. It is indicated by the occurrence of floods in the rainy season and in contrary water shortage in dry season. Unexpected hydrology functions can be attributed to inappropriate land use at the upstream. Therefore, in order to maintain the hydrologic function of the dam, it is necessary to formulate suitable land use at upstream of the river basin. This research is objected to formulate the suitable land use, in term of reducing sedimentation rate in Garugu dam.

This study employed RUSLE (Revised Universal Soil Loss Equation) for calculating erosion as well as sedimentation rate. Fuzzy Multi Attribute Decision Making (FMADM) and Analytic Hierarchy Process (AHP) which is combined with Geographical Information System (GIS) were used to formulate optimum land use at the upstream. Focus Group Discussion (FGD) was conducted in order to validate the obtained land use model using FMADM formulation.

The optimum land use composition for Mamasa River basin that control of dead storage of sediment (DSS) is: 38.01% of agro-forestry, 17.88% of forest, 15.66% of mixed agriculture, 11.30% of mixed garden and forest fruit crops, and the rest of the conservation actions and land use such as strip cropping, rotation of crops, use bench terrace in rice fields, reforestation, cover crops and coffee plantation. The optimal land use composition can control the sedimentation rate up to $127.22 \text{ m}^3/\text{ km}^2/\text{ year}$.

**Keywords:** GIS-FMADM, land use management, Mamasa River, Indonesia
Dhaka is one of the mega cities in the world and approaching to be the second largest mega city by 2015. The city is expanding with a tremendous pace. The huge urbanization results several externalities including drainage congestion and urban flood. Land reclamation principally owing to the ever growing housing projects is concentrated and expanding at the restricted fringe areas which make the urban flooding condition critical with time. In contrary, potential climate change and climate variability impact on Dhaka involves an increased temperature and precipitation.

So, the aim of this study is to examine the trend of land reclamation of the lowland water bodies and drainage channels predominantly by the real estate developers and its subsequent obvious consequence of increasing urban flood in the city considering the potential climate change impact simultaneously. The study uses all data of urbanization, city growth and climate variability mainly from secondary sources and government organizations. A conceptual framework is designed to understand the effect on urban flood from land reclamation and climate change in and around the city; however, the effect appears as synergistic from those two drivers. This analytical result will help realizing the city management authority on the dynamics of intense urban flood phenomenon which could subsequently be able to contribute in city management and planning issues.

**Keywords:** land reclamation, climate change, urban flood, Dhaka