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Research article

Perceptions of Rural Tourism Development Potential in South-Eastern Bosnia

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Abstract About 61% of the Bosnian population lives in rural areas. Meanwhile almost 95% of the Republika Srpska entity's territory is rural where 83% of the population lives. Rural tourism includes tourism products and services in rural areas in which the rural culture is a key component. The paper aims at analyzing the perceptions of villagers, service providers and rural tourism structures managers on rural tourism development potential in south-eastern Bosnia. Suggestions of local actors to attract more tourists to rural areas were discussed as well. The paper includes both secondary and primary data. A questionnaire survey was performed in summer 2012 with 120 rural tourism operators, service providers and villagers in 11 municipalities in the Republika Srpska (RS). Bosnia in general and the RS in particular have great potential for rural tourism development but it remains largely unexpressed. Rural tourism can provide new windows of opportunities for rural areas. Rural tourism is perceived by local actors as sustaining and creating local incomes, employment and growth; contributing to the costs of providing local economic and social infrastructure, amenities and services; encouraging the other sectors development; and contributing to environmental and cultural heritage conservation. Rural communities have increasingly turned to tourism as an alternative means of achieving sustainable economic growth and development through restructuring and greater diversification of economic activity. Rural tourism operators' individual satisfaction is gained from interchange with visitors. Tourist feedback positively enhances locally exerted effects and stimulates operators to recognize local opportunities and potential within their rural communities. In order to transform local stakeholders' enthusiasm into concrete and viable investments and ventures, the financial and institutional support of the entity government, especially ministries of tourism and agriculture, as well as international donors is highly needed.

Keywords rural tourism, development potential, perceptions, Bosnia

INTRODUCTION

Bosnia and Herzegovina (BiH) consists of two governing entities *i.e.* the Federation of Bosnia and Herzegovina (FBiH) and Republika Srpska (RS). Tourism is a growing sector in many rural areas and can create new employment opportunities and increase the overall attractiveness of these areas (MoFTER, 2007). Bosnia and Herzegovina has unlimited capabilities to develop rural tourism in its rural areas (Vujovic, 2007 in Ćejvanović et al., 2013). About 81% of total Bosnian area and 61% of its population can be qualified as rural. According to the OECD criteria, 114 out of the 143 municipalities in BiH can be qualified as rural (Ćejvanović et al., 2013). From a diversification point of view the types of tourism that BiH could consider focusing on include: cultural heritage, religious heritage, soft adventure, and eco-tourism. BiH is already well positioned especially in eco-tourism. Eco-tourism has been recognized as an area for strategic development for the RS and FBiH (FAO-ROECA, 2012).

The Republic of Srpska has many comparative advantages that can be exploited for rural tourism development (Radovic et al., 2013): beautiful nature; variety of village types; traditional hospitality; authentic gastronomy; rich cultural and historical heritage; preserved tradition of old crafts; and various events held in rural areas.

Primary producers and rural communities have increasingly turned to tourism as an alternative means of achieving sustainable development through diversification of economic activity. Rural tourism is considered as a form of alternative tourism. It encompasses a huge range of activities, natural or manmade attractions, amenities and facilities, transportation, marketing and information systems (Sharpley and Sharpley, 1997 in Irshad, 2010). Tourism is termed rural when the rural culture is a key component of the product on offer (Gopal et al., 2008). Rural tourism is not just farm-based tourism; it also comprises special interest nature holidays and ecotourism, walking, climbing and riding holidays, adventure, sport and health tourism, hunting and angling, educational travel, arts and heritage tourism, and ethnic tourism (Irshad, 2010).

The paper aims at analyzing the perceptions of villagers, service providers, and rural tourism operators on rural tourism development potential in south-eastern Bosnia.

METHODOLOGY

The paper is based on an extended literature review and primary data collected by structured questionnaires carried out in summer 2012 with 120 rural tourism stakeholders (45 rural tourism structures owners and managers - RTSM, 26 local service providers - LSP, and 49 villagers and municipality dwellers - VMD) in eleven municipalities of the Republika Srpska entity: Vlasenica, Han Pijesak, Milici, Zvornik, Kalinovik, Rogatica, Visegrad, Pale, Bratunac, Sokolac and Foca. Apart from data about respondents (name, age, level of education, occupation, municipality) different issues were addressed with different actors of the rural tourism industry:

RTSM: opinions and perceptions about rural tourism in the area; main reasons for which visitors choose the rural tourism structure and locality; suggestions to attract more tourists; willingness to invest more in rural tourism activities.

LSP (e.g. post officers, medical doctors, etc.): experience with the tourists utilizing services; opinions about rural tourism and its potential; and suggestions to attract more tourists to the area.

VMD: assessment of local government activities in rural tourism field; opinions on rural tourism; potential contribution of rural tourism to local economy; suggestions to attract more tourists; willingness to engage in tourism activities; training needs.

This exploratory study is intended to provide a better understanding of perceptions of rural tourism. Interviews qualitative analysis allows identifying differences and similarities in responses. The study results should help bridge what is perceived to be a gap in communication and mutual understanding among public officials, business owners, and other stakeholders with a connection to rural tourism. Improved understanding of interview respondents' perceptions may be helpful in planning for a growing rural tourism sector and in maximizing its economic benefits while minimizing its negative environmental and social impacts.

RESULTS AND DISCUSSION

The Rural Development Strategic Plan 2009-2015 of the Republika Srpska, predicted improvement of the quality of life and diversification of rural economy, particularly through improvement and development of rural tourism services (FAO-ROECA, 2012; Draganic, 2011). Rural tourism is a novelty within the tourism sector and touristic offer in RS and BiH (Draganic, 2011; Radovic et al., 2013). It is considered one of the important strategies for the diversification of rural livelihoods and economies in Bosnia. The competencies over rural and tourism development are completely with the entity level (Draganic, 2011). Support to rural tourism development in RS is secured through the Ministry of Agriculture, Forestry and Water Management and the Ministry of Commerce and Tourism. In addition to entity financial allocations, additional financial resources for rural tourism development come from the budgets of local municipalities (Radovic et al., 2013).

Different types of rural tourism establishments and structures can be found in the surveyed area. These include: cottages, houses / apartments, restaurants, small hotels, camping sites, motels, horse farms, youth hotels, travel agencies. The clientele include foreign tourists as well as locals and visitors from other Bosnian municipalities. For most of the interviewed RTSM (86.7%) rural tourism is the primary activity and the main source of income. In addition, for a large share of them (45.5%) rural tourism is a family business.

Perceptions of rural tourism development potentialy changed not only from an actor category (i.e. RTSM, LSP, VMD) but also from a municipality to another depending, among others, on the level of development of the rural tourism industry as well as its impacts on the local economy. For instance, among the surveyed municipalities, tourism in general and rural tourism in particular is more developed in Foca and Visegrad.

According to the RTSM, visitors are attracted by: typical food and drinks, diversified services offer, natural surroundings and landscape beauty, quality of services, food quality, architectural and cultural heritage. According to them, the main resources that could be used in the future for the development of rural tourism are: traditional villages; agricultural resources; natural resources (forests, streams, rivers, lakes, mountains, caves); cultural heritage (rural folklore) and old buildings (churches, monasteries, traditional houses); existing tourism facilities (hotels, ski centers, horse farms); traditional food and cuisine. Some RTSM think that there are few tourist attractions at the level of municipalities as many were destroyed during the civil war. Moreover, there are some current problems that hinder tourism development (e.g. low quality of infrastructure and services). Many of these problems are due to the general legal and legislative framework as well as socio-economic context so state and/or entity coordinated actions are needed.

Only a few rural people dare to dealing with rural tourism as it is perceived as a risky business. This is confirmed also by the fact that less than a half (47%) of the interviewed villagers would like invest in tourism activities. Moreover, only about a third of RTSM would like to be more invested in tourism activities. Risk is probably also the reason for which 75.5% of RTSM do not think about expanding their businesses in the coming years. The remaining plan to offer other services: more rooms, passenger transport services with personal vehicles, sports facilities (soccer/tennis playgrounds), tourist guiding, food services, direct sale of local products to tourists, riding schools, conference rooms, cottages, mini ethno villages, sale of air tickets.

Many of the interviewed LSP (54%) have not had any contact with foreign visitors. This is maybe due to the fact that the number of foreign tourists is limited and that most of them do not use many local services. In fact, most of them have short stays and they prefer going to neighboring urban centers for many services. Those that have more contact with tourists are physicians.

The majority of LSP think that the level of tourism development in the municipality is in line with the current tourism development in the Entity. They also believe that there is a big potential for rural tourism development in their municipalities. However, they are aware that any kind of success takes a lot of investment, innovation, learning and money. Resources are available but good will and long-term vision are needed. The main problems are the lack of outstanding tourist offers and accommodation facilities such as hotels, hostels and private houses. In fact, there is a small number of available beds and quality of existing accommodation is rather low. Moreover, tourism is still mainly a seasonal activity. Tourism could be an important economy sector for small

municipalities. LSP in Visegrad believe that tourism is on the rise but more investments are needed. The municipality is perceived to have large resources for rural tourism development.

As activities of rural tourism have become diverse, the demand for rural tourism is becoming more and more experience oriented. Rural tourism operators' individual satisfaction gained from interchange with visitors and direct feedback can positively enhance locally exerted effects that stimulate operators to recognize opportunities within their community and raise the potential for local resource use (Ohe et al., 2009). Operators gain satisfaction through providing services by receiving immediate feedback from consumers (Wilson, 2007).

All the interviewed LSP and most of VMD (92%) think that tourism can help increasing income and generating more employment opportunities. However, many of them think that this is a long-lasting process and requires good investments. Others highlighted the need for a long-term local rural tourism development strategy in order to reap these benefits. Tourism is seen also to contribute to gender equity as it can create more jobs for women. They further emphasized the multiplier effect that tourism can have on other sectors of the local economy especially agriculture. To capitalize on this effect some of the interviewees proposed to set up small tourist spots in rural areas where farmers could sell their products to tourists and visitors. Moreover, local authorities should consider tourism as a priority sector. Those think that tourism has no positive effect alleged the fact that it is still underdeveloped and there are no rural tourism strategies at local level.

There is a great potential through tourism, for resolution of many chronic dilemmas faced by rural communities (Knowd, 2001). Even if rural tourism may be minor in relation to the overall tourism market its importance to the development of specific rural areas may be critical. Thus, the multiplier effect is often more impacting in rural areas where the entire rural lifestyle is looked for as the main attraction (Gopal et al., 2008).

Tourism has a wide range of positive livelihood impacts, many of which go beyond monetary benefits. Tourism in rural areas offers a viable option for livelihood diversification. Moreover, tourism considerably expands household economic prospects by improving education, health, physical amenities and financial assets (Shakya, 2011). Many studies dealt with social and cultural, economic and environmental impacts of rural tourism. Cohesive effect of the development of rural tourism includes tourism as a mechanism for developing a balanced regional development. The development of rural tourism significantly affects the preservation of local identity, traditions and customs, and other values in rural areas (Mrdalj and Todić, 2012). Rural tourism supports development of new tourist destinations giving special contribution to the development of the continental tourism. It is a way for family-owned farms to provide additional income by engagement of members of family (Ćejvanović et al., 2013).

Most of the interviewed villagers think that their municipalities have great potential for rural tourism that is still not properly exploited. This is especially the case in the municipalities of Foca, Milici, Bratunac, Kalinovik, Han Pijesak and Zvornik. Inhabitants of Visegrad, Sokolac and Pale have more positive perceptions about rural tourism in their municipalities. Generally speaking, almost all the interviewees think that municipal councils should do more to develop rural tourism in their municipalities. The most critical ones are the inhabitants of Foca, Milici, Bratunac, Kalinovik, Han Pijesak, Sokolac and Zvornik. Meanwhile, dwellers of the municipalities of Vlasenica, Visegrad and Pale were somehow more benign.

Key findings from other contexts (San Juan County, Utah, USA) show that rural community members have mostly positive perceptions of tourism, show general support for future tourism development, and are optimistic about the future role of tourism. They also highlight that the tourism industry is perceived to provide positive economic benefits and mostly positive social benefits. Some residents' lack of support for tourism may be related to attitudes and especially their fears of changes to their communities (Burr et al., 2007). In fact, scholars have also exposed a range of unwanted economic, socio-cultural and environmental side-effects of tourism, such as the promotion of inequality, inflation, import dependency, over-exploitation of natural resources, environmental damages and cultural alienation (cf. Shakya, 2009).

Rural tourism structures managers, local services providers and local people made many suggestions to develop rural tourism in their municipalities (Table. 1).

Table 1 Suggestions for developing rural tourism

Respondents' suggestions	Type of respondents		
	RTSM	LSP	LD
Increasing investment in rural tourism and rural socio-economic development	D	D	B
Better promotion and marketing of tourism using different media	B	D	C
Creation of new tourist attractions (ethno villages, ski resorts, festivals, sport and cultural events, open days)	C	D	C
Improvement of service delivery and quality in rural areas	B	D	A
Paying more attention to environment protection and natural (rivers, forests, waterfalls, springs) and cultural (monuments, historical sites, folklore, water mills) heritage preservation	A	D	D
Renovation of hotels and tourism facilities (old village houses, ski centers)	D	D	B
Improving human capital especially skills related to rural tourism services management through training courses, thematic workshops and seminars	C	B	C
Development of new tourism services in some municipalities (e.g. running trails, cycling, excursions, hiking, hunting, fishing, horse riding, adventure tourism)	D	B	D

Source: Authors' elaboration based on questionnaire survey results.
Legend: A: very significant (answer frequency > 50%), B: significant (25-50%), C: average (10-25%), D: poor (<10%).

All the interviewed villagers declared that local people especially young ones need training regarding rural tourism. Training should allow the trainees to know more about the resources of their municipalities and ways to valorize them through tourism activities. All require increasing municipality, entity and state funding to rural tourism. Suggested activities include also a better organization of the rural tourism sector through categorization of rural households, making an inventory of rural accommodation facilities, and preparing a register of rural tourism services providers. The establishment of local tourism organizations and agencies would help better coordinate and organize the rural tourism offer. Some tourist organizations already exist but coordination between them can be further improved. Many interviewees pointed also to the importance of engaging young people in the rural tourism sector.

CONCLUSION

Bosnia and the Republika Srpska have great natural, cultural, gastronomic, religious and historic potential for rural tourism development. Rural tourism could be a strategy for sustainable development of rural areas and also a tool for product differentiation. Rural tourism has a high potential for the diversification of rural households' livelihoods.

Most of the interviewees think that tourism development is going ahead slowly but in the right direction. That being said, they believe that there is still wide room for improvement. That requires adopting an integrated approach for designing local strategies for rural tourism development with the involvement of all relevant actors. The expansion of tourism in rural areas is perceived as designed to sustain and create local incomes, employment and growth.

The specific identification of residents' desires and expectations of the tourism industry can assist in the development of a plan to meet tourism development objectives while protecting important characteristics of rural communities and their surrounding environments. Development of rural tourism requires improving tourism standards, services and infrastructure; creating a more favorable environment for investment in rural tourism; strengthening support structures and facilities capabilities; and improving integration with general rural development plans.

It should be highlighted that the opinions and perceptions of tourism and tourism development among the tourism operators and the rural population are not sufficiently understood. Future research should attempt to discern resident preferences for different management and development objectives. Improved understanding of residents might be achieved through surveys or participatory processes such as community meetings and collaborative workshops.

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Research article

The Flowering Capabilities of Three Water lily Hybrids

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Abstract This research aims to examine the yields of water lilies belonging to the *Nymphaea* sp. (hybrid) for flowering capabilities purposes: *Nymphaea* 'Chalongkwan', *Nymphaea* 'Khaomongkol', and *Nymphaea* 'Chompoomamiew'. The randomized complete block design (RCB) was implemented in which three sets of five experiments each were carried out. The data were collected three months after the cultivars had been grown for one month at the experimental plot of Rajamangala University of Technology Thanyaburi. The research results revealed that *N.* 'Chalongkwan' was the cultivars with the highest monthly yield, i.e. 14.48 flowers per clump, each with a flowers diameter of 18.89 cm and a stalk diameter of 1.56 cm. This was followed by *N.* 'Chompoomamiew', which produced a monthly yield of 11.86 flowers per clump, each with a flower diameter of 16.06 cm and a stalk diameter of 1.31 cm. The cultivars with the lowest yield was *N.* 'Khaomongkol', i.e. only 9.91 flowers per clump, each with a flower diameter of 15.09 cm and a stalk diameter of 1.35 cm. In addition, *N.* 'Chalongkwan' produced the highest yield per rai of 5,792 flowers, followed by *N.* 'Chompoomamiew' at 4,741 flowers, and *N.* 'Khaomongkol'at 3,962 flowers.

Keywords *Nymphaea*, water lily, lotus

INTRODUCTION

Lotuses and Water lilies or Bua (Thai), aquatic plants commonly found in Thailand, have long been closely connected to the lifestyle of local people. (Lekhakul, 1992) They are used for several purposes, such as treatment of diseases, consumption, commercial cutting, and decoration. Particularly notable is their use for paying respect to the Triratna, or the Three Jewels, namely the Lord Buddha, the Dharma, and the Sangha, as lotuses represent sacredness and purity.

Farmers nationwide grow lotuses for commercial cutting, being able to supply yields to the market all year round, since they are easy to grow and maintain. Lotuses in the genus *Nelumbo*, including *Nelumbo nucifera* Gaertn, are more popular than those in the genus *Nymphaea*, including Tropical water lily, Hardy water lily, Australian Giant water lily, *N.* 'Jongkolnee', and *N.* 'Nangkwaug'.

As for water lilies in the *Nymphaea* sp. cultivars, they grow in varied beautiful colors and are fragrant, some with many layers of petal and strong stems, such as *N.* 'Chalongkwan' , *N.* 'Khaomongkol', *N.* 'Chompoomamiew' and *N.* 'Director George T. Moore' Such qualities make them suitable for ornamental functions. It would be of interest, therefore, to examine how to maximize the yields of these three cultivars of water lily in the genus *Nymphaea*.

OBJECTIVE

To examine the yields per plot of three cultivars of water lily belonging to *Nymphaea* sp., the size of flower for each cultivars.

METHODOLOGY

Three sets of five experiments each were conducted following the randomized complete block design (RCB). The three cultivars of water lily, namely *Nymphaea* 'Chalongkwan', *Nymphaea* 'Khaomongkol', and *Nymphaea* 'Chompoomamiew', were grown in flowerpots for 1.5 months before they were transferred to the experimental plot in which four rows of waterlilies were grown per 80 m^2 sub-plot. The growing interval, i.e. distance between rows and distance between trunks, was 2x2 m.

Prior to growing, the soil was prepared by ploughing once, and two tons of manure fertilizer was then added per rai. Fourteen days after planting the water lilies, three packs of 30 g 25-7-7 chemical fertilizer were added for each trunk in opposite directions. Then three packs of 30 g 25-7-7 and of 30 g 8-24-24 chemical fertilizer were added for each trunk at 30, 60, and 90 days after the planting. During this period, blemished leaves were removed, and pesticides were sprayed every 15 days. The data were collected one month after the water lilies were planted. Their growth, flower diameter, and stalk diameter, yield per month were recorded. The data analysis was carried out following the RCB. Additionally, Duncan's new multiple range test (DMRT) was done to determine the differences between the three cultivars).

RESULTS

As shown in Table 1, the flower diameter of *N.* 'Chalongkwan' was the largest with an average size of 18.89 cm, followed by that of *N.* 'Chompoomamiew' (16.06 cm) and *N.* 'Khaomongkol' (15.09 cm). In terms of stalk size, the numbers were 1.56 cm, 1.35 cm, and 1.31 cm for *N.* 'Chalongkwan', *N.* 'Khaomongkol', and *N.* 'Chompoomamiew', respectively. Regarding to the yield, *N.* 'Chalongkwan' produced 14.48 flowers per clump per month. In second time, *N.* 'Chompoomamiew' produced 11.86 flowers per clump per month. The observed cultivar with the lowest yield was *N.* 'Khaomongkol', producing 9.91 flowers per clump per month. DMRT indicated statistical significant between the three cultivars in all aspects.

Table 1 Flower diameter, stalk diameter and no. of flowers/clump/month

Cultivars	Flower diameter	Stalk diameter	No. of flowers/clump/month
N. 'Chalongkwan'	18.89 a[1]	1.56 a[1]	14.48 a[1]
N. 'Khaomongkol'	15.09 c	1.35 b	9.91 c
N. 'Chompoomamiew'	16.06 b	1.31 c	11.86 b
F-test	**	**	**
C.V. (%)	1.81	1.00	2.69

[1]Similar vertical numbers indicate no statistical significant at df = 0.95.

Table 2 Average yield of flowers 1 to 3 month after plant/rai

Cultivars	Yield of flowers after plant		
	1 month after plant	2 month after plant	3 month after plant
N. 'Chalongkwan'	5776.0 a[1]	5696.0 a[1]	5904.0 a[1]
N. 'Khaomongkol'	3712.0 c	4192.0 c	3984.0 c
N. 'Chompoomamiew'	4448.0 b	4816.0 b	4960.0 b
F-test	**	**	**
C.V. (%)	5.99	4.34	3.39

[1]Similar vertical numbers indicate no statistical significant at df = 0.95.

Table 2 shows that each cultivar had a relatively high yield. The cultivar with the highest yield was *N*. 'Chalongkwan', producing between 5,696.00 and 5,904.00 flowers per month. *N*. 'Chompoomamiew' produced the second highest yield of between 4,448.00 and 4,960.00 flowers per month. *N*. 'Khaomongkol' was the least productive cultivars, producing only 3,712.00 to 4,192.00 flowers per month. DMRT demonstrated that the yields of the three cultivars were statistically different.

DISCUSSION

According to the study, the flowering capabilities of three hybrids water lily. The results indicate that *N*. 'Chalongkwan'was the cultivars with the largest flower diameter and stalk diameter, as well as the highest number of flowers per clump per month, i.e. 18.89 cm 1.56 cm and 14.48 flowers. The *N*. 'Khaomongkol' was the least flower diameter and number of flowers per clump per month, i.e. 15.09 cm and 9.91 flowers. The results that average yield of flowers per rai, the *N*. 'Chalongkwan' was the cultivars with the highest average yield of flowers per rai, followed by *N*. 'Chompoomamiew' and *N*. 'Khaomongkol'. This experiment shows that the water lily flowers of three cultivars grown in the same environment. The flowering indicated statistical significant between the three cultivars. This is consistent with Techapinyawat (2001) found that the process was flowers are factors involved in the regulation of flowering many factors. Different species and even in the same environment with the ability to create a different flower, depending on the plant itself and external factors also contribute to the promotion and inhibition of flowering. Also Qichao and Xingyan (2004) found that lotus plants are long day, and the intensity of the light affects the growth and flowering. The hardy water lily varieties Gladstone when adding the aperture will be extended and accelerated the bloom (Kelly and Frett, 1986). This is consistent with Wasuwat (1997) found that the water lily or lotus is the need of a period of full bloom and the sun varies.

N. 'Chalongkwan' is propagated from shoots or rhizomes. As one shoot or rhizome can grow into several clumps, it is necessary to plant them separately; otherwise, the flowers will become smaller in size. In contrast, *N*. 'Khaomongkol' and *N*. 'Chompoomamiew' are bred from shoots growing in the middle of leaves. Such leaves need to be trimmed in order to allow new shoots to develop. In addition, if left to grow in an uncontrolled manner, the leaves will get densely layered, leading to possible damage from pests such as Erionotathrax.

CONCLUSION

Based on the findings, the *N*. 'Chalongkwan' was cultivars with the largest flower diameter and stalk diameter equaled 18.89 and 1.56 cm, respectively. Additionally, the number of flowers per clump per month was 14.48, and the average yield of flowers per rai was 5,792 flowers.

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Review article

Governance of Agricultural and Rural Development in Serbia: A Review

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Abstract Agriculture still ranks among the most important sectors of Serbia's economy, with significant contributions to economic and social stability. Primary production accounts for about 10% of the gross domestic product. Over half of the population is rural. Serbian agriculture and rural areas face many problems including an underdeveloped institutional infrastructure. The paper aims at analyzing governance of agricultural and rural development (ARD) in Serbia. The work is based on an extensive secondary data review. It focuses on ARD policy design, implementation and evaluation and organizations dealing with ARD in each phase of the policy cycle. Agricultural policy objectives are set by the Law on Agriculture and Rural Development (LARD). The LARD, implemented through specific measures included in the Agricultural and Rural Development Strategy, also provides a general rural policy framework. ARD policy effectiveness and efficiency is linked also to governance arrangements and coordination mechanisms adequacy. Many national, regional, provincial and local public institutions are involved in the ARD arena. The range of key actors includes also some civil society organizations. Bilateral and multilateral donors implemented many projects during last years. However, the ARD policy framework needs further adjustments to be aligned with the European legal framework. The Serbian agricultural policy requires fundamental reforms at all levels and in all stages of the policy cycle. More attention should be given to rural development. Collaborations between the sectors dealing with rural development can lead to substantial improvements and push for more innovation and cross-sectoral participation. Governance levers require government leadership at all levels - from national to local. Improved policies should maximize complementarities between public, civil society and private stakeholders.

Keywords rural development, agriculture, governance, Serbia

INTRODUCTION

The Western Balkan region is now in a phase of consolidation and overall economic growth. Economic development went hand-in-hand with rising agricultural productivity (Volk, 2010). The countries of the Western Balkans face different challenges in transforming and modernizing their agriculture. Their rural sectors have lagged behind the rest of the economy in growth and poverty reduction, their agro-food sectors are undercapitalized and highly fragmented, and their agro-processing capacities limited. Added to this scenario are the challenges and opportunities of adopting the European Union (EU) *acquis* relating to agriculture (Lampietti et al., 2009).

Agriculture is still an important sector of Serbia's economy, with significant contributions to overall economic development and social stability (EC, 2011a; Volk, 2010; Bogdanov and Bozić, 2010). Primary production from agriculture, hunting, forestry and fisheries accounted for over 10% of GDP in 2009 (EC, 2011a). The share of the food, beverage and tobacco industry in GDP is 5.5% on average (Bogdanov and Bozić, 2010). Agricultural exports contributed about 24% of total Serbian exports in 2009 (EC, 2011a). About 43% of the total population lives in rural areas (RDNS, 2010). Around a third of the active population depends at least partly on agriculture for their livelihood (EC, 2011a). In rural areas more than 45% of the active population is employed in agriculture, forestry, hunting and fishing (Stevanović et al., 2005). Rural areas have suffered from intensive migrations and low levels of economic diversification. They lag behind urban areas in terms of service delivery and household incomes. Rural businesses lack access to affordable credit for investment and support services (European Integration Office-Serbia, 2011).

Effectiveness of agricultural and rural development (ARD) policy is linked, among others, to the adequacy of the policy system and governance arrangements put in place. The term *governance* has been deployed and used in the scientific literature with different meanings (Rhodes, 1996; Lewis *et al.,* 2002). According to FAO (2012), the concept of governance is built around notions such as transparency, participation, consensus orientation, accountability, *responsivity*, efficacy and the rule of law. The World Bank distinguishes between an analytical and an operational use of governance thus referring to three aspects of governance: (i) the form of political regime; (ii) the process by which authority is exercised; and (iii) the capacity of governments to design, formulate, and implement policies (World Bank, 1992). Governance is also defined as '*the process of decision-making and the process(es) by which decisions are implemented*' (UNESCAP, 2009). Governance analysis focuses on the actors involved in decision-making and implementing the decisions made and the structures that have been set in place to arrive at and implement decisions (Sheng et al., 2007).

The review paper aims at analyzing governance of ARD in Serbia. In particular, it analyses the legal and political framework (policies, laws, strategies) in the field of ARD and identifies the main public and civil society institutions dealing with ARD policy in Serbia.

RESULTS AND DISCUSSION

Actors Dealing with ARD in Serbia

The design and implementation of ARD policies involves several different supra-national, national and sub-national actors (regional and local) (OECD, 2006). In order to define the key public, private and civil subjects who have influence on and interest in supporting the rural development process, an analysis of key stakeholders was implemented by the Rural Development Network of Serbia (RDNS). The range of stakeholders identified by the founders of the RDNS is very wide and varied. The main stakeholders include (RDNS, 2010): Ministry of Agriculture; Ministry of Economy and Regional Development; Provincial Secretariat for Agriculture - Vojvodina; regional chambers of commerce; regional development agencies; veterinary stations; institutions of higher

education and scientific research; local governments; public companies and institutions; tourism organizations; agricultural expert services; donor organizations; religious communities; rural local communities; agricultural and rural development associations; media; registered farms; and private companies.

Agricultural and rural development policy is under the jurisdiction of the Ministry of Agriculture; the key government body developing and implementing legislation for the sector. The Ministry of Agriculture set up a new Department for Rural Development in 2005 (Arcotrass et al., 2006). Nevertheless, many other ministerial departments - such as those in charge of environment, regional development, tourism, health, etc. - have been dealing with rural development (Tar, 2007).

Agricultural and rural development design and, especially, implementation, have been increasingly decentralized during the last decade. The opportunity is given to the Autonomous Province of Vojvodina (APV) and local governments to implement agricultural policies in their territories (RDNS, 2010). Significant funds were invested by the APV in support for mechanization, land amelioration, introduction of food quality standards, and promotion of local products and events in Vojvodina region (Bogdanov and Bozić, 2010). Local governments mainly have active offices to assist the village and/or offices to support agriculture. After adopting the Law on Agriculture and Rural Development, local governments have begun with the establishment of local funds for agricultural development (RDNS, 2010).

Since 2007 the strengthening of local partnerships and the capacity of local rural stakeholders has been supported (Bogdanov and Bozić, 2010). The Ministry of Agriculture established the Rural Development Support Network of 16 regional and 140 local offices to prepare local communities for LEADER (*Liaison Entre les Actions de Développement de l'Économie Rurale*)-type programs (European Integration Office-Serbia, 2011). Different associations are active in the field of agricultural and rural development at local and regional levels. These include the members of the Rural Development Network of Serbia (RDNS, 2010). Nevertheless, as for the area of rural development, it seems that strong links between the administration and stakeholders through the extension service and rural finance institutions have yet to be put in place (EC, 2013).

The ARD sector in Serbia is also characterized by the presence of many bilateral and multilateral donors and financial institutions. The most significant donors in the ARD sector, according to the amount of disbursed funds in 2011, are the European Union (EU), the World Bank, the USA and Denmark (Serbian European Integration Office, 2012). Apart from the EU, other donors are also contributing to the adoption of agro-environment and agri-business schemes, and rural development, with support from Japan, the Netherlands, Norway, Romania, Spain, Sweden, the United Nations and the USA (USAID) (European Integration Office-Serbia, 2011). The main specialized agencies of the United Nations System operating in Serbia are FAO, ILO and UNDP.

Coordination and programming of the assistance at country level is the responsibility of the Department for Planning, Programming, Monitoring and Reporting on EU Funds and Development Assistance (DACU) within the Serbian European Integration Office (SEIO). Other donor coordination capacities at central level include the high-level Commission for Programming and Management of EU Funds and Development Assistance and Sector Working Groups (Forum on Aid Effectiveness, 2011).

ARD Policy-Making and Governance

Agricultural and rural development policy-making in the Western Balkan region in general and Serbia in particular has often been dictated by ad-hoc considerations and lacked a clear orientation towards the EU's Common Agricultural Policy (Volk, 2010). In Serbia, the institutional framework of agricultural policy was not transparent, lacked continuity and often resulted in conflicting solutions. From 2007, the implementation of agricultural policy has been continuously changing (Bogdanov and Bozić, 2010).

The Law on Agriculture and Rural Development (LARD) was adopted in May 2009. The LARD regulates the objectives and implementation of agricultural policies, forms of incentives in agriculture and rural areas, the eligibility for incentives and its beneficiaries. Major parts of the LARD in terms of rural development policy are related to the adoption of the Rural Development

Program and establishment of a new structure of the Sector for Rural Development (RDNS, 2010). As regards rural development, the LARD put in place a strategic framework that largely resembles the one established under the current EU legislation (EC, 2011b).

Implementation of the policy is based on the Strategy of Agriculture and Rural Development, the National Program for Agriculture and the National Program of Rural Development (RDNS, 2010). The Agricultural and Rural Development Strategy for the period 2011–2020 has not yet been adopted (EC, 2012, 2013). A clear policy direction for agriculture is provided in the Agricultural Strategy (2005) and re-iterated in the National Agricultural Program 2010-2013 (2010), which aims at production and institutions restructuring; market development; and improving rural development and environmental protection (European Integration Office-Serbia, 2011).

The EU has funded a technical assistance project titled Support to Rural Development Programming and Payments System (2006-2008), managed by the European Agency for Reconstruction. The project introduced the Ministry of Agriculture staff to the preparation, implementation, monitoring and evaluation of rural development programs, as well as planned procedures and tools to support these actions. Some of these skills have been developed, and National Rural Development Strategy Plan 2008-2013 and National Rural Development Program for 2008-2013 were prepared (Bogdanov and Bozić, 2010).

The National Rural Development Program 2011-13 identifies different strategic objectives: improvement in food safety, veterinary and phytosanitary activities; and, sustainable development of the rural economy and rural areas by encouraging diversification (European Integration Office-Serbia 2011).

In addition to the Law on Agriculture and Rural Development, a whole set of laws regulating specific issues related to agriculture and rural development was adopted (RDNS, 2010). In fact, thirty new primary laws have been adopted in 2009-2010 to harmonize with the *acquis communautaire*, and 94 regulations were passed in 2010 alone, addressing the implementation of the requirements for agriculture, food safety and phytosanitary issues, water, forestry and rural development sectors (European Integration Office-Serbia, 2011).

Other key national strategies affecting the agricultural and rural development sector include: Energy Development Strategy of the Republic of Serbia; the Biomass Action Plan for the Republic of Serbia 2010-2012; the National Sustainable Development Strategy (2008); the Strategy for Regional Development (2007-2012); the National Employment Strategy 2005-2010; the Strategy for the Development of Tourism of Serbia (2005-2010); the National Program for Environmental Protection (2010); and the Poverty Reduction Strategy of the Government of the Republic of Serbia (2003) (European Integration Office-Serbia, 2011).

Main Governance Challenges

The biggest challenge for Serbia will be the institutional changes and the capacity building that will be necessary for creating a system in ARD field comparable to the EU countries (Arcotrass et al., 2006). Harmonization in the area of agriculture is particularly demanding, especially for countries whose agricultural policy usually has a different role than that in the EU (Erjaveć, 2008). In order to achieve all this, Serbia needs effective governance and coordination in the design and implementation of ARD policies.

In Serbia, the institutional framework of agricultural policy was not transparent, lacked continuity and often resulted in conflicting solutions. From 2007, programs and regulations were changed and/or abolished several times during the year, and payments to the users were delayed (Bogdanov and Bozić, 2010).

The agricultural policy in Serbia is only partly designed on a strategic basis and in recent years it has been characterized by the increasing estrangement from the EU model of support. The current strategy has not been supported by the accompanying program documents, so the measures for its implementation inconsistently followed the goals. Frequent changes in administrative structures brought radical changes in the system of support (Bogdanov and Bozić, 2010).

Agricultural policy is still implemented mostly based on annual programs of budget allocation, which are not stable in terms of funds, support measures and eligibility criteria (Volk, 2010). Implementation of agricultural policy is done through the following types of subsidies (RDNS, 2010): direct subsidies (bonuses, subsidies for production, recourse and support to non-commercial farms), market incentives (export subsidies, storage costs and credit support) and structural incentives (measures of rural development, improvement and protection of agricultural land quality and institutional support).

In relation to State aid, apart from market-related subsidies and rural development measures, Serbia applies a number of additional measures. Direct aid payments are currently granted for Serbia's key production sectors: dairy, meat and crops (EC, 2011b). In addition to a substantial drop in total support, dramatic change in the structure of direct producer support can be seen in recent years – a switch from direct payments to input subsidies. The prevailing direct producer support form is input subsidies (Volk, 2010).

In the 2012 agricultural budget direct aid payments account for more than 90% of the support measures. There was an increase in the allocation for rural development measures in the budget. Support measures continue to be reviewed and revised on an annual and ad-hoc basis. This does not provide security and predictability for producers and processors to engage in the required investments (EC, 2012).

Generally speaking, in the last decade, there have been quite substantial changes to agricultural policy. Rural development policy is generally subordinate to production support. Funds aimed at supporting rural development are much lower, although show an increasing tendency. These funds are mainly intended for restructuring agriculture through investment support. Serbia has been preparing to implement rural development policy according to EU rules. However, progress has been relatively slow, since rural development is a demanding policy, and also because the country has different sectoral and development priorities (Volk, 2010).

CONCLUSION

The agricultural and rural situation has gradually improved in Serbia but the country lacks a stable ARD policy and a true strategy of reforms. The main problem of the existing legal framework is that it is not fully developed and doesn't have adequate action plan and strategy for enforcement. Policy-making and measures definition has often been dictated by short-term ad-hoc considerations rather than long-term strategic goals. Problems regarding rural development span over the whole policy cycle. Rural development policy is subordinate to production support. Funds aimed at supporting rural development are still low. While there were some attempts to decentralize the implementation of ARD policy, most of local and regional development strategies, including measures regarding ARD, have not been transformed in concrete and time-bound action plans due to the lack of human and financial resources.

Serbian ARD policy requires fundamental reforms at all levels. More attention should be given to rural development, which should gradually become a central policy. Integrated rural policy design and implementation requires changes in relations between governance levels and among the governance actors (public structures, the private sector and the civil society). Overcoming weaknesses and setting the conditions for an increasingly harmonized policy approach will be crucial for moving closer to EU accession. Among the necessary steps towards this goal are the modernization of agricultural policy administration and the implementation of appropriate policy monitoring and evaluation systems. With this respect, strengthening the capacity and *modus operandi* of the Ministry of Agriculture, Trade, Forestry and Water Management is a priority. A systematic implementation of the ARD strategies and the modernization of public services regarding agriculture and rural development are also necessary elements. Increased capacity for monitoring, analyzing, evaluating and programming policy is another important part of agricultural and rural development policy reform process.

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Research article

Rural Livelihood Diversification in South-Eastern Bosnia: Influence of Household Financial Management

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Abstract A growing body of evidence shows that agriculture is no more sufficient to ensure sustainable rural development in Bosnia and Herzegovina (BiH) therefore rural livelihoods diversification is crucial. Farm activity diversification issue can be considered in terms of resources (land, labor or capital), location (on-farm or off-farm) and output (farm or non-farm). Well-developed financial systems are associated with more rapid and inclusive rural development and foster rural economy diversification. The paper aims at analyzing rural livelihoods diversification in south-eastern BiH with a particular focus on the influence of household financial management. The paper is based on an extended literature review and a questionnaire survey performed in March 2013 with 147 randomly selected rural households from nine municipalities in south-eastern BiH. The majority of the surveyed rural households (68.7%) have mixed (farm and non-farm) livelihoods. Household sources of income are quite diversified and many rural households have different non-farm income sources. More than two-fifths of the surveyed households had an activity on development or started new non-farm businesses in the last five years. However, about a half of these gave up because of many problems such as the lack of financial resources and time. Weak business skills are also a limiting factor. Financial literacy is often lower in rural areas. Moreover, it is positively associated to education level and negatively correlated to age. It comes no surprise that well educated and young rural people are those who started more new diversification businesses during the last five years. They find it less difficult to deal with paperwork, bureaucratic procedures and administrative documentation needed to make request for loans. Effective household financial management, depending mainly on household head financial skills, plays a significant role in determining livelihoods strategies and diversification endeavors success.

Keywords rural finance, household financial management, livelihood diversification, Bosnia

INTRODUCTION

Agriculture is no more sufficient to ensure the sustainable development of rural areas that's why rural economy should be diversified (Antonelli et al., 2009; Haggblade et al., 2007; OECD, 2006). The framework provided by OECD (2009) considers the issue of farm household diversification by differentiating between activities in terms of resources (factors of production: land, labor or capital), location (on-farm or off-farm) and output (agricultural or non-agricultural). The major differentiation between activities is made on the basis of the location of the activities, either on-farm or off-farm. Within each location, diversification activities are further differentiated as to the type of output, whether agricultural production or continuation (e.g. processing of food or providing contracting services).

Rural dwellers involved in activities related to economic diversification have different investment needs. Generally speaking investment needs can be categorized as follows (FAO-ROECA, 2012): investment in new technologies (e.g. equipment, storage facilities); investment in new tourism facilities (e.g. restaurants and accommodation facilities in order to meet European Union's standards); investment in marketing (e.g. marketing materials, websites and marketing strategies). Therefore, they use often loans and have different needs in terms of financial services.

One cause of poverty is the lack of access to credit, especially among rural households (Coleman and Wynne-Williams, 2006). A growing evidence body shows that well-developed and inclusive financial systems are associated with more rapid growth and better income distribution. Finance helps extend the range of individuals, households, and firms that can get a foothold in the modern economy (Basu, 2006). According to Richter (2011), rural finance is the provision of financial services in rural areas that support a wide range of economic activities and households of various income levels. Rural communities could make use of a wide range of financial services like savings, money transfer services, insurance products, loans, leasing, factoring, loan guarantees, venture capital, and investment funds.

Budgets for agriculture and rural development of the Bosnian Entities - Republika Srpska (RS) and Federation of Bosnia and Herzegovina (FBiH) - remain low. Subsidies to farmers are mainly product-based. The lack of an efficient administration and effective rural credit schemes hamper the efforts to increase the productivity and competitiveness of the sector (EC, 2012).

The paper aims at analyzing the influence of household financial management on rural livelihoods diversification in south-eastern Bosnia and Herzegovina (BiH).

METHODOLOGY

The paper is based on secondary data from an extended literature review and primary data collected by a questionnaire survey carried out in March 2013 with randomly selected 147 rural households in nine municipalities of south-eastern Bosnia: Vlasenica, Han Pijesak, Milici, Zvornik, Rogatica, Pale, Bratunac, Sokolac and Foca.

The questionnaire dealt with different issues including:

- General information about the interviewees: age; gender; role in household (head or member).
- Household characteristics: type of household (agricultural, non-agricultural, mixed); number of male and female members; age structure; level of education of household members.
- Household livelihood diversification: household sources of income; main occupations of household members; sources of household primary income; significance of income from agriculture (main income, additional income, no income from agriculture); attempts to start new non-agricultural businesses to improve household financial situation; kinds of businesses tried out; main problems and constraints faced.
- Financial management of rural households: household financial manager's age, gender, educational level and occupation; membership in saving/credit groups.

The average age of the interviewees was 47.4 (minimum: 19; maximum: 70). The majority of the respondents were males (91.2%). Almost all the interviewees were rural households' heads (89.2%). Nevertheless, 15 respondents were not but they deal with financial management in their households so they were entitled to answer the questions. Regarding household structure, the number of household members ranges from one to 14. As for education level, 4.7% of household members are illiterate while the rest have different education levels (primary school: 26.9%, secondary school: 17.7%, high school: 37.6%, and high education diploma: 13.1%).

RESULTS AND DISCUSSION

Livelihood Diversification Strategies

The majority of the households considered in the present field survey (68.7%) were mixed households that's to say that their livelihoods are based on both farm and non-farm income-generating activities. Meanwhile, 6.8% of the target households consider themselves as non-agricultural.

Household livelihood strategies are quite diversified and many rural households have different farm and non-farm income sources. Nevertheless, the most important sources of income are crop production and animal husbandry, pensions, salaried work and wage labor (Table 1).

Table 1 Sources of income of rural households

Source of income	%*	Source of income	%*
Crop and animal production	62.6	Non-farm self-employment or businesses	5.4
Pensions	36.7	Handicraft	4.8
Salaried work	34.7	Trade	2.7
Wage labor	26.5	Land and property renting	1.4
Services provision	16.3	Social aid and assistance	0.7
Forestry	8.8	Industry	0.7

**Multiple answers were possible.*
Source: Authors' elaboration based on the field survey results.

Despite the fact that about two-thirds of the surveyed rural households deal with agriculture (crop production and animal husbandry) the percentage of households whose primary income source is outside of agriculture is quite high. In fact, about a third of the target households (33.2%) declared that income from self-employment or business ownership is their primary income source. Other important primary income sources are salaried work (48.2%) and income from wage labor (18.6%). However, it should be highlighted that salaried work, and to a certain extent, also wage labor, includes also agriculture-related activities. In fact, income from agriculture is the main income for 24.5% of the surveyed households and additional income for 63.3% of them.

More than two-fifths of the surveyed households (40.8%) had an activity on development or started new non-farm and off-farm businesses and activities in the last five years to improve their financial situation and livelihoods. Of these, only about a half (51.7%) still deal with the non-farm activities that they have started up. The main off-farm and non-farm activities that the surveyed rural households tried out during the last years are handicraft (23.3%) and trade (23.3%). Other developed income-generating activities include: food processing, transport, rural tourism, timber and non-timber forest products collection, services provision (equipment and machines), teaching and wood processing.

Effect of Access to Credit and Household Financial Management on Livelihood Diversification

About a half of the surveyed rural households in south-eastern Bosnia that invested in new diversification activities gave up because of many problems especially lack and/or difficult access

to funding and loans and lack of time to deal with new activities. According to FAO-ROECA (2012), the barriers to starting additional income generating activities in Bosnia are mostly economic. The lack of funding and access to credit is the barrier that most frequently mentioned by Bosnian farmers. Rural dwellers and enterprises are not seen as attractive customers and banks do not have enough experience of the risks surrounding diversification activities and so are unable to evaluate business plans and credit requests. This makes interest rates very high. The conditions are better for microloans; that is, the interest rates are lower.

One reason for which some loans requests were rejected was age of applicants. The age of the surveyed households' financial managers ranges from 22 to 71 (average: 48.1 years). Females represent just 8.8% of the household financial managers. According to FAO-ROECA (2012), women and young people in BiH face difficulties in getting loans since they are rarely the owners of the land or assets on which they want to make investments.

Another important loans rejection reason is also the lack of collaterals. Many Bosnian mentioned lack of access to financing (including savings) as the main obstacle to livelihood diversification. Farmers mention mortgages and having to find guarantors as other obstacles (FAO-ROECA, 2012).

Nevertheless, many rural households' heads do not even apply for loans because the application procedure is too complicated for them. This is true not only regarding loans but also for other administrative procedures (e.g. for getting subsidies). Another rejection reason is the presentation of bad quality business plans. This also explains why many diversification endeavors are hampered by the lack of market since most rural people do not carry any feasibility study. All showed the importance of the human capital of the household financial manager.

Only 7.5% of the interviewed household financial managers have high education diploma, most of them have secondary school levels while 12.9% stopped their education at primary school. Only a very small percentage of the financial managers (2.1%) are illiterate. Regarding the occupation of household financial managers, 23.8% are government employees, 25.9% are retired, 15.6% are self-employed, and 11.6% are private company employees. Others are unemployed and housekeepers.

Many factors influence the diversification of farm households into non-farm activities, including government intervention (OECD, 2009). Prerequisites for encouraging private investments include improving the business climate, and providing business development and financial services suited to the needs of small rural entrepreneurs. Acquiring a labor force with appropriate skills is crucial. Strengthening the rural people's capabilities to take advantage of opportunities in the rural non-farm economy is essential. Education and skills are particularly important (IFAD, 2010).

According to the Working Group on Diversification of the British Department for Environment, Food and Rural Affairs (DEFRA, 2007), key barriers to farm diversification include validity of market research, capacity to develop a considered business case, quality of business skills and training, availability of appropriately skilled personnel and regulatory controls, and access to specialist business advice. Access to finance was also identified as a potential barrier.

According to Richter (2011), in general, levels of financial literacy are often low in rural areas so it is important to promote a finance culture among rural populations through awareness campaigns, financial education trainings or experience/testimony-sharing.

Diversification endeavors success is influenced by financial literacy. Control of financial resources can improve good management practices. By learning how to manage their enterprises better, women, as well as men, can become more capable of controlling their economic activities and thereby better able to evaluate their resources (Sudan, 2007).

Rural people tend to operate not just with one but with several livelihood activities. They often switch from one to the other even within the same day and also by seasons. Diversification makes even more complicated financial management as households with mixed livelihoods should manage variable cash flows and match income and expenditure requirements by saving and borrowing from different sources (CARE India & FAO, 2007).

Lack of experience is another problem that was faced by many Bosnian rural households that tried to diversify their livelihoods. In fact, many rural Bosnian people were forced to start new

businesses for which they had no experience prior to the civil war, or were faced with high competition and were selling their products almost at a loss to the food processing factories. They would have needed skills to start something new that the market needed. Bosnian rural households are nowadays aware of the fact that also in agriculture it is especially important to follow technology and to obtain technical assistance so as to be able to develop a business plan, minimize risks and put aside profit from the business. Education on how to run such businesses is of utmost importance. Risk in agriculture is always high and one has to gain experience so as to minimize its impact once it occurs (Matul & Tsilikounas, 2004).

Difficult access to funding is aggravated by the fact that only 12.9% of the surveyed rural households are members in saving/credit groups such as "Mali akcionari" (small shareholders) and "Mali poljoprivrednik" (small farmers) organizations, microcredit foundation "EKI", and Mikrofin. Micro-credit in BiH stimulated household reconstruction as it provided an efficient and long lasting coping mechanism for households after the war. For most clients micro-credit helped at least to sustain their household self-employment activities (Matul & Tsilikounas, 2004).

Membership in local financial groups helps developing financial management skills. As Sudan (2007) points out, regular micro-credit clients adopt good management practices more substantially, in particular with regard to calculating profits on the basis of records. In fact, the clients are more inclined to use costs and earnings records than are non-client group. The clients appear better able to estimate their sales, expenditure and profits than those in the non-client group. The main management practices in use are: capacity to keep enterprise money separate from money for personal expenses and ability to calculate profits based on records and to estimate profits.

Rural households got in touch with saving/credit organizations to get loans but also for saving purposes. The choice of these groups and organizations is based on many reasons including that they trust the members of the group or they are friends with some of them. The other rural households never applied for joining saving and credit groups or their applications were rejected. One of the reasons for not applying was that the application procedure is considered quite complicated especially for those that have low education levels. Moreover, apart from the lack of collaterals another reason for rejecting some applications was that they were badly prepared.

Evidence from India shows that credit groups must have sufficient knowledge and skills to deal with the organizational and technical issues related to various aspects of the economic activities, in addition to relevant management skills. Therefore, training meant for grassroots organizations must deal with formation and structure of credit groups, their roles and responsibilities, and account-keeping and financial management (Sudan, 2007).

CONCLUSION

Most of the surveyed rural households in south-eastern BiH have mixed livelihoods as they rely on both farm and non-farm income-generating activities. More than two-fifths of the surveyed households started new non-farm businesses and activities such as services provision and on-farm processing in the last five years. However, they faced many problems and constraints such as the lack of financial resources. Weak business skills are also a limiting factor. Well educated and young rural people are those who started more new diversification businesses during the last years. They find it less difficult to deal with paperwork to get loans and subsidies. They are also better informed about availability, terms and conditions of specialized credit lines. Moreover, the financial management skills of the borrowers are taken into consideration by lending institutions when analyzing loan requests. Educated rural people are also more likely to perform some bookkeeping, which is positively valued by financial institutions.

Harnessing farm diversification, especially in the non-farm economic activities, requires improving the environment, thus strengthening incentives and reducing risks. Fully exploiting rural economy diversification potential in Bosnia requires also upgrading rural people's human capital (including financial management skills), strengthening rural social capital and improving access of the rural population to finance. Access of rural households to financial services is crucial for creating an enabling environment for fostering Bosnian rural economies diversification. However,

that depends not only on the existence of a good institutional and political environment that harnesses diversification and makes easier access to loans but also on rural people's financial management skills. Therefore, future projects and initiatives dealing with livelihood diversification should also address this issue. This can be done by organizing training sessions about financial management and bookkeeping for rural people. Moreover, extension services should include training about soft financial management skills in their activities.

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Research article

A Preliminary Survey of Insect Pests at the Community Forests of Khon Kaen Province, Thailand

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Abstract A survey of insect pest from community forests including Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha khiri district) community forests, Khon Kaen province, were carried out from May to September 2013. Insect samples were collected by manual collecting and light trap. Fifty eight species were identified representing 34 families relating to 9 insect orders. The diversity of insects in Kok Soke Hin community forest consisted of Coleopterans (3.63%), Lepidopterans (3.63%), Hemipterans (0.52%), Homopterans (3.63%), Orthopterans (0.36%) and Hymenopterans (3.63%). The diversity of insects in Phu Wat community forest consisted of seven orders of insect including Orthopterans (29.49%), Coleopterans (24.36%), Lepidopterans (24.36%), Hemipterans (3.85%), Homopterans (16.67%), Dipterans (3.63%) and Hymenopterans (1.28%). Among the insects identified, insect pests were about 61.54 percent. The community forests of this study are considered to have a low diverse and numerous insect fauna in the area. Order Coleoptera was found abundant and dominant among other orders.

Keywords survey, insect pest, community forest

INTRODUCTION

The community forest area of Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha khiri district are lowland semi-deciduous forests as the community forest in the northeastern Thailand (Zhu T. et al., 2011) in a central agricultural production area in Khon Kaen Province. Kok Soke Hin (Ban Fang district). Kok Soke Hin was declared as a community forest in 2005 and the forest covered about 440 ha. The Phu Wat forest area covers about 560 ha, and it has been managed as a community forest since the 1970s. Over 1 million species of insects have been described, but current estimates of total insect diversity vary from 5-80 million species of insects. Beetles (Coleoptera) make up 40% of described insect species. Five orders of insects stand out in their levels of species richness such as the Hymenopterans, Dipterans, Coleopterans, Lepidopterans, and Hemipterans. In ecosystems, biodiversity is instrumentally important not only for the production of food, but for other ecological services, including the recycling of nutrients, regulation of microclimate and local hydrological processes, suppression of undesirable organisms and detoxification of noxious chemicals. However, some of them become pests in forest (Triplehorn and Johnson, 2005). These areas have been chosen because of the less known diversity and abundance of insects in these forests. Therefore, identification of insects around the area will give more insight on the species richness of insect diversity in forest ecosystems, the structure of their populations, their interrelationships and interaction with their habitats. The objective of this study was to determine the diversity and abundance of the insect fauna at the Kok Soke Hin and Phu Wat community forests.

METHODOLOGY

Insect specimens were collected around the community forests (Fig.1) including Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha khiri district) community forests, Khon Kaen province.

Sampling was conducted during May to September 2013 in the wet season. Sampling methods in this study were based on Triplehorn and Johnson (2005), Insect specimens were collected using light trap and manual collecting. In each area, light trap were set up from 7.00 pm until 11.00 pm and manual collecting were done for 3 h during the day time. All of the collected specimens were preserved in 70% ethyl alcohol in the multipurpose containers, and were brought back to the laboratory for pinning and identification. Identification of insects to order, family, genus and species was based on the keys by Triplehorn and Johnson (2005). However, the detailed identification was based on comparison with specimens in the Insect Museum in the Entomological section, Faculty of Agriculture, Khon Kaen University and several taxonomic references. The percentage of insect samples was used by combination two sampling methods.

The Shannon-Wiener's diversity index (Krebs, 1999), was used to calculate the diversity of insect collected. The formula of the Shannon-Wiener's diversity index used is presented below

$$H' = \sum_{i=1}^{S} (pi)(\ln pi) \quad (1)$$

Where H' = Species diversity index, s = Number of species, pi = Proportion of the total sample belonging to ith species.

The evenness index (Krebs, 1999) was calculated to determine the equal abundance of ants in each study site as follows:

$$E' = \frac{H'}{H'_{MAX'}} \quad (2)$$

Where H' = Observed index of species diversity, $H'_{MAX'}$ = Maximum possible index of diversity.

The diversity values for Shannon-Weiner were classified based on scale developed by Fernando (1998) and is presented in Table 1.

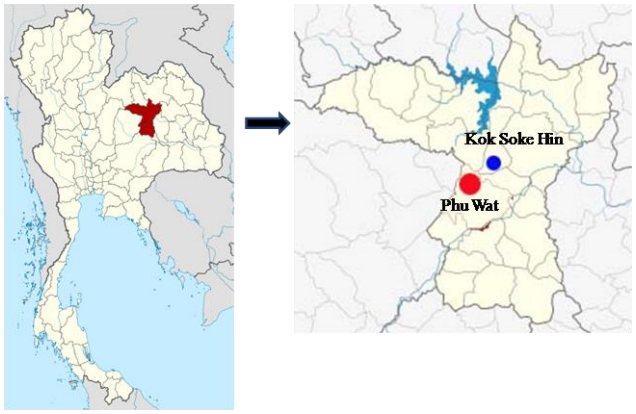

Fig. 1 Study area at the Kok Soke Hin (blue dot) and Phu Wat (red dot) community forest in Khon Kaen Province in Northeastern Thailand

Table 1 Classification of species richness indices (*adopted from Fernando 1998*)

Relative values	Species diversity	Evenness
Very high	>3.50	>0.75
High	3.00 – 3.49	0.50 – 0.74
Moderate	2.50 – 2.99	0.25 – 0.49
Low	2.00 – 2.49	0.15 – 0.24
Very low	<1.99	< 0.14

Table 2 Classification of insects surveyed at the Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha Khiri district) community forests, Khon Kaen province

Order	Family	Genus/species
Coleoptera	Scarabaeidae	*Copris nevinsoni*
Coleoptera	Scarabaeidae	*Xylotrupes gideon*
Coleoptera	Scarabaeidae	*Amomala grandis*
Coleoptera	Scarabaeidae	*Anomala* sp.
Coleoptera	Scarabaeidae	*Catharsius molossus*
Coleoptera	Scarabaeidae	*Copris magicus*
Coleoptera	Scarabaeidae	*Gymnopleurus aethiops*
Coleoptera	Scarabaeidae	*Lepidiota stigma*
Coleoptera	Scarabaeidae	*Orcytes rhinoceros*
Coleoptera	Hydrophilidae	*Hydrous cavistanum*
Coleoptera	Lucanidae	*Aegus amplus*
Coleoptera	Cerambycidae	*Batocera rufomaculata*
Coleoptera	Cerambycidae	*Batocera rubus*
Coleoptera	Cerambycidae	*Celosterna pollinosa sulphurea*
Coleoptera	Cerambycidae	*Cyriopatus wallacei*
Coleoptera	Cerambycidae	*Aristobia approximator*
Coleoptera	Cerambycidae	*Plocaederus ruficornis*
Coleoptera	Cerambycidae	*Xytrocera globosa*
Coleoptera	Cerambycidae	*Xoanodera striata*
Coleoptera	Cerambycidae	*Rhaphuma mutabilis*
Coleoptera	Cerambycidae	*Dorysthenes granulosus*
Coleoptera	Cerambycidae	*Dorysthenes buquet*
Coleoptera	Meloidae	*Electica castanea*
Coleoptera	Staphylinidae	*Paederus* sp.
Coleoptera	Passalidae	*Tiberioides* sp.
Coleoptera	Cicindelidae	*Calochroa flavomaculata*
Coleoptera	Curculionidae	*Sepiomus* sp.
Coleoptera	Lampyridae	*Luciola brahmina Bourgeois*
Coleoptera	Tenebrionidae	*Tribolium* sp.
Coleoptera	Buprestidae	*Sternocera ruficornis*
Orthoptera	Gryllotalpidae	*Gryllotalpa orientalis*
Orthoptera	Gryllidae	*Gryllus bimaculatus*
Orthoptera	Gryllidae	*Gryllus testaceus*
Orthoptera	Gryllidae	*Acheta domesticus*
Orthoptera	Acrididae	*Cyrtacanthacris tatarica*
Orthoptera	Acrididae	*Oxya japonica*
Orthoptera	Mantidae	*Tenodera sinensis*
Orthoptera	Blattellidae	*Pycnoscelus indicus*
Orthoptera	Tetrigidae	*Paratettix* sp.
Orthoptera	Tettigoniidae	*Holochlora nigrotympana*
Orthoptera	Tettigoniidae	*Conocephalus longipennis*
Orthoptera	Plasmatidae	unknown
Hymenoptera	Xylocopidae	*Xylocopa* sp.
Hymenoptera	Formicidae	*Pheidole* sp.
Hymenoptera	Formicidae	*Solenopsis saevissima wagneri*
Hymenoptera	Formicidae	*Camponotus* sp.
Hymenoptera	Vespidae	*Vespa* sp.
Hemiptera	Notonectidae	*Anisops* sp.
Hemiptera	Cydnidae	*Stibaropus molginus*
Hemiptera	Pentaomidae	*Nezara viridula*
Hemiptera	Pentaomidae	*Tessaratoma papillosa*
Hemiptera	Coreidae	*Anoplocnemis plasiana*
Hemiptera	Cicadellidae	*Nephotettix* sp.
Homoptera	Cicadidae	*Meimuna opalifera*
Homoptera	Coccidae	Pseudococcus sp.
Odonata	Libellulidae	*Crocothemis servilia (Drury)*
Lepidoptera	Noctuidae	*unknown*
Lepidoptera	Arctiidae	*Creatonotos* sp.
Isoptera	unknown	*unknown*
Diptera	Chiromomus	*Chiromomus* sp.

RESULT AND DISCUSSION

In this study, fifty-eight insect species were identified as shown in Table 2. A total of 914 individuals of insects from nine orders and thirty-four different families were collected. They are from the orders of Orthoptera, Coleoptera, Hemiptera, Homoptera Hymenoptera, Diptera, Isoptera, Lepidoptera, Odonata, and Diptera (Table 3). The order Hymenoptera had nine species of five different families. The Coleopterans had thirty species of eleven families, while the order Orthoptera had eleven species of nine families. The order Hemiptera had six species of four families, while the order Hymenoptera had five species identified in three families. The orders Homoptera and Lepidoptera had two species belonging to two families. The specimens from the order Isoptera were not identified. The family Cerambycidae had the highest number of 11 insect species followed by the family Scarabaeidae (9 spp.). The results showed that Coleoptera (39.39%) had the most dominant insects in both forest communities, followed by Hemiptera (29.54%), Orthoptera (11.38%) Hymenoptera (7.98%) and Isoptera (5.69%), The following insect orders got lower than 2% (Table 3), Isoptera, Odonata and Diptera. The generally low species diversity observed is due to the very few species recorded in the present study.

Table 3 Taxonomic distribution of insects at the Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha Khiri district) community forests, Khon Kaen province

Order	Taxonomic distribution			Percentage of order
	Population	No. of families	No. of species	
Orthoptera	104	9	11	11.38
Coleoptera	360	11	30	39.39
Hemiptera	270	4	6	29.54
Homoptera	2	2	2	0.22
Hymenoptera	73	3	5	7.98
Lepidoptera	41	2	2	4.48
Isoptera	52	1	*	5.69
Odonata	2	1	1	0.21
Diptera	10	1	1	1.09
	914	34	58	100

**unidentified*

Among the insects identified, forty- eight species of insects in 13 families and eight orders were found as insect in the community forests. The highest number of species was recorded in the Kok Soke Hin community forest (27 species) and the Phu Wat community forest found only fourteen species of insect pest (Table 4).

Table 4 Percentage of insect pest at the Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha khiri district) community forests, Khon Kaen province

Insect Pest	Number of insect pest		Total	Percentage of insect pest (%)		Total
	KSH	PW		KSH	PW	
Order	5	3	8	38.46	23.08	61.54
Family	8	5	13	28.57	17.86	46.43
Species	27	14	41	42.86	22.22	65.08

Note: KSH= Kok Soke Hin community forest, PW = Phu Wat community forest.

The diversity of insect in this study is presented in Table 5. Overall, the results show that insect diversity value for the community forest was very low with H´=1.55 while the specie evenness values show that the community forest had the highest with E´=0.70. The diversity of order Coleoptera is the higher than the others in this study with H´ = 0.37, this is because of scarab beetles were commonly collected in the forest areas. Furthermore, majority of the timber trees were in the forest where the greatest number of cerambycid occurred. The survey revealed that, the insect species include insect pests, insect pollinators, saprophytic insects, parasitoids, and predators. Not many of the insect species identified are major pest to the forest pest in the area except scarab and cerambycid beetles that is a major pest. This implies that the trees in the forest area could be

conducted with less insect pest problem in the areas. However, lower diversity in study areas were influenced by the condition during the time of study. This is because samplings were conducted during raining season. Wardle and Barker (1997) indicate that rainfall leads to direct death to larvae and egg and causes the development of insect to shift. Furthermore, insects will seek protection by reducing foraging activity and finding shelter during this wet duration.

Table 5 Diversity index and Evenness index of the insect community at the Kok Soke Hin (Ban Fang district) and Phu Wat (Mancha Khiri district) community forests

Order	Diversity index (H´)	Evenness index (E´)
Orthoptera	0.25	0.11
Coleoptera	0.37	0.17
Hemiptera	0.36	0.16
Homoptera	0.01	0.01
Hymenoptera	0.20	0.09
Lepidoptera	0.14	0.06
Isoptera	0.16	0.07
Odonata	0.01	0.01
Diptera	0.05	0.02
Total	1.55	0.71

CONCLUSION

From this study, the community forests of Khon Kaen province including Kok Soke Hin and Phu Wat are considered to have a low diverse and numerous insect fauna in the area. Order Coleoptera was found abundant and dominant among other orders. However, the results which were being presented in this paper might be the first comprehensive list of insects in the community forest. It is therefore recommended that, similar survey should be conducted during dry season of the year to have a list of insect occurring at every particular season of the year and the economic importance of insects surveyed should also be investigated.

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Research article

Organic Food Production as a Development Opportunity for Serbia

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Abstract Serbia doesn't have many competitive advantages in relation to the competition it faces. The growing demand for food has led to the fact that agricultural production relies mostly on the use of chemicals, which endanger human health and disrupt nature balance, and all in order to achieve a higher yield and profit. However, in the process of globalization, the only thing Serbia could rely on, except trained staff, are the natural resources. Favorable climate, large areas of arable land and forests, a healthy environment are the main prerequisites for the development of organic production (OP) in Serbia. This paper aims at giving an overview of the current situation of the Serbian organic sector especially potential, animal and crop production, governance, legal framework and market. Some solutions to overcome the main barriers to OP development are discussed. This paper is based on a secondary data review and exploratory semi-structured interviews - dealing mainly with reasons for converting to organic; marketing channels; problems; impacts; access to agricultural extension - conducted in summer 2013 with 40 organic producers randomly chosen from cities/municipalities all over Serbia. Statistical methods, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, induction and deduction, as well as the technique of comparative analysis were used. The results indicate the advantages which increase in the organic production could bring to Serbia, such as economic growth, increased exports, reduced trade deficit, sustainable natural resources management and rural development. For allowing OP to express all its potential, domestic market should be further developed, legal framework and governance enhanced and institutional and financial support secured. Due to high prices of organic food in the world market organic production can be a key generator of economic growth and socio-economic development in Serbia, especially in rural areas.

Keywords organic production, economic development, Serbia

INTRODUCTION

In developed countries, where modern agriculture with the aggressive use of all available chemicals has led to degradation of the quality of air, water, land, is almost impossible to establish organic production, resulting with a huge lack of organic products. Therefore, the developing countries, where the agricultural system is still preserved, have a chance to increase their exports through organic products. In the European Union (EU), sales of organic products have tripled in the period 2001 to 2008 (FiBL, 2010). The largest European market for organic products is in Germany. It is estimated that the share of these products in the food market will continue to grow in the coming years.

Serbia has 5.11 million hectares of agricultural (60% of the territory) and 4.1 million hectares of arable land (Chamber of Commerce and Industry of Serbia, 2013). Serbian agriculture is facing many problems, such as the small size of the private households, unorganized farmers, reduced state subsidies, inability to achieve sales, etc. Even so, Serbia has conditions and outstanding opportunity in the production of organic food.

The fact that over 80% of land in Serbia is in uncontaminated soil, that there are areas that are not still exploited, which could be used for organic production (OP) without major investments, as well as a high percentage of rural population, can be pointed out as the important prerequisites for the successful development of the OP in Serbia (Ćurkovic, 2013). Inglorious facts about the low level of industrial production in Serbia, gives to this country, in terms of the development of organic agriculture, an incomparable advantage in relation to the EU, due to the lower concentrations of pollutants in the environment. Organic agriculture is focused on the future and improvement of the environment and human health; therefore the benefits of investing in it have timeless character.

Today's state of Serbian agriculture, its potentials and limitations, still have the same trend - that in agriculture are used less inputs than are really needed - and therefore the results are lower than desired. The last 10 years, agriculture is going through a transition phase, and the entire Serbian economy as well, which involved privatization process that has been implemented without adequate and clearly defined measures of agricultural development policy. Currently the only competitive advantages of Serbia are the natural resources, low labor costs and low land prices (Tomic & Tomic, 2011).

However, available resources (favorable natural and climatic conditions) are not sufficient for the survival of agriculture and sustainable rural development. It is necessary to support the development of agricultural and rural policy with adequate and intensive budget allocation. Organic farming achieves more stable and better yields (Kilrcher, 2007). The market of food products has greater earning power through higher selling prices, and thus provides greater economic benefits in the form of profit and long-term economic benefits.

The most important organic agro-food products in Serbia are wild or cultivated berries, frozen and dried plums, sour cherries, organic certified jams, sweets, apple concentrate, vinegar and juices, and salted and dried wild mushrooms. The main regions for organic fruit production are Central and South Serbia.

Certified organic vegetable production is relatively small. While fresh, frozen and preserved vegetables, especially ground red peppers, are mainly exported, some fresh vegetables find their way to domestic market as well. In Vojvodina, organic cereals are well developed. There are few examples of organically certified livestock production.

The Serbian market is still largely dominated by conventionally produced products. There is a slight growth of demand for organic products, but still consumers are skeptical and confused, since there have been many products on the market with labels for "healthy food" like natural, bio, eco, organic, but none of them is certified organic product. Market channels of the organic products in Serbia are on-farm selling, farmers green markets, large supermarket chains and specialized shops of healthy food.

This paper aims at giving an overview of the current situation of organic farming (legal framework, production, market) in Serbia and highlighting its potential as a development opportunity for Serbian rural areas.

METHODOLOGY

The work is based on a secondary data review and exploratory semi-structured interviews. The main secondary data sources were ministries (Ministry of Agriculture), professional organizations (Chamber of Commerce and Industry of Serbia, Serbia Organica association), universities (Belgrade, Novi Sad), the International Federation of Organic Agriculture Movements (IFOAM), Research Institute of Organic Agriculture (FiBL), the Mediterranean Organic Agriculture Network (MOAN), United States Department of Agriculture (USDA), etc.

Semi-structured interviews (SSI) were conducted in summer 2013 with 40 organic producers randomly chosen from several cities/municipalities all over Serbia: Sombor, Kraljevo, Novi Sad, Negotin, Kovacica, Vrsac, Pozarevac, Cacak, Subotica, Zrenjanin, Soko Banja, Bojnik, Barajevo, Bela Crkva, Pecinci, Petrovac na Mlavi, Kursumlija, Becej, Sremski Karlovci, Kanjiza, Vrbas, Zagubica, Srbobran, Krusevac, Kikinda, Alibuna and Zabalj. The checklist prepared for SSI included 24 questions dealing mainly with: reasons for converting to organic farming; organic animal and crop production as well as beekeeping; main marketing channels; problems and constraints; main economic, social and environmental impacts of organic agriculture; access to agricultural extension and subsidies; main sources of information about organic agriculture; involvement in organic agriculture projects and initiatives; social capital of organic producers; collaboration and contact with other institutions and actors; etc. Some solutions and recommendations to overcome the main barriers to organic production development are discussed.

The average age of the interviewed organic operators is 48.3 (age range: 29-73). In the total number of interviewees, 75% are men and 25% are women. Among the interviewees there are no illiterate, 80% have secondary education, while 20% of them have high education. The surveyed rural households generate income mainly through farming, pensions and salaries from the public sector. Farm surface ranges from less than one to about 2000 hectares. Land use is dominated by arable crops mainly cereals and vegetables.

It should be pointed out that the lack of a central database system makes it very hard to give precise figures about the size of organic production in Serbia.

RESULTS AND DISCUSSION

For the last ten years, production and processing of organic products in Serbia became more popular and economically more important, considering the first steps made in OP in late 70's (GAIN, 2009). According to the MOAN, with a view to further development of organic farming in the Mediterranean countries, Serbia is at the very top as the country with the largest number of hectares intended for organic production, immediately after Italy. As Serbia is full of regions that are practically "untouched nature", there is a chance for these areas to be immediately engaged in organic farming without wasting time for conversion (which is a big advantage in terms of cost saving and profit) (MAIB, 2008).

The Serbian Law on Organic production and a number of regulations control the production of agricultural products and other methods of organic production and processing, storage, transportation, marking, labeling and sale of these products, their certification and recertification, as well as other important issues in this area (Republic of Serbia, 2010). The goal is to obtain a product with documented production procedure, contributing to sustainable socio-economic rural development, consumer protection, sustainable natural resources management, soil fertility, etc. Nevertheless, the process of harmonization of Serbian legislation with the EU *acquis* in the field of organic farming is still pending. For this reason, there is an ongoing initiative for amending the existing Law from 2010.

An increase of about 30% of plant area with organic production as well as a complete growth of organic livestock production has been recorded in Serbia from 2011 to 2012. Arable land used for organic farming occupies an area of over 11,000 hectares, dominated by fruit (46.36%) and crops (41.31%), with the constant growth in production of grains and oilseeds, meadows and pastures (7.57%), while the vegetables are grown on 4.77% of organic area. Most of these products are exported, especially in the EU, as the domestic market is underdeveloped due to lack of purchasing power. Legislation for organic food harmonized with EU regulations is the basis for such food production and its export, but as itself is not enough. State support in the placement of goods to foreign markets and to small producers of organic food is essential. If considered that organic food is 30-50% more expensive than conventional, and the standard of living in Serbia is very low, it can be concluded that the only secure sales that can be provided to organic food producers, are sales across national borders.

Although in recent years the production of organic food is gaining importance in Serbia, the number of people engaged in this branch of agriculture is extremely low. In this area it is necessary to possess the adequate knowledge and skills to deal with the OP, as well as the knowledge of applying fairly strict standards and controls. The problems faced by the OP in Serbia are primarily low social and political awareness of the importance of organic agriculture to life and health of the nation, as well as the economic benefits of this type of agriculture. Due to the lack of adequate, understandable and easily accessible literature, actors involved in organic agriculture are poorly informed. High cost of certification, lack of state support to organic agriculture, a declining budget for agriculture, underdeveloped markets and sales channels are the main difficulties faced by farmers entering the sector of organic production.

With less than 0.01% of the products consumed in Serbia being organic, compared with 3-4% within Europe, growth is inevitable (GAIN, 2009). Almost 90% of organic products in Serbia are aimed at the export market (e.g. EU, U.S., Japan). As the demand on the world market increases, it is expected that in the future period the production in Serbia will find more customers - both abroad and in the country - thus fostering economic strength and competitiveness of the Serbian economy. As the organic farming does not use harmful synthetic chemical substances in the form of pesticides, requires more labor force participation, i.e. this type of production can be very supportive in reducing unemployment in rural areas. In Serbia there is still a trend of migration of population from rural to urban areas, so that rural areas become economically depressed and devastated. The potential that has organic farming and its benefits can significantly improve employment and thereby reduce the gap in living standards between the big cities and rural areas, as well as keep population growth in agricultural Serbian areas (Berber et al., 2011).

The exploratory field survey showed that the main reasons for converting to organic farming are: economic profit; environmental protection; personal satisfaction and healthy production. Most of the interviewees consider that organic agriculture has generated multiple economic benefits to their rural households and communities thanks to higher prices (premium prices) and income, lower production costs and local economy revitalization. The main social impacts of organic agriculture are the level of trust and solidarity achieved within society, physical and psychical satisfaction, and social capital strengthening. Meanwhile, the main environmental impacts are reduced soil and water pollution and the conservation of biodiversity (*e.g.* local and traditional varieties).

All the interviewed organic operators were crop and animal producers. However, some of them deal also with other activities such as processing (67.5%), retail sale (17.5%) or beekeeping (7.5%). The field survey showed that a wide range of crops is grown organically in Serbia. The most common organically grown crops are: onion, pepper, carrot, potato, tomato, rye, maize, buckwheat and barley. As for livestock, the most important reared species are bovines, goats, sheep and poultry. The interviewed organic operators have about 46 beehives.

The main marketing channels used by the interviewed organic producers are on-farm sale and farmers' markets. Also, supermarkets, exhibitions and fairs are relevant marketing channels.

Most of the interviewed organic operators (82.5%) think that the decision to convert to organic was appropriate as production of healthy food is a good way to increase household income and to make agricultural production more sustainable. The main problems faced by the interviewed

organic operators are difficulties in finding organically allowed inputs in the market, high certification costs and absence of support. They mentioned also other constraints such as high prices of organically allowed inputs, marketing/sale difficulty, very rigid regulation, lack of training on organic farming.

According to the organic operators, institutions that should make more efforts to solve the problems they face are: the State, municipalities, cooperatives and the extension service. It is clear from the provided answers that a joint effort of many institutions is necessary.

Half of the interviewed organic operators declared that they received subsidies and 45% didn't receive them. The main subsidies and incentives needed by the interviewed Serbian organic operators are for certification, input procurement, equipment and more financial resources meaning easier access to funds and loans with low interest rates. However, additional requests concern support for organic farms mechanization and for storage, processing and irrigation facilities.

As for the social capital of organic operators, 70% of the interviewees are members of agricultural and/or rural associations and cooperatives. Some organic producers are also members of other participatory and civil society groups or organizations. Only 10% of the interviewees do not have any ongoing collaboration with other institutions. The remaining, 90%, deal with the following institutions: municipalities, Ministry of Agriculture; cooperatives (*e.g.* Ekoland herbs, Spice Germany), research institutes (*e.g.* Veterinary Institute of Serbia, Institute of Field and Vegetable Crops, Institute for Nature Conservation of Serbia, SP Laboratory Becej), certification bodies, extension service, etc.

The interviewees get information about organic agriculture through magazines and newspapers mostly and via Internet; a significant number of organic operators are informed through courses and conferences, trips and visits to other organic farms as well as through TV and radio. More than a half of the interviewed organic producers (60%) has contact with the agricultural extension staff and uses services provided by them. Used extension services and information are related to fruit and vegetable growing technologies, subsidy possibilities, soil fertility management and certification. According to MAIB (2008), most organic producers and processors in the Western Balkan Countries (WBC) complain about the lack of adequate advisory services which are crucial for the well-functioning of the whole organic supply chain. The creation and improvement of supporting structures and services for production and market development is crucial.

Around 70% of interviewees do not know anything about organic agriculture programs and projects, but would like to know more, while only 20% of them have been involved in previous ones. According to the National Association for Organic Production - Serbia Organica (2013), with the aim of further promoting and reaching a higher share of organic food at the greenmarkets, "Serbia Organica" launched in July 2011 - in cooperation with the Public Utility Company "City Markets" - the project "Organic Food Greenmarket", currently implemented on one of the Belgrade greenmarkets. Stalls with organic products are present at other Belgrade greenmarkets as well. In view of the success of the project and interest shown by both buyers and sellers, organic food stalls should be part of permanent offer at the city greenmarkets.

EU Member States in their own significant production still show the need for imports of organic products. Serbia can take advantage of this opportunity and provide the foreign market with important amounts of organic products. Production and economic impact of agriculture in Serbia are not at the level of the opportunities provided by rich natural resources and the country lags behind competitor countries in the region. The world market for organic food is ruled by the same economic principles as well as in other sectors. Demand is growing much faster than domestic supply, and it is this trend that can lead one economy to transform its potential of organic food production into export opportunities. With this possibility and opportunity Serbia could easily strengthen export and domestic market as well. The increase in exports is one of the most important prerequisites for increasing economic activity in every country, especially in small developing countries. The increase in exports contributes to macroeconomic stability of the country, increasing production, and therefore employment and living standard of citizens and allows service of external debt.

The interviewed organic producers provided many recommendations for improving the development process of OP in Serbia: more active involvement and support of the Ministry of Agriculture and other state institutions, higher level of state subsidies, favorable loan conditions and better support from the financial institutions, faster and easier certification, more strict State's control on traffic of pesticides in organic production and in regulating markets, implementing of appropriate strategy for development of organic farming, etc.

CONCLUSION

The economics of the current food system are unfavorable for many food chain actors including producers and consumers. Many studies highlight the potential of organic agriculture as a sustainable development opportunity for developing and transition countries. Organic agriculture development brings about multiple and multifaceted benefits to rural economies, urban consumers and the society as a whole. It contributes also to farmer livelihoods improvement, environmental protection and public health enhancement. Organic farms have economic multiplier effects that go beyond the farm boundary. They support local economies in rural communities by providing jobs for community members and purchasing local products. Short supply chains initiatives (e.g. farmers markets, food cooperatives, community-supported agriculture) allow consumers to put their money directly into farmers' pockets thus strengthening sustainable regional food systems.

Organic production is very important for Serbia as it has always been an agricultural country with rich natural resources and a long production tradition. As more consumers consider the environmental, health and social consequences of industrial food production, demand for sustainably raised foods is growing. Contemporary trends and awareness of the necessity of a healthy society and preservation of the environment fostered an organic production as an alternative to conventional agriculture. Farmers are dedicating more and more land to organic production in response to consumer demand.

Organic farming has a significant role in rural areas as it allows developing economies, diversifying activities and attracting financial resources therefore it is an integral part of rural and agricultural development strategy. Organic agriculture provides opportunities for the development of family farms and small producers in Serbia, the promotion of eco- and agro-tourism and the preservation of traditions. In this sense, the contribution of the state, in the form of proper funding and subsidies to organic producers, is invaluable and important for the whole national economy. At the same time, state's interventions should also aim at improving the access of organic producers to information and communication of organic food products properties and features to consumers.

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Research article

Comparative Assessments of Ecosystem Services between Rural and Urban Areas

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Abstract From the last century, landuse was drastically changed in both urban and rural areas. Design and planning are needed for sustainable development in not only rural area but also urban area kept being harmony with ecosystems and biodiversity. Ecosystem provides various goods and services for the human society. We carried out quantitative assessments of ecosystem services in both urban and rural areas in Japan. In a rural area, material circulations (water, carbon and wood) were estimated by a process-based ecosystem model. In an urban area, ecosystem services were estimated calculated by maps of land use classified from digital maps. From the results, both rural and urban ecosystems study areas were deeply affected by land use, provisioning service changes directly related to societal demands. Urban ecosystems might provide complementary functions for urban area residents in the condition of decreased value of provisioning service. Types of rural ecosystem services also may change for social and economic reasons. The information may be useful for environmental planning for each area but also for more large regions including urban and rural areas.

Keywords ecosystem modeling, ecosystem services, GIS, land use, urban area

INTRODUCTION

"Ecosystem Services" is a crucial keyword for sustainable development and society. After the studies of Costanza et al. (1997) and following the Millennium Ecosystem Assessment (2005), our perspective on ecosystems has changed. Ecosystems are essential to human society because they provide food, materials, and moreover services such as carbon absorption, water supply management, water quality control, disaster control, biodiversity conservation, and cultural services.

In Japan, forest and agricultural ecosystems cover over 60% and 10% of the total land area, respectively, most of which is located near urban areas that have become highly developed with the rapid Japanese economic growth. However, these ecosystems have some serious problems.

During the 1960s in Japan, a policy of converting natural forests to artificial forests was implemented (referred to as the "forest conversion policy" in this study). Today, a large portion of these artificial forests are mature. However, owing to economic reasons, these artificial forests have not been optimally managed. Imported timber and wood materials have an economical advantage when competing with Japanese forestry products. Depressed domestic forestry results in depopulation of rural areas, where forestry is the main industry, and also degrades plantation forest ecosystems.

In urban area in Japan, many cities gradually recover green space (parks, agricultural fields, and secondary forests) in contrast to the serious issues of air and water pollution experienced during rapid economic growth. The big Japanese cities of Tokyo and Osaka exceed 10% green space, and Nagoya, the chief central Japan city, exceeds 20% green space.

Over the last decade in Japan, many evaluations of ecosystem services have been conducted. Various types of ecosystems were assessed, i.e., the Sub Global Assessments (Japan Satoyama

Satoumi Assessment, 2010). Several studies have also been conducted on urban green space functions (i.e., Dobbs, 2011, Ishimatsu et al., 2012, Plieninger, 2013). However, a comparison of the ecosystem type and temporal change between urban and rural areas has been lacking in these ecosystem service studies. Urban residents need more cultural and biodiversity ecosystem services and rural residents need more economic support for nearby ecosystems.

OBJECTIVES

In this study, ecosystem services assessments were conducted in both rural and urban areas. The case study areas were an upstream region of rural Toyota city and urban Nagoya city. Geographical Information Systems (GIS) data sets were compiled from various sources. Rural ecosystem services were estimated from a biogeochemical forest model. On the other hand, urban ecosystem services were estimated from land use maps and also served as preliminary results for future analysis. A comparison of these estimation results suggested that sustainable ecosystem services can be maintained in both urban and rural regions.

METHODOLOGY

Study Areas

The forest areas in Toyota city and Nagoya city were selected as the rural and urban study areas, respectively (Fig. 1). The annual averaged temperature and precipitation for these areas are 15.8°C and 1535.3 mm and 11.5°C and 1964.0 mm, respectively.

The rural study area of Toyota city (ca 18,000 ha), located upstream of the Yahagi River, includes the two communities of Asahi and Inabu. The annual averaged temperature and precipitation were 11.5°C and 1964.0 mm, respectively. The artificial and other forest (secondary or natural) covers were about 11,000 and 3,600 ha, respectively. The 2013 population was about 5,600.

With a population of about 2,260,000, nearby Nagoya (ca. 32,600 ha) represents urban Japan, and is the fourth largest city in Japan. The averaged temperature and precipitation were 15.8°C and 1535.3 mm, respectively.

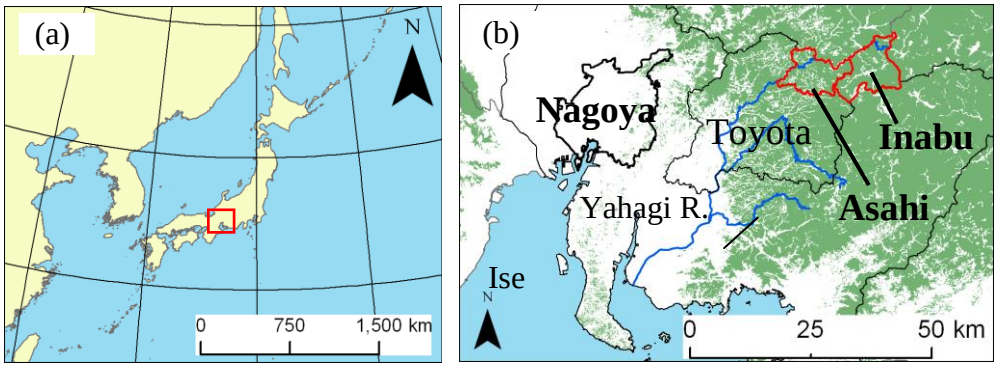

Fig. 1 Location of Japan and studied areas (a) and the studied rural and urban areas (Nagoya and two areas in Toyota) (b) (*Note: Green areas represent forest area*)

Rural Assessment

Ecosystem services related to material cycles (water, carbon, and nitrogen) were quantitatively estimated using detailed forest maps and an ecosystem model. Forest inventories, yield tables, and forest maps of Aichi prefecture were compiled. Using the methods outlined in our previous study (Ooba et al., 2010), we developed a forest GIS database that included detailed forest type and

location attributes at the semi-compartment level. The total forest area has changed slightly since the forest conversion policy began (ca. 1960), but forest polygons were not changed in this study.

The BGC-ES model (version 1.1; Ooba et al., 2010, 2011) was used to simulate daily water cycles and annual carbon and nitrogen cycles. In this model, biomass growth is limited under insufficient light and low nitrogen availability conditions.

The forest ecosystem simulation unit was assumed to consist of homogeneous tree species and understory vegetation was ignored. Mixed forest stands (e.g., stands of broadleaf and needleleaf or mixed-age stands) were classified into homogeneous forest units based on crown area.

Mass cycle simulation for 1980-2060 was conducted based on current forest distribution. Before the simulation, a spin-up procedure achieved the initial condition for the model. The following proxies of forest ecosystem services were the main model outputs: timber accumulation, water runoff, carbon sequestration, and nitrogen leaching from the forest.

More detailed information about this simulation is available in our previous publications (Ooba et al., 2010, 2011, 2013).

Urban Assessment

Urban ecosystems were very disturbed by human activities. Consequently, ecosystem hysteresis effects (history) may be minor. We chose a simple and understandable urban assessment method using land use maps instead of a detailed, complicated ecosystem model. We assumed that the urban land use type (agricultural field and secondary forest) determined the type and extent of ecosystem services.

Digital land use maps from 1977 and 1997 at 10 m mesh level were obtained (Japan Map Center). Maps showed fifteen land use types that we aggregated into five types: urban area, agricultural field, forest, road, water surface. A paper land use map from 1955 was obtained from the Geospatial Information Authority of Japan, converted into digital format, and classified into five land use types using the maximum likelihood method (ArcGIS 10.1, ESRI). We manually corrected minor errors in the digitized land use map caused by the classification method.

Table 1 Ratios of land use types in Nagoya city at 3 different years (%)

Year	1955	1977	1997
Water surface	5	6	5
Residential and industrial area	36	53	57
Road	2	17	19
Agricultural field	38	10	6
Forest	17	13	10
Green area	55	23	16

Green area = Agricultural field + Forest

RESULTS AND DISCUSSION

Rural Ecosystem Services

Time series of timber accumulation, water runoff, carbon sequestration, and nitrogen leaching from the all forests in the studied area are shown in Fig. 2.

The accumulated trunk (timber) volume of the study area forests was averaged over 10 years to represent a saturated level. However, the 10 year average carbon sequestration rate was the maximum at the 1990s, and then continuously decreased. This was caused by the extensive conversion from natural to artificial forests. Young artificial forests are strong carbon sinks (Ooba et al., 2010). Post-1970s, low forestry disturbance (thinning and regeneration rates) provided effective carbon accumulation. The models predict that the carbon sequestration rate will not rise again after 2050, due to forest aging and lack of plantation forest regeneration. Model-predicted spatial distributions of carbon sequestration for three decades are shown in Fig. 3.

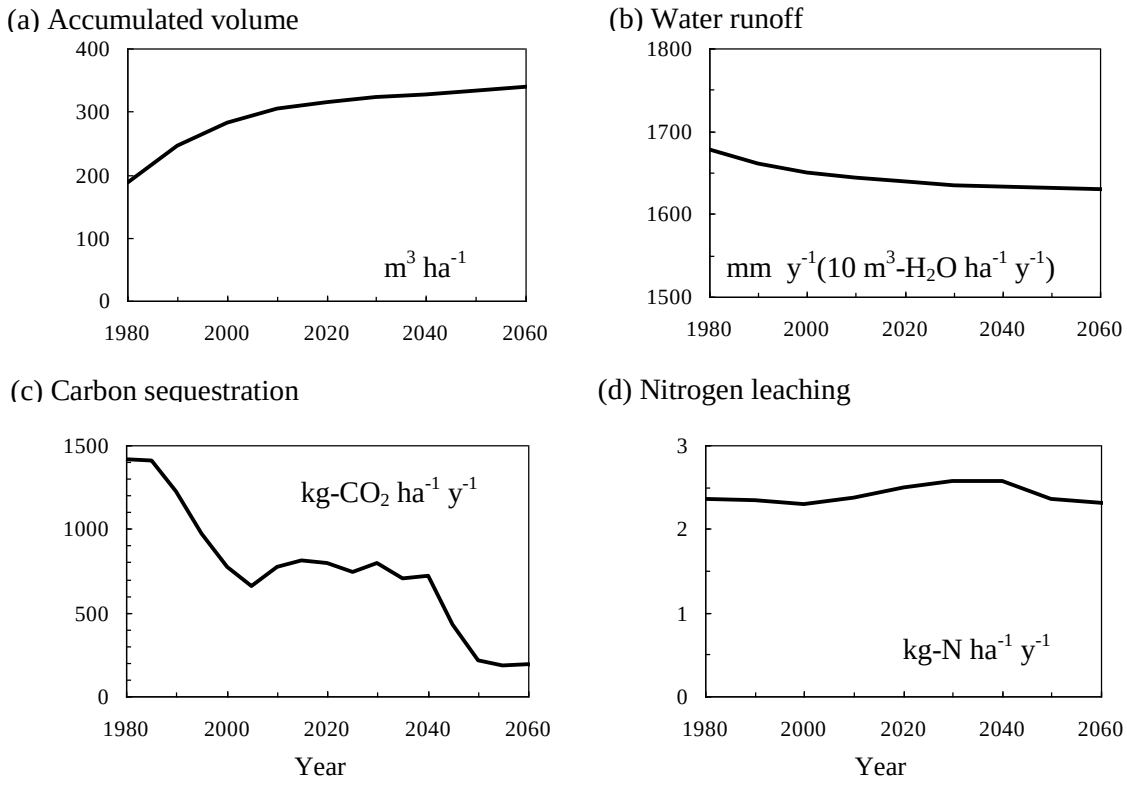

Fig. 2 Time series estimated by the BGC-ES model from 1980 to 2060 in the all forests of studies areas (Inabu and Asahi areas)
The results were averaged for 10-years at a unit area

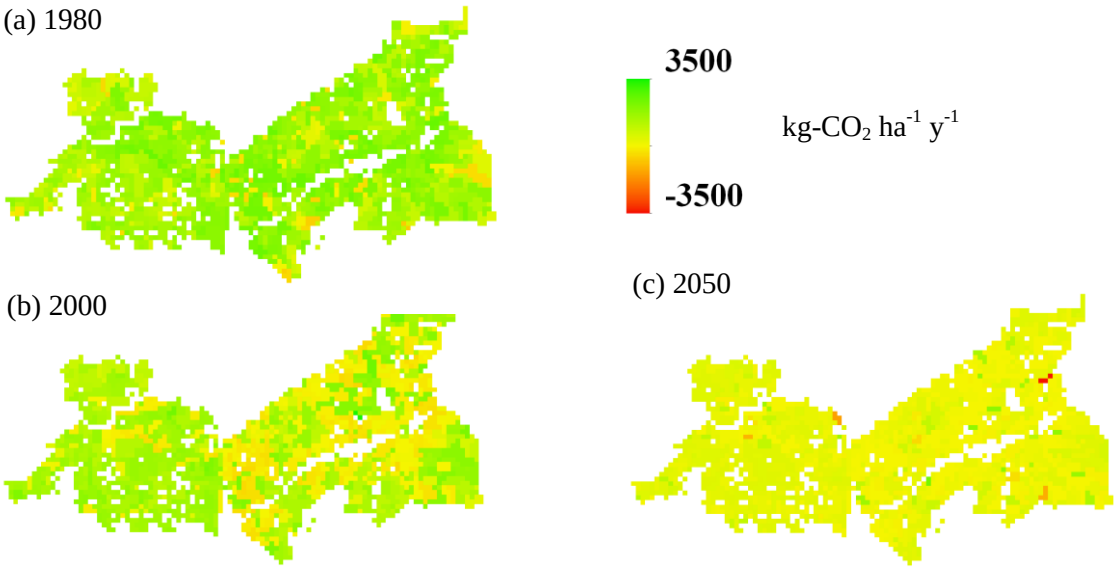

Fig. 3 Carbon sequestration rate in forests of studies areas (Inabu and Asahi areas)
(a) 1980 (b) 2000 (c) 2050 at 250 m mesh

No remarkable variation in water runoff or nitrogen leaching from the forest was observed among the model scenarios (Fig. 2b and 2d), similar to our previously published results (Ooba et al., 2010, 2011, 2013).

Urban Ecosystem Services

A comparison of the urban land use in 1955 and 1977 showed that green space decreased drastically (Figs. 4a and 4b), including agricultural fields and forests in Nagoya city. In contrast, the urban green space slightly decreased between 1977 and 1997 (Figs. 4b and 4c, Table 1).

28% of agricultural fields were converted into urban area in northern and western parts of Nagoya city. The largest land use change from 1955 to 1977 affected provisioning services (agricultural products). However, valuation of agricultural ecosystem services in urban area obviously declined during rapid economic growth, resulting in economic benefit from residential, or industrial, land use.

Urban forest area also decreased from 1955 to 1977 (4%), reducing ecosystem services related to carbon sequestration. Urban forests had been an important fuel source before the end of World War II. After the war, firewood and charcoal use gradually declined in favor of fossil fuel use. Urban forests were also converted to urban land use for economic reasons. It is notable that area of forest decreased (3%) from 1955 to 1977, in contrast to the change in agricultural field.

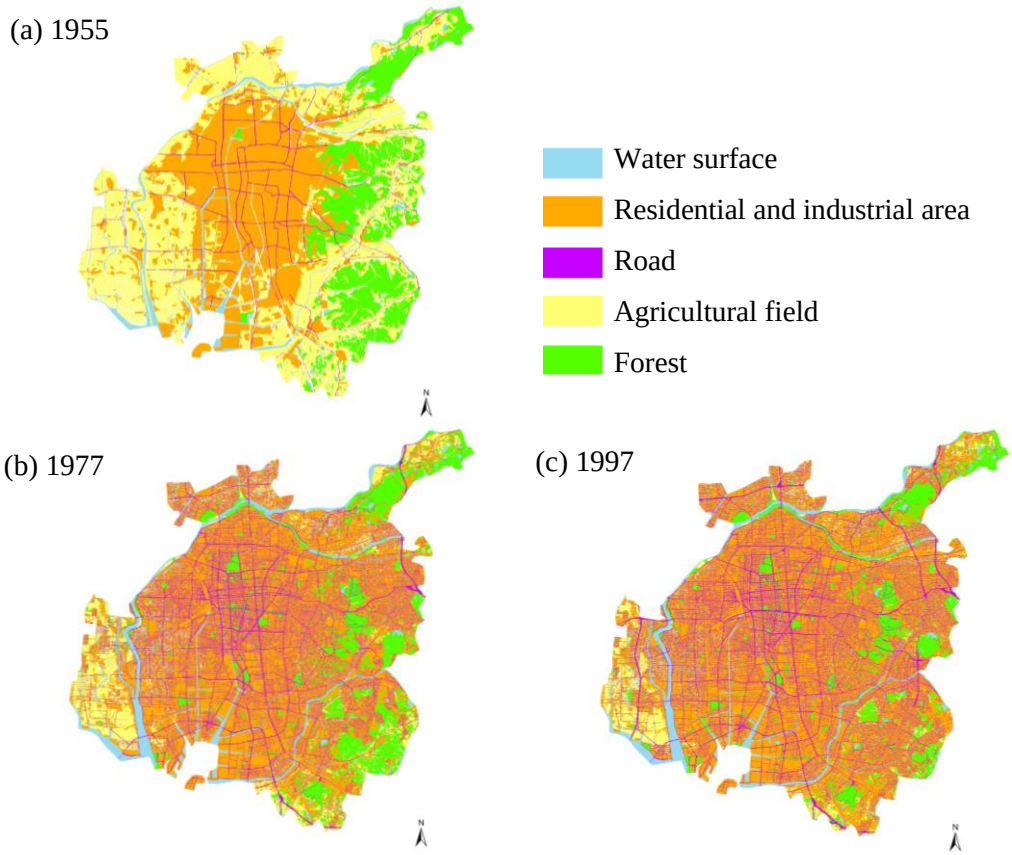

Fig. 4 Land use types in Nagoya city at 3 different years
(a) 1955 (b) 1977 (c) 1997

Ecosystem Services Comparison between Rural and Urban Study Areas

Ecosystem characteristics essentially differ between the rural and urban study areas. Rural ecosystems have broad spatial and temporal extents, contribute such regional mass cycles as hydrological and climatological circulations, and provide such goods as water, wood, and agricultural products. Urban ecosystems are relatively small and fragmentized.

Initially, both rural and urban ecosystems study areas were deeply affected by land use provisioning service changes directly related to societal demands on estimating ecosystem services. The shift from wood to fossil fuels as an energy source resulted in large carbon emissions in the

urban study area, but more carbon storage in the rural study area. From this, we deduce the necessary ecosystems services for residents of both the rural and urban areas have changed since 1955. Urban ecosystems might provide complementary functions for urban area residents, including aesthetic, cultural, and biological values. Types of rural ecosystem services also change, for social and economic reasons.

This study indicates both rural and urban areas undergo spatial distribution and temporal changes in ecosystem services. A future study incorporating the systematic and integrated evaluation of ecosystem services would improve upon this study's shortcomings.

CONCLUSION

Rural forest ecosystems provide many ecosystem services; demand is less to provisioning services such as wood biomass and carbon sequestration. In urban areas, needed ecosystem services shifted from provisioning to other services. Our results are useful for rural and urban area environmental planning, particularly on a regional scale.

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Research article

Engineering Properties of Adobe Brick for Earth Structures

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Abstract The aim of this research is to investigate basic engineering properties of soil mixture materials and adobe bricks for earth structures. The soil mixture materials consist of soil, sand and rice husks. Samples of soil mixture materials and adobe bricks were collected from three villages (i.e. sources) in northeastern Thailand with adobe brick earth structures. The raw materials obtained from the three sources are: (1) soil, sand and rice husks from Baan Sikha Thai village of Nakhon Ratchasima province, (2) soil and rice husks from Baan Sai Rung village of Chaiyaphum province, and (3) soil and rice husks from Baan Thep Pana village of the province of Chaiyaphum. The physical properties of soil mixture materials and the mechanical characteristics in terms of adobe bricks and wall bearing strength (prism strength) were carried out. According to ASTM D-2487 of the Unified Soil Classification System, the soils from the three sources are of sand-poorly graded (SP) type. PI of soils and the horizontal compressive strength (σ_c) of adobe bricks from the first, second and third sources were 7.93, 6.02 and 2.88%; and 21.76, 15.76 and 13.48 kg/cm^2 (ksc), respectively. The findings indicate a positive relationship between plasticity index (PI) from Atterberg's limits test and horizontal σ_c. A comparison was made between the horizontal σ_c of adobe bricks of three sources and those specified in the Uniform Building Code (UBC) Standard 21-1. The horizontal σ_c of the first, second and third sources relative to the UBC standard (17.6 ksc) were 21.76, 15.76 and 13.48 ksc, equivalent to 123.65%, 89.57% and 76.57% of the standard, respectively. The horizontal flexural strengths (f_b) of adobe bricks from the three sources were 5.86, 3.24 and 4.27 ksc. Thus, no indefinite relationship exists between f_b and PI as well as horizontal σ_c. In addition, a comparison between the horizontal σ_c of adobe bricks from three sources and the wall bearing strength (prism strength) of walls made from the identical three sources was performed. The wall bearing strength values of the first, second and third sources were 9.44, 6.39 and 3.63 ksc, respectively. The results show a positive relationship of prism strength to PI and to horizontal σ_c. The performance of adobe bricks in terms of greater strength and lower shrinkage could be enhanced by inclusion of appropriate quantities of sand and rice husks in the mixture.

Keywords earth structure, adobe brick, engineering properties

INTRODUCTION

A form of architectural work, earth structures harmoniously coexist with the environment and are perfectly suitable for the tropics. In addition, most earth structures have been designed and constructed in line with the livelihoods of local inhabitants. Raw materials of adobe bricks which are subsequently used to construct earth structures are mostly natural materials, e.g. clay, sand and plant fibers, and can be acquired locally and inexpensively. Besides, several reused items, e.g. glass bottles, wooden windows and frames, are used in the construction of earth structures. Thus, earth structures are a viable alternative to meet the housing demand of low-income earners and in line with the concept of self-sufficiency economy, which in turn promotes the community sustainability.

The current practices of adobe brick-making are nevertheless varied by which local residents make adobe bricks relying on their past experience and rough estimation. This leads to substandard

adobe bricks in terms of horizontal compressive strength, horizontal flexural strength and wall bearing strength.

Although previous research studies on improvement of adobe brick-making exist, the local villagers prefer the traditional local brick-making methods to the improved ones. Therefore, this research paper attempts to examine the engineering properties of raw materials and adobe bricks. The findings could be adopted as a guideline in building of earth structures to guarantee the stability and safety of the final constructions.

METHODOLOGY

Determination of variables: Types of raw materials and mixing ratios are factors that affect the strength of adobe bricks. To obtain the results that adequately represent actual outcomes, the raw materials and their respective quantity in this research work are: 10 kg each of soil and sand from three sources (30 kg of soil and 30 kg of sand in total); and 35 finished adobe bricks each from three sources (105 ready-to-use bricks in total). The dimensions of adobe brick are 20x40x10cm (WxLxH). Figure 1 illustrates a photograph image of an adobe brick and a drawing of its dimensions.

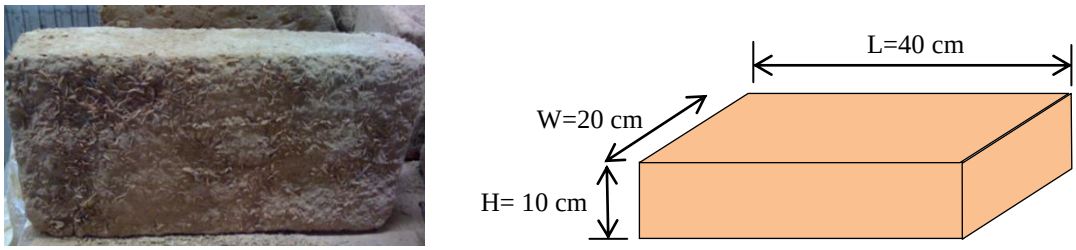

Fig. 1 Image of an adobe brick and a drawing of its dimensions

Selection criteria of sources for collection of raw materials and bricks: The selection criteria of locations for collection of raw materials and adobe bricks are that: (1) there are a number of adobe brick earth structures in the area; and (2) local residents are economically self-reliant. The areas from which the sample collection were carried out are: (a) Baan Shikha Thai village, Nhong Bua Sala sub-district, Muaeng Nakhon Ratchasima district of Nakhon Ratchasima province; (b) Baan Sai Rung village, Tha Mafai sub-district, Khang Kroa district of Chaiyaphum province; and (c) Baan Thep Pana village, Baan Rai sub-district, Theb Satit district of Chaiyaphum province.

Test methods: Tests were carried out on the raw materials and on adobe bricks. The raw materials, i.e. soil, sand and rice husks, were examined according to ASTM standards of the Unified Soil Classification System. The soil grain size was classified by sieving according to the ASTM D422 standard. Atterburg's limits of soils were performed according to ASTM D4318, while Atterburg's limits of soils mixed with sand were conducted according to ASTM D4318. The soils mixed with sand were obtained by crushing adobe bricks from the three sources. Soil specific gravity values were determined according to ASTM D854. In addition, the ASTM C128 standard was used to determine sand specific gravity and absorption values, while the sand grain size was classified by sieving as per ASTM C136. The separation of sand and rice husks from adobe bricks was carried out using the wet sieve method.

Table 1 Physical requirement of adobe brick

Minimum compressive strength (ksc)		Water absorption (%)	Mowasture content (%)	Minimum modulus of rupture (ksc)	
21.13 (Average)	17.60 (Minimum)	2.5	4.0	3.52 (Average)	2.46 (Minimum)

Source: Table 24-B: Uniform Building Code, 1994

The strength of finished adobe bricks was tested according to the American Standard for Testing Material (ASTM) and referenced to the UBC Standard 21-9 (Table 1). The horizontal σ_c and horizontal flexural strengths (f_b) of adobe bricks were determined according to ASTM C67-13a. The wall bearing wall strength was tested according to the Standard Test Methods for Compressive Strength of Masonry Prisms (ASTM E447 – 74).

RESULTS AND DISCUSSION

Engineering Properties of Soils

Based on the ASTM D2487 standard of the Unified Soil Classification System, soils from the three sources are of coarse grain, poorly-graded soil and sand. Their coefficients of uniformity (C_U) and of concavity (C_C) are presented in Table 2.

Table 3 summarizes Atterberg's limits of soil and soil mixed with sand according to the ASTM D4318 standard.

The specific gravity of soils from the three sources belongs to the SP group. In addition, the composition of soils from the province of Chaiyaphum (i.e. 2nd and 3rd sources) is 50% sand, a condition that enables adobe brick-making without additional sand required. However, soils from Nakhon Ratchasima province (i.e. first source) contain much less sand, thereby necessitating an addition of sand to the mixture for brick-making. Thus, the specific gravity of sand of the first source (i.e. Nakhon Ratchasima province) was determined.

The findings also show that types and ratios of raw materials contained in adobe bricks influence the brick strength. For example, if the bricks were made of purely or mostly soil, they would easily disintegrate under the horizontal compressive strength and flexural strength. To improve the brick performance, sand and rice husks should be added to the mixture because the additional raw materials (i.e. sand and rice husks) increase the cohesiveness and strength resistance. Table 4 presents the specific gravity values and material proportions by weight of the raw materials.

Table 2 Characteristics of soil and sand of three sources under study

Source	Avg. passing No.4# (%)	Avg. passing No.200# (%)	Avg. C_u	Avg. C_c	Group symbol
Baan Sikha Thai	93.784	2.06<5	2.852	0.772	S
Baan Sai Rung	90.715	5<6.396<12	6.621	0.641	S
Baan Thep Pana	99.327	5<7.435<12	3.333	1.071	S

Table 3 Atterberg's limits of soil and soil mixed sand as per ASTM D4318

Properties	Baan Sikha Thai	Baan Sikha Thai (Soil+Sand)	Baan Sai Rung	Baan Thep Pana
Liquid Limit, LL (%)	21.17	30.84	28.47	20.68
Plastic Limit, PL (%)	18.84	22.91	22.45	17.80
Plasticity Index, PI (%)	2.32	7.93	6.02	2.88
Shrinkage Limit, SL (%)	9.93	9.37	9.39	7.77
Unified Soil Classification, U.S.C.	SP	SP	SP	SP

Table 4 Specific gravity and material proportions by weight of the raw materials

Source	Specific gravity		Material proportion by weight (%)		
	Soil	Sand	Soil	Sand	Rice husk
Baan Sikha Thai	2.681	2.53	74.754	18.800	6.346
Baan Sai Rung	2.513	-	90.405	-	9.595
Baan Thep Pana	2.542	-	88.947	-	11.053

Engineering Properties of Adobe Bricks

With respect to the effects of rice husks and sand proportions on the horizontal σ_c, the horizontal compressive strength values of adobe bricks for different proportions of sand and rice husks are illustrated in Table 5 and Fig. 2.

Based on Fig. 2, the relationship between the proportion of rice husks and the adobe brick horizontal σ_c; and that between the proportion sand retained with No.4 sieve and the horizontal σ_c of adobe bricks can be expressed by equations (1) and (2), respectively.

$$\text{Horizontal compressive strength}_{\text{rice husks}} = -1.7737(\%\text{ of rice husks}) + 32.96 \quad (1)$$

$$\text{Horizontal compressive strength}_{\text{sand}} = 0.2154(\%\text{ of sand}) + 7.3919 \quad (2)$$

The relationship of PI and the horizontal σ_c is depicted in Figure 3. The figure indicates a positive correlation between PI and the horizontal σ_c.

Table 5 Effects of rice husks and sand proportions on the horizontal compressive strength

Propertion of mixeture materials by weight (%)	Baan Sikhathai	Baan Sairung	Baan Theppana
Percent of sand retained sieve No.4#	56.09	51.44	26.30
Percent of Rice husk	6.35	9.60	11.05
Horizontal σ_c (ksc)	21.76	15.76	13.48

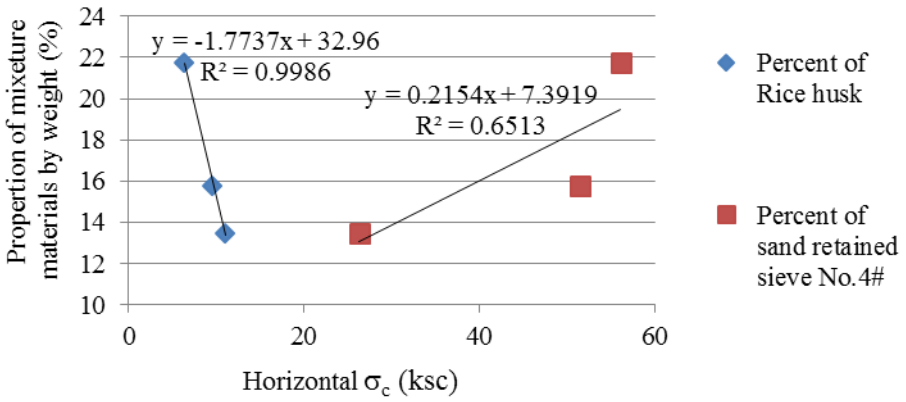

Fig. 2 Horizontal compressive strength of bricks for different sand and rice husk proportions

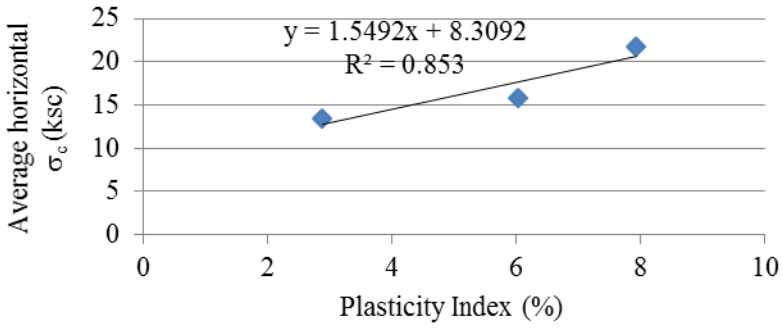

Fig. 3 Plasticity Index (PI) and horizontal σ_c of samples from the three sources

The relationships of PI of soils to the horizontal σ_c of adobe bricks from the three sources can be determined by equations 3, respectively.

$$\text{Horizontal } \sigma_c = 1.5492PI + 8.3092 \quad (3)$$

where PI denotes plasticity index.

The horizontal σ_c, f_b and minimum strength according to the UBC 21-9 standard of adobe bricks are depicted in Figure 4. The horizontal σ_c of adobe bricks from the first, second and third sources and the minimum standard strength are 21.76, 15.76, 13.48 and 17.6ksc, respectively. This validates the positive relationship between the horizontal σ_c and PI.

Although adobe bricks from the three sources outperform the minimum standard strength with regard to f_b, the bricks performed less satisfactorily relative to the horizontal σ_c. f_b of the first, second and third sources and the minimum standard strength are 7.40, 3.36, 4.27 and 2.46ksc, respectively. The low f_b are normal since no additives, e.g. cement or rubber milk, were included in the mixture.

The relationship between the horizontal σ_c and the wall bearing strength (prism strength) is illustrated in Figure 5. The figure shows a strong correlation between the prism strength and the horizontal σ_c, which is similar to that of PI and the horizontal σ_c. The prism strength of adobe bricks of the first source is highest. The relationship between the horizontal the horizontal σ_c and the prism strength can be written as:

$$\text{Prirm strength} = 1.4346\sigma_c + 7.6943 \quad (4)$$

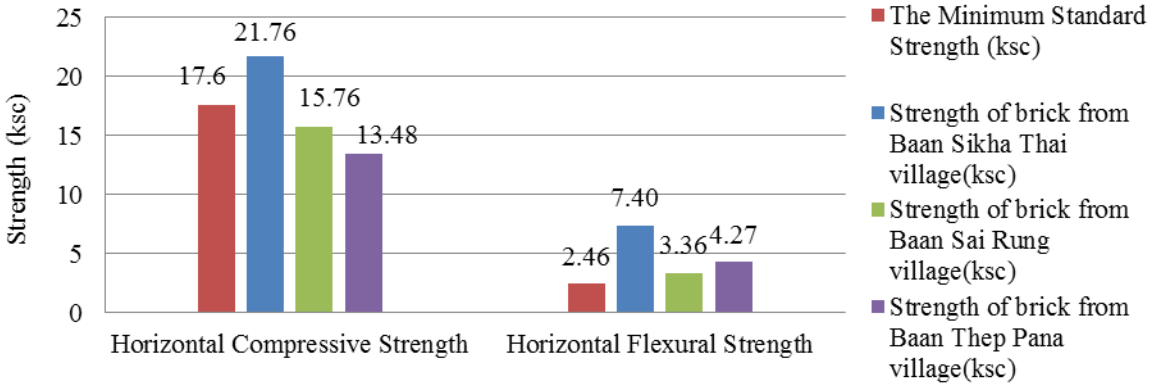

Fig. 4 Horizontal compressive and flexural strengths of adobe bricks from three sources and the minimum standard strengths

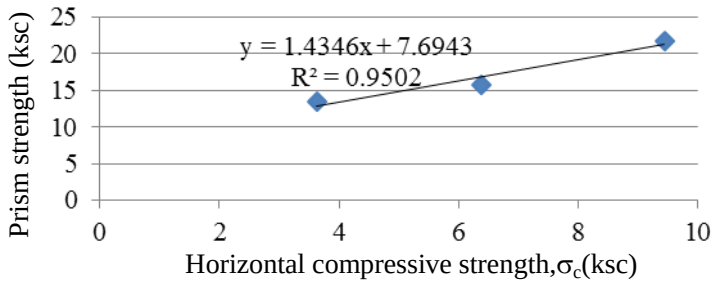

Fig. 5 Relationship between horizontal compressive strength and Prism strength of adobe bricks from three sources

CONCLUSION

The experimental results show that prism strength is subject to PI of soil and the horizontal σ_c of adobe bricks. The proportion of sand in the brick mixture affects the horizontal σ_c, while an addition of rice husks into the mixture reduces the brick shrinkage.

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Research article

Gas Chromatography with Vacuum-Assisted Sampling System in the Analysis of Hydrogen-Balanced Nitrogen Gas

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Abstract A vacuum-assisted (VA) sampling system in gas chromatography (GC) with a thermal conductivity detector has been developed to analyze low-pressure hydrogen-balanced nitrogen gas (H_2/N_2) sample. The objective is to determine hydrogen-balanced nitrogen gas by GC assembled with the vacuum-assisted (VA) gas sampling system comparison to the conventional system, pressure reduced to zero (PRZ) gas sampling system. The results show that both systems were not significantly different at the 95% confidence level. The developed sampling system was applied to analyses the quality of the low-pressure-volume gas.

Keywords vacuum-assisted sampling system, pressure reduced to zero sampling system, gas chromatography

INTRODUCTION

Nitrogen is a colorless, odorless and tasteless substance. It present in the atmosphere at a concentration of 78.1%. It is used widely in commercial and technical applications. As liquid nitrogen, it is used for cooling in many industrial processes and in the food industry. As gaseous nitrogen, it is used to form an inert blanket over substances that would otherwise be oxidized by the air. It can be distributed as a cryogenic liquid or as a gas in cylinders (Greenwood, and Earnshaw, 1997, Kaganer et al.1967).

Gas chromatographic methods have been utilized for determination of many compounds present in air and gaseous mixtures (Slemer et al. 2004, Taverniers et al. 2004). In the conventional method, the GC with the pressure reduced to zero (PRZ) gas sampling system (or pressure flow sampling system) is used. This system allows the compressed gas in cylinders or containers flow into the analysis system of GC as shown in Fig. 1. Unfortunately, this method is available for the gas sample with appropriate volume and pressure. In this work, the vacuum-assisted (VA) gas sampling system in GC, as shown in Fig. 2, was developed for the analysis of low-pressure gas. Therefore, the gaseous sample was easily collected by using a gas bag and conveniently transported to the laboratory.

The present work describes a developed VA sampling system of GC for determination of low pressure - volume hydrogen-balanced nitrogen (H_2/N_2) gas. The result obtained through the use of this newly developed sampling system was statistically compared to the conventional sampling system of GC.

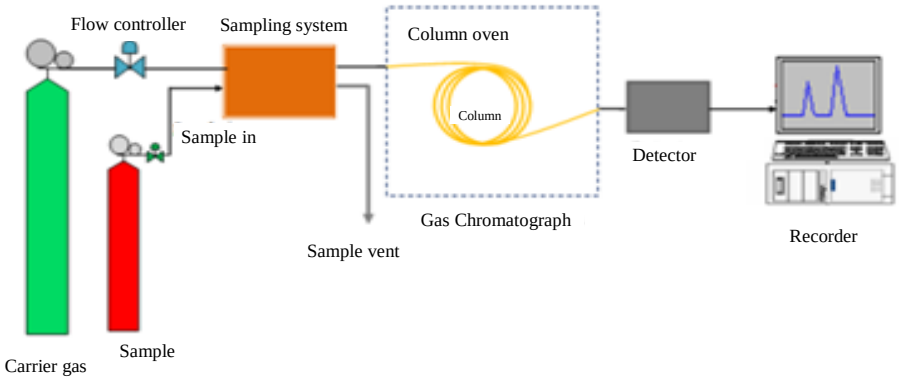

Fig. 1 Schematic diagram of the GC equipped with pressure reduced to zero gas sampling system

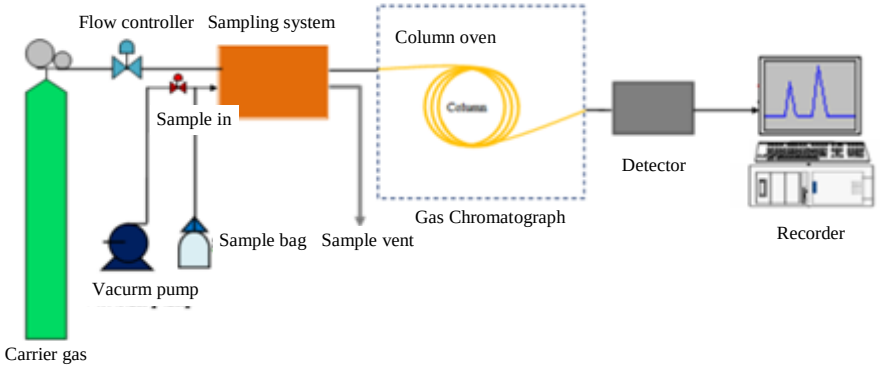

Fig. 2 Schematic diagram of the GC equipped with vacuum-assisted sampling system

OBJECTIVES

Followings are the objectives of this study.

1. To developed the vacuum-assisted sampling system in gas chromatography
2. To analyze the hydrogen-balanced nitrogen gas sample by gas chromatography equipped with the developed sampling system

METHODOLOGY

The gas chromatograph (GC) with a thermal conductivity detector (TCD) (Agilent, CA, USA) was used for quantitative analyses of the H_2/N_2 gas. Ultra high purity argon (Ar) gas cylinder with a purity of 99.99% as the carrier gas was connected to the GC. Separation was carried out in an HP-PLOT Molesieve (5Å zeolite molecular sieve, porous layer open tubular) column (30 m × 0.25 mm i.d., and film thickness 0.25 μm). The oven temperature was isothermal at 30 °C. The detector temperature was maintained at 250 °C.

The standard gas was 49.66% mol H_2/N_2 gas certificate reference material (CRM).

The working standard H_2/N_2 gases with different concentrations were individually prepared. Then the calibration gas mixture was introduced and a chromatogram was recorded. The values of peak area (y) were plotted against the concentration (x) of H_2/N_2 to obtain a calibration curve.

Regression analysis for a calibration line, y = ax + b, was carried out by Deming's least square method (International Organization for Standardization, ISO6143:2001, 2001).

Analysis of H_2/N_2 was conducted with a GC- TCD. A vacuum-assisted gas sampling system and a pressure drop to zero gas sampling system were tested. The results obtained from the analysis of both sampling systems were compared.

RESULTS AND DISCUSSION

The response linearity of the gas analysis by GC equipped with the developed sampling system and the conventional sampling system were determined by analyzing different concentrations of the mixed standard gas containing 10-50% mol of N_2. The response factor of the standard solutions was calculated.

For the GC equipped with VA sampling system, the peak area of N_2 gas response was plotted against the concentration of standard gas to obtain the calibration curve (Fig. 3(a)) and was found to be linear over the concentration range of 1-50% mol and the values of correlation coefficient (r^2) 0.9984. Linear regression least squares fit data are given in Table 2. Mean recovery was estimated to be 98.45%. The limit of detection (LOD), evaluated as three times the signal-to-noise ratio, was estimated to be 3.4 μmol/mol. The limit of quantification (LOQ) of the method, as the concentration that produced a signal 10 times the baseline noise, was calculated as 4.2 μmol/mol. The results of precision as relative standard deviation (RSD) of the proposed sampling system are summarized in Table 2.

For the GC equipped with PRZ sampling system, the obtained calibration curve (Fig. 3(b) was found to be linear over the concentration range studied with the values of correlation coefficient (r^2) 0.9997. Linear regression least squares fit data are given in Table 1. The LOD was estimated to be 3.2 μmol/mol. The LOQ of the method was calculated as 5.3 μmol/mol. The results of relative standard deviation (RSD) of the PRZ sampling system are summarized in Table 2. The results indicating that there was no significant difference at 95% confidence level between the developed sampling system and conventional sampling system.

The optimum experimental conditions were used to assess applicability of GC equipped with developed and conventional sampling systems for quantitative determination of H_2/N_2 gas sample analysis. The average analytical concentrations and %recovery of the nitrogen gas samples were determined by GC. The results, as shown in Table 3, showed that the values of average analytical concentration of N_2 gas samples (n=3) for GC(VA) and GC(PRZ) were 9.62%mol and 9.70%mol, respectively. The percentage recovery of gas analysis determined by GC(VA) and GC(PRZ) give values in the acceptable range, 100±2% (AOAC Peer-Verified Methods. Nov. 1993). The analysis of the test system and vacuum sampling system is created that can use analyzing. The analysis is correct and is in an acceptable range.

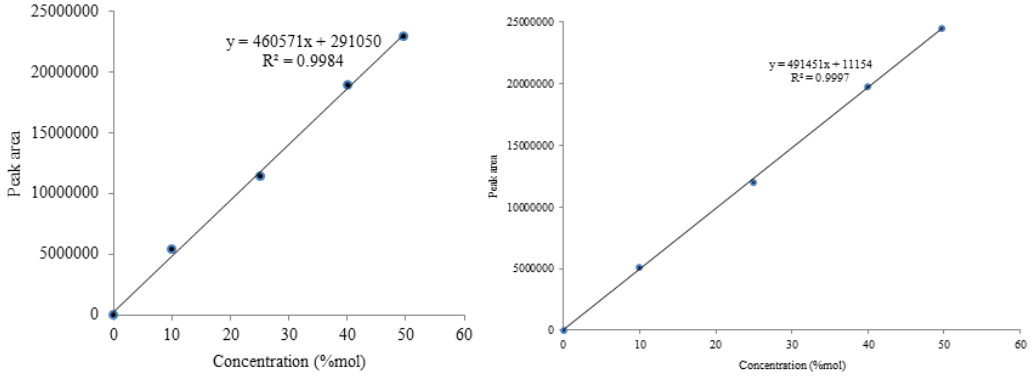

Fig. 3 Calibration curves for the standard gases with different concentrations analyzed by GC equipped with (a) vacuum-assisted (VA) and (b) pressure reduced to zero (PRZ) sampling systems

Table 1 Equations, correlation coefficients, and recovery percentage of the N_2 in the mixtures standard

Sampling system of GC	Calibration curve equation	Correlation coefficient (r^2)	Mean recovery (%)	LOD (μmol/mol)	LOQ (μmol/mol)
VA	y = 460,571x + 291,050	0.9984	98.45	3.4	4.2
PRZ	y = 491,451x + 11,154	0.9997	97.27	3.2	5.3

Table 2 Standard deviation, t-value, and percentage standard deviation of the N_2 in the mixtures standard

	VA	PDZ
SD	0.0058	0.0200
t_{cal}	-0.1632	-0.2845
t_{crit}	4.3	4.3
%RSD	0.0595	0.1050
$\%RSD_r$	1.1880	1.1880

Table 3 Analytical concentrations and %recovery of the H_2/N_2 gas sample analyzed by GC(VA) and GC(PRZ)

Sampling system of GC	Analytical concentration (%mol)	% Recovery
GC (VA)	9.62	99.95
GC (PRZ)	9.70	99.15

Note: VA = vacuum-assisted sampling system and PRZ = pressure reduced to zero sampling system.

CONCLUSION

In this study, the vacuum-assisted sampling system for GC was developed. It was considered as an efficient sampling system for the determination of H_2/N_2 gas. The GC equipped with vacuum-assisted sampling system compared to the GC equipped with pressure reduced to zero sampling system were not significantly difference with a statistical type F-test and t-test at confidence level of 95%.

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Research article

Evaluation of Nitrate Pollution in River Water at Agricultural Watershed

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Abstract Nitrate pollution of river water and groundwater in agricultural areas is a serious problem in many countries, and many people are unconcerned with, or ignorant of, the problem. In recent years, environmental education on the relationship between agriculture and water has been provided to the general public in many areas in Japan. In this report, the nitrate nitrogen (NO_3-N) concentration in river water at the normal water level was evaluated in two agricultural areas in Eastern Hokkaido. The concentration results obtained using an official analytical method were compared with those obtained using simplified methods. By focusing on the differences in the results of the measurement methods, the applicability of simplified methods for NO_3-N concentration to water environmental education was examined. The investigation was carried out in two agricultural areas in Eastern Hokkaido in late August 2006. NO_3-N concentration was measured using an official method and two simplified methods. The comparison between the two results showed the NO_3-N concentration values measured by using the simplified methods to be 64% to 72% of those measured by using the official analytical method. The values obtained from the simplified methods were slight underestimates. However, there was a significant positive correlation between the two sets of values. Even though some consideration is necessary regarding the accuracy of the simplified methods, it can be said that the use of such methods in water environmental education is sufficiently effective. It is also expected that by actively introducing experience-based environmental education in which river water quality is measured by learners using simplified methods, it will be possible to make environmental education truly useful in the conservation of desirable watersheds in which sustainable agricultural and forestry are developed and desirable water quality is maintained.

Keywords NO_3-N concentration, simplified method, official analytical method, environmental education

INTRODUCTION

It is well known that nitrate pollution of river water and groundwater in agricultural areas has grown to become a serious problem in many countries of the world. Another fact is that there are

many people who are unconcerned with, or ignorant of, the problems on nitrate pollution of river water. In considering the problem of agriculture and water in terms of environmental education and learning experiences for basic knowledge, it is necessary to evaluate nitrate nitrogen (NO_3-N) concentration in river water in a watershed with agriculture and forestry.

In Japan, there are two major water quality standards that use nitrogen as indices. "The Environmental Standards Concerning the Protection of the Human Health" specifies 10 mg/L as the highest acceptable combined concentration of NO_3-N and nitrite nitrogen (NO_2-N). "The Environmental Standards Concerning the Conservation of the Living Environment" specifies 1 mg/L as the highest acceptable concentration of total nitrogen (T-N).

The authors have been investigating the concentration of NO_3-N in river water at the normal water level for many years in two agricultural areas with different land-use characteristics in Eastern Hokkaido, which possesses valuable regional characteristics as a part of the region that is influenced by Asian monsoons (Yamazaki et al, 2013; Muneoka et al, 2013; Yamazaki et al, 2014). It is anticipated that investigations that lead to the development of measures for controlling the amount of nitrate flowing into river water in watersheds in agricultural and forestry areas will progress by using the basic data accumulated in such activities.

In recent years, university faculties have been providing environmental education to the general public as outreach activities for local communities. One theme is the problem of agriculture and water (Muneoka et al, 2007; Muneoka et al, 2012).

When researchers and engineers measure the NO_3-N concentration in river water for their investigations and studies, they generally follow official analytical methods, such as the Japan Industrial Standards (JIS). Such measurements involve burdens such as time and expense for obtaining and maintaining facilities and equipment for measurement. Training to foster technical skills that guarantee the accuracy of measured values is also indispensable.

Currently, a simplified method which makes use of inexpensive and easy-to-use water test kits is widely available in Japan. These make it possible for lay citizens to perform environmental surveys and for educators to use them in environmental education for children, who will be the main players in the environmental conservation activities of the future and in lifelong learning programs for adults. Few studies have tested the accuracy and reliability of these simplified methods.

This report discusses the evaluation of nitrate pollution in river water in two areas with different agricultural land uses in Eastern Hokkaido, based on the perspective of environmental education. The NO_3-N concentration in river water at the normal water level analyzed using the official analytical method and that measured using the simplified methods were compared. Examination was done on the applicability of simplified methods in water environmental education, focusing on the difference between the two types of measurement methods.

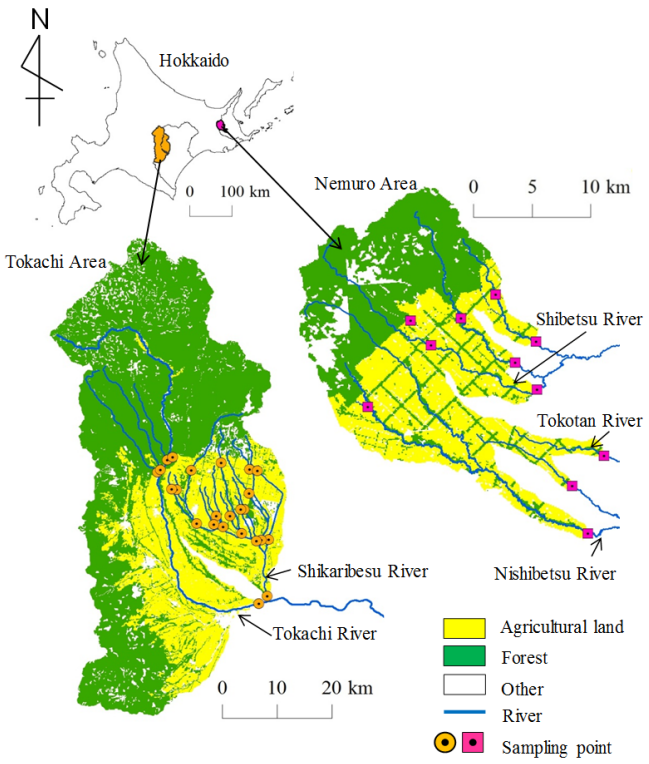
METHODOLOGY

The two investigated areas are outlined in Fig. 1. The Tokachi area, which has 24 watersheds (No. 1 to 24), is in the northwestern part of the area under the jurisdiction of the Tokachi General Subprefectural Bureau and is an area with upland and dairy farming. The Nemuro area, which has 11 watersheds (A to K) located in the western part of the jurisdiction of Nemuro_Subprefectural Bureau, is an area mainly of dairy farming.

For the years 1981 to 2010, the annual mean air temperature and the yearly precipitation were 5.9 ˚C and 840.7 mm at Komaba in the Tokachi area, and 5.4 ˚C and 1158.0 mm at Nakashibetsu in the vicinity of the Nemuro area. Both areas have a relatively cold climate with less rainfall than other agricultural areas in Japan.

The proportion of land use were determined in the two watersheds, and the investigation of the river water quality was conducted at the normal water level at 35 sampling points in the two investigated areas in late August 2006. Later, NO_3-N concentration was measured in the laboratory, using the above-described official analytical method and two simplified methods. The details of the compared methods are shown in Table 1.

One simplified method for measuring NO_3-N is Pack Test, which use is extremely easy. First, the sampled water is put in a plastic tube that contains a reagent, and it is shaken several times to mix it well. After 3 minutes, the color of the contents of the plastic tube is compared with the color in the test kit chart, to determine which color in the chart is closest to the sample color. The closest color is the NO_3-N value for the sample. When the sample color is in between two colors in the chart, the value between the two colors is read. In this way, measurers can visually obtain the NO_3-N value at the range from 0.23 mg/L to 10 mg/L.



Sampling Point	River name	Bridge name	Area (km^2)	Land use (%)	
				Agricultural land	Forest
Tokachi area					
1	Tokachi	Oojika	632	1	94
2	Penkenai	Pennai	23	0	98
3	Penkenikorbetsu	Penkenikorobetsu	48	2	96
4	Penkenikoro	Minamiiwamatsu	72	2	97
5	Tokachi	Nakajima	1798	21	70
6	Shikaribetsu	Urimaku	217	4	91
7	Sikanosawa	Kikuchi	5	83	13
8	Kamihoronai	Kamihoronai	3	88	12
9	Shikaribetsu	Momiji	256	13	81
10	Minami1sen	Nakashikakann2gou	13	72	17
11	Iketo	Minamisawa	9	95	2
12	Pankebibaushi	Kousui	27	90	7
13	Urimaku	(no bridge)	9	13	66
14	Poronai	(no bridge)	3	90	7
15	Urimaku	Mutsu	49	58	32
16	Penkeutorei	Honnmaki	3	88	11
17	Pankeutorei	(no name)	5	93	6
18	Pankeutorei	Komadome	17	65	25
19	Penkechin	Okuyama	26	22	49
20	Ponchin	Kamimaki	13	75	18
21	Penkechin	Isami	63	46	33
22	Pankechin	Sinnei	10	52	32
23	Pankechin	Taneuma	72	72	15
24	Shikaribetu	Kunimi	667	48	45
Nemuro area					
A	Kanjiushi	Yourouushi	11	4	71
B	Keneka	Minori	41	7	81
C	Keneka	Hakuyou	82	32	57
D	Shibetsu	Nagori	54	3	91
E	Shibetsu	Kamisibetu	82	22	72
F	Masu	Masukawa	10	32	64
G	Masu	Kenebetsu	28	49	46
H	Tokotan	Houtoku	12	81	14
I	Nishibetsu	Kousai	19	10	60
J	Nishibetsu	Nishisyunnbetsu	149	54	32
K	Pononnebetsu	Akashi	19	73	21

Fig. 1 Outline of the Tokachi and Nemuro areas

Table 1 Measurement methods on the NO_3-N concentration

Measurement method	Official analytical method	Simplified method	
	Chromotrope acid method	Pack Test	Digital Pack Test
Measurement Equipment	Test tube / Reagents / Deionized water etc. (Absorptiometer)	Water Test Kit (Test kit chart)	Water Test Kit (Original absorptiometer)
Measuring range	0.2-30 mg/L	0.23-10 mg/L	0.2-5.0 mg/L
Sensitivity	0.1 mg/L	coarse precision	0.1 mg/L
Coloring time	5 minutes	3 minutes	5 minutes
Measuring value	Numerical value (Digitalized value)	Comparison with "Test kit chart"	Numerical value (Digitalized value)
N.B.		cf: Naphthylethylene diamine method after zinc reduction	cf: Naphthylethylene diamine absorptiometry after zinc reduction

Another simplified method is Digital Pack Test, which is an improved version of the conventional Pack Test, this method (absorptiometer) gives digitized value with an accuracy of 0.1 mg/L to 5.0 mg/L.

In this report, the values of NO_3-N concentration in river water obtained from both two simplified methods and the official analytical method were compared.

RESULTS AND DISCUSSION

Relationship between NO_3-N Concentration and Proportion of Agricultural Land Use

From the 35 sampling points in the two watersheds, a positive correlation has been found between the proportion of agricultural land in the watershed and the NO_3-N concentration in river water in each area as measured by the official analytical method (Fig. 2 (a), (b)). For the area with a high proportion of upland fields, the NO_3-N concentration in river water was found to exceed that specified in various water quality standards (i.e., total nitrogen concentration of 1 mg/L or lower).

When we consider the problem of agriculture and water and the effect of hands-on learning in environmental education, in which the learners actually measure the water quality, it is desirable that the NO_3-N concentration obtained using simplified methods have as high measurement accuracy as possible.

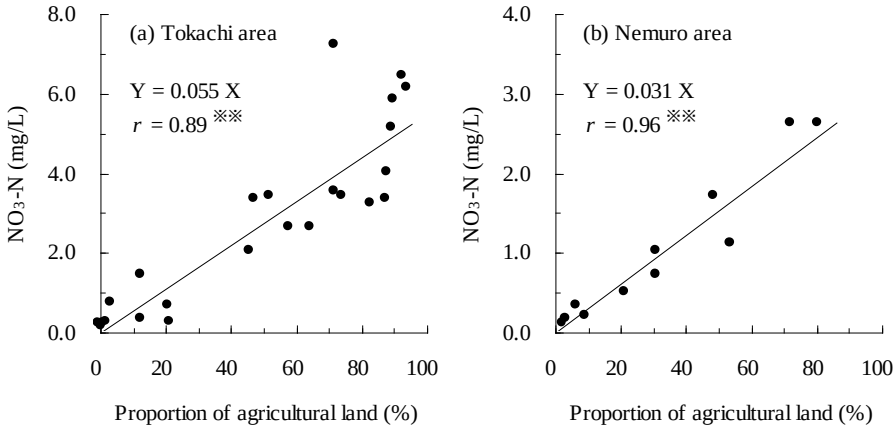


Fig. 2 Relationship between NO_3-N concentration and Proportion of Agricultural land use
(*Tokachi and Nemuro areas, 2006*)

Difference of Measurement Methods in Relation to the NO_3-N Concentration

To compare the NO_3-N concentration in river water as measured by the official analytical method (X axis) with that measured by the simplified methods using Pack Test and Digital Pack Test (Y axis), the regression line that represents the relationship between the two sets of values ($Y = aX$) and the coefficient of correlation r were obtained (Figs. 3 (a), (b) and 4 (a), (b)).

The comparison found a correlation with a significance level of about 1% between Y and X for both of the investigated areas. The NO_3-N concentrations in river water as measured by the simplified methods were 64% to 72% of those as measured by the official analytical method. The values as measured by the simplified methods were underestimates. However, it is sufficiently effective for water environmental education that using the simplified methods to objectively evaluate the water quality by actually measuring it to determine whether nitrogen levels are safe or not.

It is hoped that effective education of the general public of a wide range of ages will be possible by implementing water environmental education that combines conventional lecture-oriented learning of basic knowledge on problems of agriculture and water with hands-on learning

in which the learners measure the NO_3-N concentration of river water. The simplified methods-Pack Test, in particular-are very beneficial, because the general public is able to visually determine the NO_3-N concentration in river water easily and at low cost.

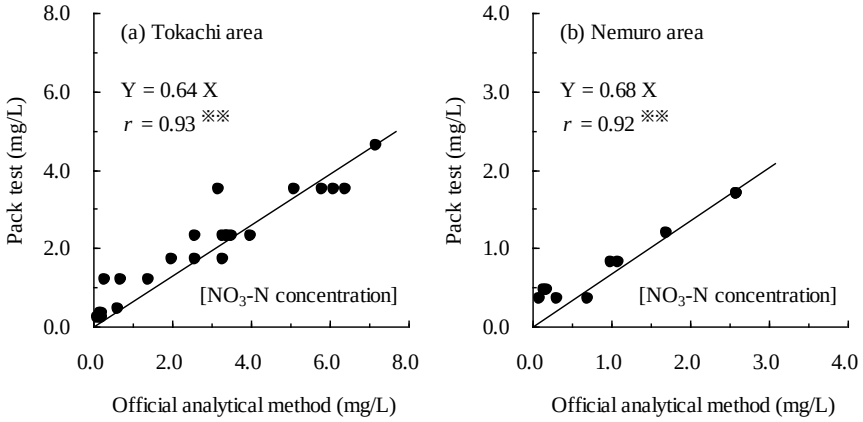


Fig. 3 NO_3-N concentration obtained by Pack Test and Official analytical method
(*Tokachi and Nemuro areas, 2006*)

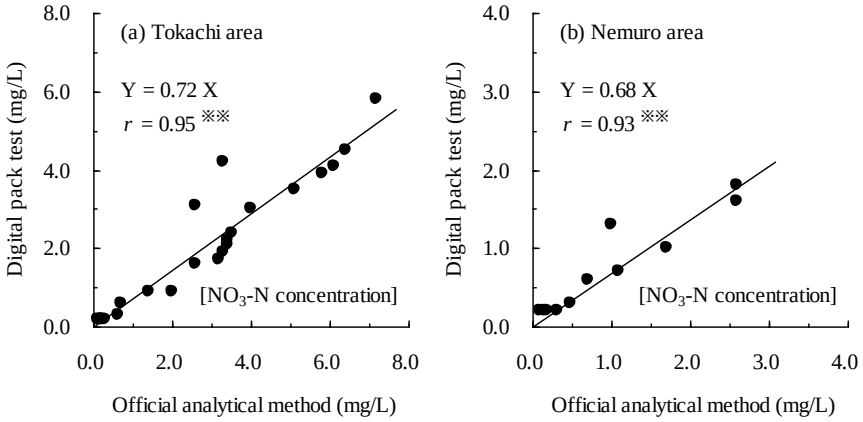


Fig. 4 NO_3-N concentration obtained by Digital Pack Test and Official analytical method
(*Tokachi and Nemuro areas, 2006*)

Desirable conservation of watersheds in agricultural and forestry areas that takes into consideration the realization of sustainable agriculture and the conservation of river water quality is also expected to be possible through the active introduction of hands-on environmental education in which river water is measured by using simplified methods.

CONCLUSION

In improving the effectiveness of water environmental education such that it combines lecture-oriented learning of basic knowledge with experience-oriented learning in which the participants measure river water quality, further improvement in the water measurement methods and the accuracy of such methods is an indispensable issue to be addressed. It is necessary to examine the applicability of the simplified methods to environmental problems related to agricultural activities and water quality indices other than NO_3-N concentration.

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Research article

Metals and Nutrient Seasonal Variations in the Namphong River NE Thailand and Land Use Practices

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Abstract The Namphong river catchment in NE Thailand, part of the Mekong River catchment, has agro-industrial activities, dry land farming, rice cultivation and river cage aquaculture. Most utilize irrigation while larger industrial activities extract groundwater. The tropical wet and dry seasons cause variation in river flow. Potential effects of water quality may arise annually from constituents introduced by agricultural and other practices. Nutrients are added to soil to improve agricultural production and directly to the river in cage aquaculture from fish feed. The seasonal variations were considered from heavy metals (cadmium, copper, iron, manganese, lead and zinc) and nutrients in the Namphong River during one annual cycle and their relationships to water quality. Water samples were collected from 10 sites along the Namphong River in January 2012 (dry season mean flow 8 sec/m) and 9 sites in September 2012 (wet season mean flow 28 sec/m). Labile metals estimated by the Diffusive Gradient in Thin Films (DGT) technique showed no toxicity to aquatic biota. Most metals showed concentration and location consistency in both seasons. Iron and manganese in pulp mill discharge and vegetable cultivation downstream showed high concentrations in September indicating a groundwater or saturated soil seepage source from reducing conditions. Nutrients decreased by half from January to September; total N was higher at upstream sites in January while nitrate and orthophosphate were not significant and pH and electrical conductivity were consistent for both seasons. Hardness and alkalinity increased in September and were highest in pulp mill discharge indicating a groundwater source. Total and suspended solids were affected by wet season runoff. Variations in metals and nutrients in January and September were attributed to differences in Namphong River flow and from seasonality and agricultural activities. Large agro-industries, particularly pulp, contributed the highest concentrations of nutrients and metals to the river.

Keywords metals, nutrients, seasonal, variations, river flow, land use practices

INTRODUCTION

The Namphong River in the NE part of Thailand is within a sub-catchment of the Mekong River (Fig. 1). The Namphong River flows to the Chi River and via the Mun River to the Mekong River. Below Ubolratana Dam, there are extensive agro-industry and farming activities along the Namphong River. The wet-dry agricultural activities use irrigation from dam storage and some supplementary groundwater supply. A key question is: what are the effects of seasonal variations of heavy metals and nutrients in the Namphong River and their relationships to other water quality parameters associated with agro-industry and farming activities. The prevailing tropical wet and dry seasons cause variation in river flow. The background water quality is influenced by water seepage through geological strata and soil before entry to the main river channel. Nutrients are added to soil to improve agricultural production and in river cage aquaculture are transferred directly from fish feed to the river water. Potential effects are therefore possible from constituents added to river water during the annual cycle that may arise from heavy metals and nutrients introduced by agricultural, aquaculture, urban discharges from Khon Kaen to tributaries and other practices.

OBJECTIVE

This study aimed to understand the effects of seasonal variations of heavy metals and nutrients in the Namphong River during one cycle and their relationships to other water quality parameters associated with land use practices comprising agro-industry and small-scale farming activities along the Namphong River, a sub catchment of the Mekong River located in NE Thailand. The study compares water quality data with existing water quality criteria during one annual wet-dry season cycle.

METHODOLOGY

Water samples were collected from 10 sites along the Namphong River in 19-23 January 2012 and 9 sites 20-24 September 2012 (Fig. 1). Site C is on a small tributary less than a few km to the Namphong River from the pulp and paper mill (Fig. 1.C). Water quality parameters including heavy metal and nutrient concentrations were measured using standard techniques (APHA-AWWA-WEF, 1998). Concentrations of labile metals were estimated by the Diffusive Gradient in Thin Films (DGT) technique (Komarova et al. 2012, 2013). The DGT technique accumulates labile metal species in waters (Davison and Zhang, 1994; Davison et al. 2000; Zhang and Davison, 1995; Zhang and Davison, 2000). The DGT technique incorporating passive sampling gives an integrated concentration measurement (Davison and Zhang 1994) and was previously described for measurement of labile metal forms in water and predicting their toxicity to aquatic biota (Komarova et al. 2012, 2013).

The DGT passive samplers were deployed to accumulate labile heavy metals at the 10 sites (Fig. 1) and were used to measure labile metal forms in waters at sub-nanogram per liter levels. Passive samplers are defined as human-made devices where sample collection is completely passive (Komarova et al. 2012). Measurements were made of pH, electrical conductivity (EC), temperature, dissolved oxygen (DO) concentration in river water using field equipment. Active (direct) sampling was employed to collect water samples (1L) before and after DGT deployment at each site in January and September for total dissolved solids (TDS), suspended solids (SS), total alkalinity (mg/L $CaCO_3$), hardness (mg/L $CaCO_3$), nutrients [total N and P, nitrate (NO_3^-) and ortho-phosphorus (P)] and dissolved organic carbon (DOC). All measurements on the active water samples were undertaken in the field or at the Division of Land Resources and Environment, Department of Plant Sciences and Agricultural Resources, Faculty of Agriculture Khon Kaen University. Following deployment, DGTs were sent by air courier to the Queensland Health Forensic and Scientific Services (QHFSS), Inorganic Chemistry laboratory at Coopers Plains, Australia for the extraction of the heavy metals from the gel and analysis by inductively-coupled

plasma mass spectrometry (ICPMS). The time-averaged concentration of dissolved heavy metal species in the bulk solution, C, is then calculated using the DGT equation derived from Fick's first law of diffusion (Komarova et al. 2012, Zhang and Davison, 1995).

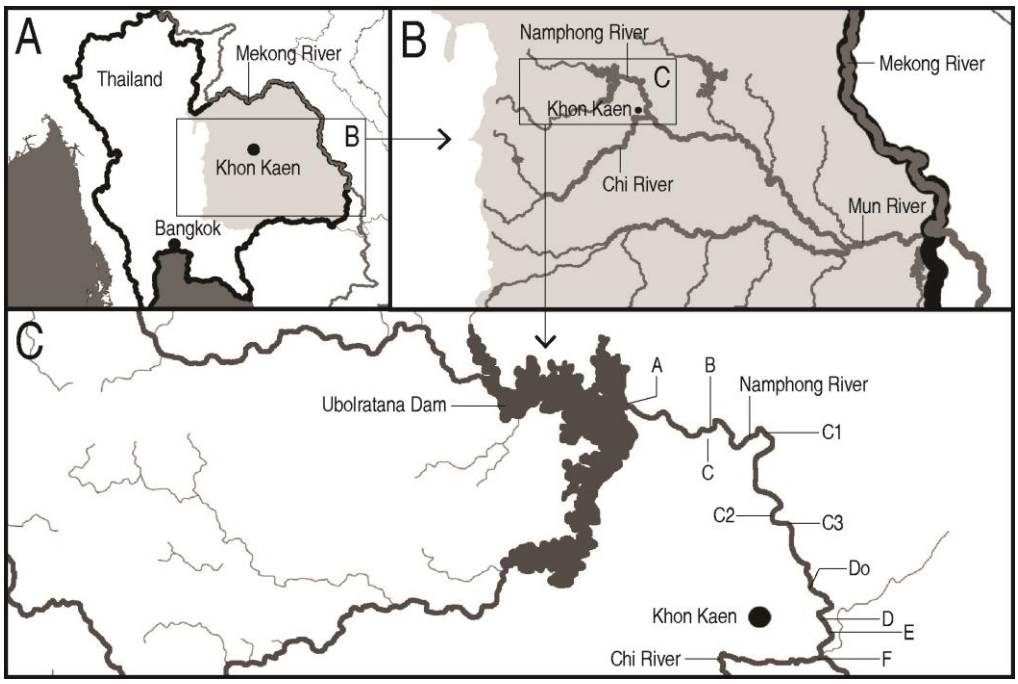

Fig. 1 Location of study site in the Mekong River basin NE Thailand (Maps A and B) and sampling sites along the Namphong River (Map C)

Sites A – Ubolratana Dam; B – fish cage (in-river cage aquaculture for Tilapia production); C – pulp/paper industrial plant (discharge via small tributary to main river); sugar industrial plant; C2 cucumber culture; C3 corn culture; Do vegetables culture; D vegetable culture and paddy fields; E vegetables culture; and F – vegetables culture, residential discharge to Chi River just upstream from confluence with Namphong River

Water quality was assessed by comparison with the Water Quality Standards of the Pollution Control Department, Ministry of Natural Resources and Environment, Thailand and the protection of the aquatic ecosystem of the Australian ANZECC/ARMCANZ (2000) decision tree process for assessing heavy metal toxicity in water. Site-specific trigger values for metals were calculated by using a correction for hardness (mg/L $CaCO_3$) to the default ANZECC/ARMCANZ (2000) heavy metal guideline value. Aquatic metal toxicity decreases with increasing water hardness as soluble metal is precipitated. The metal concentrations in labile or bioavailable forms (DGT technique) and metals in particulate and insoluble colloidal fractions were also measured following filtration (<0.45µm membrane) and were shown to be much higher compared with the bioavailable fractions of metals in Namphong river water (Komarova et al. 2013).

RESULTS AND DISCUSSION

Tables 1 and 2 give average water quality and nutrient data for January and September at the 10 sampling sites (Fig.1). The Namphong River mean flow was 3.6 times lower in January (dry season mean flow 8 sec/m) compared with September (wet season mean flow 28 sec/m). Table 3 gives average labile metal concentration data using DGTs [cadmium (Cd), copper (Cu), iron (Fe), manganese (Mn), lead (Pb) and zinc (Zn)] for each sampling period at the 10 sampling sites.

The water quality shows little difference in pH, DO and DOC between January and September. Temperature was lower in January (mean 24 ^{0}C) compared with September (mean 32 ^{0}C) (Tables 1 and 2). Mean EC (TDS) in January was 65% of September and indicated wet season flushing of salts or groundwater contribution to the river; both alkalinity and hardness showed the same feature. Mean SS in January was 51% of September indicating wet season runoff of solids and an

association with EC. DOC was higher in September showing the effect of runoff or biological activity in the river. Total N in January and September were similar but in January the contribution from upstream was higher and was subsequently diluted moving further downstream. Nitrate was lower in September indicating dilution with wet season flow. Total (not shown) and ortho-P were both similar in January and September but localized additions to river water were apparent. Water quality standards for Thailand (Tables 1 and 2), excepting SS, were not exceeded.

Table 1 Seasonal variations of water quality in the Namphong River

Sampling site	pH		EC(µS/cm)		Temp (^{0}C)		DO (mg/L)		SS (mg/L)		TDS (mg/L)	
	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep
A. Ubolratana	7.4	7.4	94	116	23.0	31.9	6.28	5.20	53	213	46	59
B. River cage aquaculture	7.7	7.4	86	106	23.0	32.3	5.45	5.78	80	274	47	52
C. Pulp mill	8.2	8.4	1250	1040	25.0	31.7	5.88	4.60	1790	1067	672	508
C1.Sugar mill	7.8	7.4	97	143	25.0	32.8	5.29	5.18	360	314	52	62
C2.Cucumber	7.9	7.5	80	154	23.0	32.2	7.65	6.20	107	264	47	76
C3. Corn	7.7	7.4	99	122	23.0	32.7	7.31	5.62	80	290	51	61
Do.Vegetable	7.9	7.3	102	164	25.0	32.6	5.46	5.20	133	210	55	80
D. Vegetable/ paddy field	7.9	7.4	106	191	25.0	33.1	5.75	5.44	120	287	55	95
E. Vegetable	7.7	7.5	109	171	25.0	33.4	5.54	5.05	150	244	57	84
F. Vegetable	7.8	7.4	110	181	25.0	30.8	5.47	4.72	150	317	57	89

Note: Water Quality Standards Pollution Control Department, Ministry of Natural Resources and Environment, Thailand Freshwater animal Temperature (^{0}C) 23-32, pH 5-9, Dissolved Oxygen (mg/L) 3 min., Suspended solids (mg/L) 25 max.

Table 2 Seasonal variations of water quality and nutrient content in the Namphong River

Sampling site	Alkalinity (mg/L $CaC0_3$)		Hardness (mg/L $CaC0_3$)		DOC (mg/L)		Total N (mg/L)		NO_3^- (mg/L)		Ortho-P / Total P (mg/L)	
	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep
A. Ubolratana	18	65	64	684	2.3	4.6	23	10	1.8	1.2	0.04/ 0.34	0.004/ 0.40
B. River cage aquaculture	31	63	66	745	1.9	8.8	26	11	2.8	1.0	0.05/ 0.36	0.002/ 0.26
C. Pulp mill	131	190	227	1289	2.3	22.5	28	8	2.5	0.5	0.22/ 1.31	0.024/ 2.6
C1.Sugar mill	24	59	70	532	3.4	3.7	19	11	3.1	1.1	0.05/ 0.39	0.002/ 0.25
C2.Cucumber	29	74	69	613	1.9	5.3	23	12	2.9	1.4	0.04/ 0.37	0.008/ 0.88
C3. Corn	12	65	67	412	1.8	4.0	12	10	2.0	1.1	0.04/ 0.33	0.008/ 0.94
Do.Vegetable	18	70	65	839	1.3	4.1	13	12	1.9	1.1	0.04/ 0.35	0.007/ 0.72
D. Vegetable/ paddy field	23	55	69	549	3.6	6.2	12	12	3.0	1.0	0.04/ 0.33	0.006/ 0.64
E. Vegetable	30	61	61	377	2.9	5.9	12	10	2.2	0.8	0.04/ 0.36	0.006/ 0.53
F. Vegetable	30	65	66	499	3.1	3.2	7	9	2.4	1.2	0.03/ 0.36	0.006/ 0.68

Note: Water Quality Standards Pollution Control Department, Ministry of Natural Resources and Environment, Thailand protecting Water Source Class 3 (applies to Namphong River). NO_3-N 5 mg/L; Effluent Standard B Point Source Total TKN (mg/l) 35, Total N (mg/L) 410, Total P (mg/L) 0.5.

The labile metal DGT concentrations for Cd, Cu, Pb and Zn are very low and do not exceed the Water Quality Standard Class 3 (Table 3). Comparison of Cd, Cu, Pb and Zn labile concentrations against the ANZECC/ARMCANZ (2000) criteria adjusted for hardness (Table 3) indicates that these metals are not likely to be toxic to aquatic biota in the Namphong River.

Table 3 Seasonal variations of labile metal concentrations using DGT (passive) sampling (average of before and after DGT sampling for 19-23 January and 20-24 September 2012, respectively)

Sampling site	Cd (µg/L) DGT conc.		Cu (µg/L) DGT conc		Fe (µg/L) DGT conc		Mn (µg/L) DGT conc		Pb (µg/L) DGT conc		Zn (µg/L) DGT conc	
	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep	Jan	Sep
A. Ubolratana	0.021	0.00	0.39	0.37	0.68	4.80	1.19	9.17	0.032	0.00	2.96	3.86
B. River cage aquaculture	0.021	0.01	0.30	0.40	2.43	4.03	6.76	27.9	0.024	0.00	2.75	2.90
C. Pulp mill	0.020	0.00	0.24	0.41	34.3	31.5	269	106	0.049	0.00	2.16	4.08
C1.Sugar mill	0.021	0.00	0.22	0.02	2.19	1.39	13.0	8.62	0.026	0.00	2.08	2.04
C2.Cucumber	0.021	-	0.19	-	27.8	-	21.5	-	0.040	-	1.68	-
C3. Corn	0.021	0.01	0.23	1.71	15.5	35.2	20.6	66.7	0.042	0.05	3.82	6.08
Do.Vegetable	0.020	0.00	1.45	0.23	8.23	18.5	23.9	126	0.031	0.00	1.42	2.65
D. Vegetable/ paddy field	0.020	0.00	0.25	0.36	4.84	5.26	30.8	32.1	0.13	0.00	9.25	0.93
E. Vegetable	0.020	0.00	0.21	1.17	3.00	9.23	16.9	36.4	0.17	0.05	8.53	1.40
F. Vegetable	0.027	0.00	0.28	0.19	8.00	3.31	26.9	16.8	0.50	0.00	1.47	1.33

Note: Water Quality Standards Pollution Control Department, Ministry of Natural Resources and Environment, Thailand protecting Water Source Class 3 (applies to Namphong River): Cd 5 µg/L (hardness <100 mg/L $CaCO_3$) or 50 µg/L (hardness >100 mg/L $CaCO_3$); Cu 100 µg/L, Pb 50 µg/L and Zn 1000 µg/L. Trigger value (µg/L) 95% of aquatic species protection (adjusted for hardness) Cd (0.5 µg/L), Cu (3.5 µg/L), Fe (-), Mn (-), Pb (13.6 µg/L) and Zn (20.0 µg/L) (ANZECC/ARMCANZ, 2000).

The Mn and Fe DGT concentrations show high levels in the pulp mill effluent at Site C and at downstream Namphong River Sites C2, C3 and Do (Fig. 1.C). Below Site Do labile Fe decreases to levels similar to upstream while labile Mn decreases but remains higher than found upstream. It is clear that the source of labile Fe and Mn at and below Site C2 is different from Site C and the location of Site C2 is more than 20 km downstream from Site C (Fig 1.C). Thus there is a different source of labile Fe and Mn at and below Site C2 which may be shallow seepage from water-saturated soil, including paddy fields as there is no increase in total alkalinity and hardness as observed at Site C (Table 2). The Cu DGT concentrations are low but show some increase at Sites C3 (September), Do (January) and Site (E) (September) (Fig. 1.C).

Wet season transfer of particulate and soluble constituents is a key feature of the water quality data from this study. The industrial area (Sites C and C1 - pulp and sugar mills) was a major potential source of contamination of the Namphong River associated with increased levels of labile heavy metals in both sampling periods. The increase of total alkalinity, hardness and EC (Tables 1 and 2) for both periods confirms that groundwater was being used in the pulp mill (Site C). The release of Cu and Pb in the Namphong River occurred in the area of rice and mixed vegetable cultivation (Sites C3 - E) and was most likely related to extensive pesticide use (metals in the pesticides used such as carbamates). At Site F in the Chi River labile metal levels were low, excepting for Fe and Mn, and were similar to the Namphong River at the upstream Site A (Fig 1.C).

The overall finding is that there is little effect on the water quality of the Namphong River from upstream to downstream from the extensive river cage aquaculture and vegetable farms and paddy fields and taking account of dilution removing observed additions of suspended solids and labile metals from the major agro-industrial activities located upstream.

CONCLUSION

Variations in the levels of heavy metals and nutrients were observed in the Namphong River in January and September 2012. These variations could be attributed to differences in river flow and associated with seasonality and agricultural activities in the catchment. Although the industrial area (pulp and sugar industries) is a major source of contamination of the Namphong River with heavy metals, there is sufficient dilution from the Namphong River to give safe levels downstream for protection of aquatic species. The outcome of this study will help to develop more focused monitoring of specific toxic heavy metals at particular locations on the Namphong River.

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Research article

Assessment of Rice Assistance Program for Institutional Development in Selected Municipalities of Bohol, Philippines

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Abstract This study evaluated the performance of the Rice Assistance Program for Institutional Development (RAPID) in selected municipalities of the province of Bohol, Philippines. There were 240 farmer beneficiaries of the program who served as respondents for the normative survey conducted. Seed was commonly availed by the beneficiaries and respondents revealed that delivery of inputs was on time and repayment was also on time. During the implementation of the program beneficiaries observed problem which is the failure of the Community Organizers to visit farmer's field. With regards to the performance of the farmer beneficiaries, majority affirmed that their attendance to meetings and involvement in the activities have increased after the program was implemented. There was also an observed increase of members in the organization. On the impact to the environment majority affirmed that the project resulted to having increased soil fertility and fewer pest incidences in their crops. On the economic aspect, respondents revealed that there was an increase of their yield and income after the program. The results of the study made the researchers to recommend the following: 1) the project should be institutionalized in the Municipal Local Government Unit. This means the local government must allocate funds for its sustainability especially for the travelling expenses of the technicians who will do the monitoring and evaluation of the project. Once institutionalized, 2) the project shall not be confined to the irrigated and compact areas so that farmers with small landholdings and those in rainfed areas can also avail of the assistance of the project.

K**eywords** community organizers, respondents, sustainability, compact areas, landholdings

INTRODUCTION

Rice Assistance Program for Institutional Development (RAPID) was a project of the province of Bohol, Philippines which was implemented in 2008-2011 in response to the food crisis by providing high quality rice seeds to the farmers as a strategy to increase production. RAPID was designed to strengthen the campaign for farmers to use hybrid or certified seeds, empower such farmers in the management of the business of their accredited association and strengthen the rice seed system in the province. (Bohol Rice Industry, 2005).

For decades, agricultural science has focused on boosting production through the development of new technologies. It has achieved enormous yield gains as well as lower costs for large-scale-farming. But this success has come at a high environmental cost. Further, it has not solved the social and economic problems of the poor in developing countries, which have generally benefited the least from this boost in production (Sundstrom, 2013).

Various studies on different Rice production Programs have been conducted to discuss the factors that affect implementation of these programs (OPA, 2006). The national programs were the local version of the Green Revolution which had been promoted in many developing countries in

the early part of the 1970s. Farming modernization created ecological, economic and socio-cultural impacts (Quirog, 1994).

A study revealed that during the implementation of the Rice Action Program (RAP) in Bohol, rice yield increased from 2.60 tons per hectare to 3.48 tons per hectare. This was primarily brought by the increase in fertilizer usage and the use of high quality seeds (Quirog, 1994).

This study was done to assess the performance of the Rice Assistance Program for Institutional Development (RAPID) in the province of Bohol.

METHODOLOGY

This study was conducted in 2012 in the ten (10) selected municipalities of Bohol province where RAPID was implemented in the year 2008-2011. The sites included the towns of Balilihan, Alburquerque and Catigbian (first district); Dagohoy, Trinidad, San Miguel and Ubay (second district); and Alicia, Batuan, Bilar (third district). There were 240 randomly selected farmer beneficiaries who participated in the research process using the normative survey method which collect the information through the knowledge of individual members of the farmer group with the aid of the questionnaire, interview and observation techniques. The questionnaire was translated into the dialect to facilitate easy understanding by the respondents. Research protocol was properly observed before the data gathering was done. This means necessary permits were secured at the provincial and municipal levels to ensure coordination and assistance of concerned agriculture officials in the study sites. Questionnaires were distributed and retrieved personally by the researchers to ensure that all items are properly answered.

RESULTS AND DISCUSSION

Farming Socio-Demographic Profile of the Respondents

Profile of the respondents in terms of area of rice farm, tenurial status, and number of years in farming, trainings and seminars attended related to rice farming and availment of the assistance of RAPID was documented.

Area of rice farm: Survey proved that 190 (79.2%) of the farmers owned .25 to 1 hectare of riceland, 39 (16.3%) owned 1.1 to 2 hectares and 11 (4.6%) of the farmer beneficiaries owned a 2.1 to 3 hectares of riceland.

Tenurial status: A total of 140 (58.3%) respondents were owner-operators, 108 (45%) were tenants while 35 (14.6%) were part-owners and 13 (5.4%) were leases.

Number of years in farming: Survey showed that of the total respondents 129 (53. 8%) have experienced 11 to 25 years in farming, 46 (19.2%) has an experience of 1 to 10 years in farming while 46 (19.2%) have experienced 26 to 40 years in farming, 17 (7.1%) have experienced 41-55 years in farming and only 2 (0.8%) have an experience of 56 years and above. Survey showed that the average year of farming experiences for most of the respondents was twenty-two (22) years.

Trainings and seminars related to rice farming: The findings showed that one hundred sixty seven (167) or (69.6%) of the total population have attended trainings on rice production and, Farmers Field School (FFS) using palaycheck system; 12) or (5%) attended Integrated Pest Management seminar; nine (9) or (3.8%) have attended integrated farming system palayaman and technical briefing on rice production; twelve (and; four (4) or (1.7%) on System of Rice Intensification (SRI). Of the respondents, forty eight (48) or (20%) have not attended any seminars or trainings. at all.

Availment of the assistance of RAPID: There were three components of assistance that the program provided. These include the following; seed assistance, fertilizer assistance and crop insurance assistance. Among the respondents, one hundred sixty seven (167) or (69.6%) availed of the seed assistance only in RAPID; forty eight (48) or (20%) availed of the seeds and fertilizer assistance while twenty three (23) or (9.6%) availed of the three item assistance which is the seeds,

fertilizer and crop insurance and only two (2) or (0.8%) percent farmers availed of the seeds and crop insurance assistance.

Significant Impact of the Program to the Environment

Fertility of soil: In the survey conducted, good/fertile soil was being rated by three categories namely fair, good and very good: at the rate of ten (10) where 10 was the highest five (5) was fair, eight (8) was good and ten (10) was very good. When asked to rate the fertility of their soils before RAPID was implemented, forty three (43) or 17.9% said that the fertility of their paddies was poor; One hundred fifty four (154) or 64.1% believed that their soil was fair; thirty four (34) or 14.1% stated that their soil was good enough and nine (9) or 12.8% affirmed that their soil was very good. After the implementation of the program, eight (8) or 3.3% said that their paddies were poor and not fertile; ninety six (96) or 40% pointed out that their paddies were fair in fertility; One hundred twenty one (121) or 50.4% claimed that there paddies was good in fertility and fifteen (15) or 23.1% asserted that their paddies were very fertile.

Occurrence of pest: Before the implementation of the program, study shows that six (6) or 2.5% of the total respondents have not experienced pest infestations in their rice farm; while one hundred fifty five (155) or 64.5% said that it seldom happen to have pests in their farm; on the other hand sixty nine (69) or 28.7% said that their farms was always infested by pests and fifteen (15) or 6.2% revealed that their farms was frequently attacked by pests. After the program was implemented, ten (10) or 4.1% revealed that there was no infestation of pests in their farm; One hundred fifty (150) or 62.5% said that their farm was seldom attacked by pests and eighty (80) or 33.3% proved that their farm was often infested with pests.

Occurrence of diseases: Survey showed that before the program was implemented, five (5) or 2.1% said that it never happen to have a disease infestation in their rice farm; one hundred fifty five (155) or 64.5% have experienced that their farm was rarely attacked by diseases; seventy (70) or 29.1% declared that their farm was always infested with diseases and ten (10) or 4.1% stated that their farm was frequently attacked by diseases. After the implementation of the program study revealed that of the total respondents ten (10) or 4.1% did not experienced any occurrence of diseases in their farm; one hundred fifty seven (157) or 65.4% seldom experienced disease infestation in their farms; sixty five (65) or 27.1% stated that their farms have always experience disease infestation and eight (8) or 3.3% said that they frequently experienced their farm being attacked by diseases.

Nutrient management: Before the program was implemented thirty (30) or 12.5% of the total respondents used animal manure as fertilizer to enhance the growth of rice while after the program was implemented a number of farmers using animal manure increased to thirty nine (39) or 16.2%. Using green manure as fertilizer was practiced by twenty eight (28) or 11.6% of the total respondents before the RAPID implementation and the practice were continuously done by thirty five (35) or 14.5% after the program. Usually farmers plowed back rice straws to their rice fields as fertilizer for the next crop and survey showed that before the program was introduced one hundred eighteen (118) or 49.1% of the total respondents do the practice and one hundred twenty eight (128) or 53.3% still continue to do the practice after the implementation of the program.

Survey revealed that of the total respondents two hundred thirty (230) or 95.8% applied commercial/inorganic fertilizers in their farms even before RAPID was implemented and two hundred twenty nine (229) or 95.4% applied the same after the program. Of the total respondents, there was one farmer who did not apply any fertilizers before and after the program was implemented.

Pests and diseases management: Before the implementation of RAPID, the farmers used different methods to manage pests and diseases in their farms. In the management of weeds, farmers have always appreciated the efficiency of the human factor to pull the weeds growing with the rice plants. One hundred eighty two (182) or 75.8% practiced hand weeding throughout the early vegetative part of the rice plants before the RAPID program was introduced and one hundred eighty six (186) or 77.5% do the same after the program was implemented. Use of herbicides was not encouraged in the introduced POT during the technical briefing prior to the delivery of inputs.

However survey showed that before the program started it was found out that of the total respondents forty one (41) or 17.1% applied herbicide in their farms and thirty five (35) or 14.5% still continue to apply herbicides after the program was implemented. It is evident that the presence of insects and snails were most common in rice farming and one way to manage this was by handpicking of the pests and other diseased plant parts to control the spread of these diseases to the non affected plants. Study confirmed that that the practice of handpicking insects and snails were done before and after the RAPID program was implemented. Before the program was introduced it was practiced by one hundred fifteen (115) or 47.9% and one hundred sixteen (116) or 48.8% of the total respondents do the same after the program. Though using of chemical insecticides was not promoted by the POT introduced by the program but still it was widely used by most of the respondents before and after the program was implemented. One reason why they would still insists to apply chemicals was because farmers want to make things easy for them. Applying chemicals was for them the very easy way to control insects and diseases. Assessment showed that one hundred fifty seven (157) or 65.4% used chemical insecticides before the program was introduced and one hundred fifty three (153) or 63.7% after the program was implemented.

Social Performance of the Farmer Beneficiaries before and after the Program

With regards to attendance to meetings, 75%-100% attendance was done by 15 (6.2%) before RAPID and 50 (20.8%) after RAPID; 51%-75% attendance by 55 (22.9%) before RAPID and 128 (20.8%) after RAPID; 26%-50% attendance by 107 (44.5%) before RAPID and 47 (19.5%) after RAPID and a 0-25% attendance by 63 (26.2%) before RAPID and on the performance of the beneficiaries on every activities done by the organization, 100% involvement was made by 12 (5%) prior to the program and 50 (20.8%) after the program; 75% involvement by 57 (23.7%) prior to the program and 119 (49.5%) after the program; 50% involvement by 108 (45%) prior to the program and 59 (24.5%) after the program and a 25% involvement by 63 (26.2%) prior to the program and 12 (5%) after the program.

Increase in number of members and activities of the IA / FA. Findings of the survey showed that all the respondents affirmed an increase in the number of members and activities in their association after implementation of the program. Reason for this was the interest of the farmers to have privilege to avail of the benefits of the program.

Economic Performance of the Farmer Beneficiaries before and after the Program

It was found out that the average income of the farmers was 19,333.65 before the program and it increased to an average of P31, 503.70 after the program. This was attributed to an increase in yield from 1.57 tons per hectare before the program to 2.36 tons per hectare after the program

Statistical test revealed that there is a highly significant difference on the social performance of the farmer beneficiaries before the program and after the implementation of the program at 1% level of significance at computed T at 21.80 (attendance to meetings), 20.85 (participation to activities), 19.86 (increase in number of members) and 39.62 (increase in number of activities of the organization). This implies that the difference in the social performance of the farmer beneficiaries before and after the program is highly significant.

Statistical test revealed that there is a significant difference on the farm performance of the farmer beneficiaries on the environment aspect before the program and after the implementation of the program at 5% level of significance at computed T at 9.68 (soil fertility), 2.48 (pest infestation) and 2.04 (disease infestation). This implies that the difference in the farm performance of the farmer beneficiaries on the environment aspect before and after the program is statistically significant.

Statistical test revealed that there is a highly significant difference on the social performance of the farmer beneficiaries before the program and after the implementation of the program. This implies that the difference in the social performance of the farmer beneficiaries before and after the program is statistically highly significant.

Statistical test revealed that there is a significant difference on the performance of the farmer beneficiaries on the environment aspect before the program and after the implementation of the program at 5% level of significance. This implies that the difference in the performance of the farmer beneficiaries on the environment aspect before and after the program is statistically significant.

Statistical test revealed that there is a highly significant difference on the performance of the farmer beneficiaries on the economic aspect before the program and after the implementation of the program at 1% level. This implies that that the difference in the farm performance of the farmer beneficiaries on the economic aspect during and before the program is statistically highly significant.

CONCLUSION AND RECOMMENDATION

Majority of the farmer beneficiaries of RAPID were male whose age ranges from 46-60 years old and mostly owner-operators of their farm. Most of them were married, high school graduate and had 11-25 years of farming experience in an area that ranges from 0.25 to 1.0 hectare. Most of RAPID beneficiaries have attended seminars related to rice farming. Seed assistance was the RAPID component mostly availed by the farmers.

Majority of the respondents revealed that there was a timely delivery of seeds and fertilizers and farmer-beneficiaries paid their obligation on time. An increase on the attendance of meetings and their involvement on other activities of their association were observed after the program.

Majority of respondents revealed having fertile soil and fewer pest and diseases incidence after the program. Use of commercial fertilizer and hand weeding were common practices even after the program. Respondents revealed that they observed increase in average yield and income.

There was a highly significant difference on the economic, social and environmental performance of the farmers before and after the program.

One major problem identified by the respondents on the implementation of RAPID was the failure of some technicians to visit farmer's fields.

It is recommended that RAPID be institutionalized at the municipal level by allocating a yearly budget to include travelling expenses of agricultural technicians and shall be extended even to farmers with rain feed rice areas.

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Research article

Evaluating Participation Level of Farmers in Project on Promoting Sustainable Farming Systems in Samroung Commune of Kampong Cham Province, Cambodia

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Abstract In Cambodia, 71% of labor force engage in agricultural sector and contribute 36% on 2010 of Gross Domestic Products. Recently, conventional farming based on agro-chemicals application is a major farming practice in the country. However, the application of agricultural inputs, especially chemical pesticides are not appropriate from a point of view of sustainable farming practice. As the mainstream farming systems based on agro-chemicals are not only deteriorating natural environment and ecosystem but also affecting human health. For preventing these impacts, attention has been paid to sustainable farming systems. For promoting sustainable farming systems based on natural resource circulation, Institute of Environment Rehabilitation and Conservation (ERECON) and Tokyo University of Agriculture implemented project in Samroung commune of Kampong Cham province, Cambodia since April 2011. From previous studies, it was concluded that extension approaches which are applied in Samroung commune is effective in order to change farmer's awareness for converting their farming system. In addition, the farmers in Samroung commune have motivation and potential for converting from conventional farming systems to sustainable farming systems. However, for understanding participation level of farmers properly, this study evaluate participation level of farmers from 2011 to 2013 and examine appropriate incentive for improving participation level based on the questionnaire and interview survey. This study concluded that participation level of farmers was improved through project activities year by year and there are some incentives for improving farmer's participation level. It can be said that participation level was improved according to change of interests and build incentives related to project activities.

Keywords participation level, sustainable farming systems, sustainable agriculture based on natural resource circulation

INTRODUCTION

According to Ngo and Siriwattananon (2009), agriculture has utmost important role for reducing poverty and improving the capacity for human resource development in rural area. On 2010, Cambodia has population of 14 million and 71% of labor force engages in agricultural sector and contributes 36% of Gross Domestic Products (Asian Development Bank, 2011). In this country, conventional farming systems based on agro-chemicals become a mainstream to meet market's demand. But chemical pesticides effect not only positive but also negative for the environment and human. It is also a problem that farmers do not have enough knowledge about applying agro-chemicals.

For producing foods and fiber materials on a sustainable basis harmonizing agricultural production with the natural environment, the conversion from conventional farming systems to sustainable farming systems is considered. In this study, sustainable farming systems is defined as a

system that can evolve indefinitely toward greater human utility, greater efficiency of resource use and a balance with the environment which is favorable to humans and most other species (Harwood, 1990).

For promoting sustainable farming systems based on natural resource circulation, Institute of Environment Rehabilitation and Conservation (ERECON) and Tokyo University of Agriculture implemented project in Samroung commune of Kampong Cham province, Cambodia since April 2011. For 450 local farmers as well as students and teachers in 10 elementary schools, the project not only extended techniques for sustainable agriculture but also supported to form farmers' group, organize project team on agricultural market survey and product sales, educate teachers through leader training, and establish Pellet Compost Center in Samroung commune. From previous studies, it was concluded that extension approaches which are applied in Samroung commune is effective in order to change farmer's awareness for converting their farming system. In addition, the farmers in Samroung commune have motivation and potential for converting conventional farming systems to sustainable farming systems. However, for understanding awareness of farmers properly, participation level also needs to be studied.

According to Chambers (2005) cited in Beatrice (2008), participation enables people to realize their rights to participate in and access information related to the decision-making processes which affect their lives. Pretty (1995) stated that participation is one of the critical components of success. His analysis also revealed that the outcome is seen as participation when people's ideas and knowledge are valued and power is given to them to make decisions independently of external agencies. On the other hand, Beatrice (2008) studied that development program with top-down initiatives hardly reach the people which the programs are meant for.

In order to understand participation level of farmers properly, this study evaluate participation level of farmers and examine appropriate incentive for improving participation level based on the questionnaire and interview survey conducted in Samroung commune of Kampong Cham province, Cambodia. This study defines incentive as something that encourages people to do something (Oxford dictionary, 2005).

STUDY SITE

Study site of the study comprised of 11 villages which are located in Samroung commune, Phrey Chhor district, Kampong Cham province, Cambodia. This commune is located 83 kilometers from Phnom Penh city (Fig. 1). The commune has population of 8,111 people on 2011 (ERECON, 2011). Main agricultural product is paddy rice mainly for both of sales and self-consumption, meanwhile, several kinds of vegetables also produced by farmers In Samroung commune, agro-chemicals are applied for production in order to increasing yield.

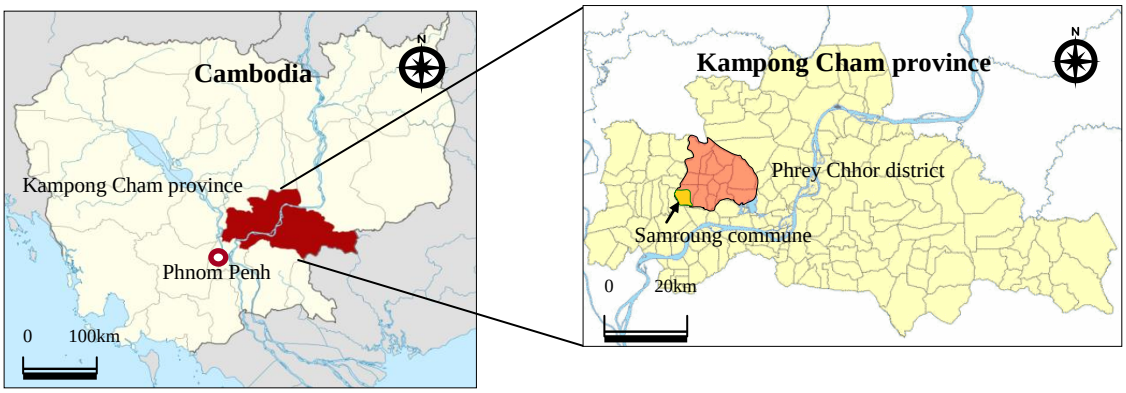

Fig. 1 Location of Samroung commune in Kamong Cham province

METHODOLOGY

In this study, incentive of improving participation level of farmers in Samroung commune was studied. For achieving objective, the study was advanced through 1) questionnaire survey, 2) interview and 3) field investigation. Through questionnaire survey and field investigation, 9 farmers who have high participation frequency compare to other farmers were selected for understanding their incentives through questionnaire survey (Fig. 2). The questionnaire was designed to measure 1) farmer's time sharing for agricultural activities including technical training, meeting, etc. and 2) comparison of their former and present interests related to agricultural activities. Besides, some farmers who not only participates activities such as meeting frequently but also considers improving their circumstances voluntarily were interviewed for detail information.

Fig. 2 Conducting questionnaire survey

Table 1 A typology of participation

No.	Typology	Characteristics of each type
1	Manipulative Participation	Participation is simply a presence, with "people's" representatives on official boards but who are unelected and have no power.
2	Passive Participation	People participate by being told what has been decided or has already happened. In involves unilateral announcements by an administration or project management without any listening to people's responses.
3	Participation by Consultation	People participate by being consulted or by answering questions. External agents define problems and information gathering processes, and so control analysis.
4	Participation for Material Incentives	People participate by contributing resources. They may provide the fields and labor, but are involved in neither experimentation nor the process of learning.
5	Functional Participation	Participation seen by external agencies as a means to achieve project goals, especially reduced costs. People may participate by forming groups to meet predetermined objectives related to the project.
6	Interactive Participation	People participate in joint analysis, development of action plans and formation or strengthening of local institutions. Participation is seen as a right, not just the means to achieve project goals.
7	Self-Mobilization	People participate by taking initiatives independently of external institutions to change systems.

Source: Pretty (1995) , Mihara and Yamaji (2004)

In addition, participation level of farmers was evaluated and compared from 2011 to 2013 based on the participatory level developed by Pretty (1995) which is cited in Mihara and Yamaji (2004). The typology of participation is divided into seven types as Table 1. It is because that high participation of farmers is essential for sustaining output of the project.

RESULTS AND DISCUSSION

Typology of Participation

Through observation of farmer's contribution and participation frequency toward project activities and interview, participation level was measured by authors based on typology of participation composed by Pretty (1995). In initial stage of the project on 2011, typology of participation of farmers was level 2, participation by consultation. It is because interviewees mainly answered questions and consulted by project implementer. But on 2013, farmer's participation level was marked as level 5 or 6 because members of farmers' group start to communicate and share knowledge each other. Moreover, key farmers especially committee members of farmers' group started to participating decision making on action plan and expanding techniques for sustainable agriculture to other farmers. However, some farmers who have high participation level evaluated as level 7 because they consider problems by themselves and improve their environment voluntary. For example, some farmers set irrigation system in vegetable farm, expand their vegetable field by fill up pond with soil, start collaboration with private company for vegetable selling, and dick big pond near vegetable field without recommendation from implement organization. They also try to improve agricultural techniques of other farmers based on natural resource circulation through showing, explaining and accepting visitors at their farm.

Result was similar to the studies of Siriwattananon and Mihara (2006), and Ngo and Siriwattanannon (2009). Their studies described that participation level at the 1st workshop was very low at level 2 or 3 but it changed to level 6 in the 3rd workshop after farmers understood well about benefits of introduced technique.

Change of Time Sharing for Agricultural Activities after the Project Implementation

For promoting sustainable agriculture based on natural resource circulation, the project implemented several activities. For example, from April 2011 to March 2012, 41 technical trainings about techniques for sustainable agriculture were implemented and totally 414 farmers were participated. Project team meeting and additional training such as pellet compost making were also conducted for key farmers such as committee members of farmers' group occasionally. In addition, technical trainings were also conducted at Thailand and Japan in order to learn advanced agricultural techniques, management system of farmers association, etc. Totally 20 farmers participated in these trainings in 2012 and 2013. (ERECON, 2012 and 2013).

By asking change of working time on agricultural activities, it was revealed that many farmers became busy after project started because project implementer organized many kinds of technical training, meeting, and etc. Normally, technical training organized by two hours and meeting at least an hour. However, some farmers who have incentives participated these kinds of activities properly even they were busy with their own activities.

By asking reasons of their participation, 100% of interviewee answered 1) learning knowledge and techniques related to sustainable agriculture, 2) holding the relationship with international Non-Governmental Organization (ERECON), 3) taking materials for conducting sustainable agriculture by ERECON, and 4) contributing improve farming way in Samroung commune were reasons of their time sharing (Fig. 3).

It can be said that farmers hope to learn and improve knowledge and technique to sustainable agriculture because it will be contribute to improve farming way in their commune. Michael (1997) mentioned one of issues on participation is acceptability of implementer. For proving it, good relationship with project implementer, international Non-Governmental Organization, is also answered as reason for farmer's time sharing.

Beatrice (2008) found that lacking of funds to start up business after training is one of limitation for improving participation level. As same as Beatrice, result of questionnaire shows that distribution of necessary materials for conducting sustainable agriculture is also important incentive for farmers. In addition, all of trainees of technical training at Thailand and Japan from

target group answered these kinds of technical training were surely one of incentives for keeping their time sharing. Therefore, project activities and relationship with implementer seems important factor to change participation level of target farmers.

Fig. 3 Making compost with supported compost box (left) and farmers learned how to make bio-fertilizer through technical training in Thailand (right)

Changes in Interests in Sustainable Agriculture of Farmers before and after the Project Implementation

For understand project impact toward awareness of farmers on sustainable agriculture, their interests in sustainable agriculture before and after the project implementation were compared (Table 2). Results of questionnaire survey showed that it was obvious that interest in sustainable agriculture of interviewee seems to change after the project implementation. As mentioned before, farmers increased their interest on sustainable agriculture through project activities such as meeting, technical training and practicing of techniques for sustainable agriculture.

Although almost all of farmers had interest to increase crops yield by conventional farming systems before the project, nobody hope to increase yield by conventional farming systems after the project implementation. It is because that farmers start to care more about their health and reduction of expense for agro-chemicals.

Table 2 Interests of farmers before and after the project implementation on April 2011

No.	Interest related to agricultural activities	Answer (N = 9)	
		(Before)	(After)
1	To increase yield of crops by applying chemical fertilizer and pesticide	8	0
2	To sell many kinds of crop to middleman	7	3
3	To grow crops with lower chemical input	5	8
4	To make higher quality compost	2	9
5	To use bio-fertilizer with higher quality	2	8
6	To use bio-pesticide with higher quality	2	9
7	To build up collaboration with private company	1	7
8	To build up collaboration with NGO (ERECON)	1	9

Source: Questionnaire survey in 2013, ERECON

In addition, almost all of interviewee increased their interest on improving technique for sustainable agriculture such as compost, bio-fertilizer and bio-pesticide. Target farmers also increased interest on build up collaboration with private company and NGO. It can be considered that farmers start to think collaboration with private company because the project tries to expand collaboration with private company in order to sell agricultural products widely. Some private companies visited and observed some farmers for checking possibility of further collaboration.

CONCLUSION

According to the results and discussion done in this study, participation level was level 2 on 2011 because target farmers just answered questions and consulted by implementer. Farmers also participated in activities after contents and schedule decided by implementer. However, it was changed to level 5 or 6 on 2013 and members of farmers' group start to communicate and share knowledge each other. In addition, key farmers especially committee members of farmers' group started to participating decision making on action plan and expanding techniques for sustainable agriculture to other farmers. Some farmers became participation level 7 because they consider and try to improve their circumstances by themselves.

Besides, it can be concluded that there are some incentives for improving farmer's participation level. These are 1) build motivation for learning, 2) relationship with implementer, 3) distribution of materials and 4) participation to technical training in other countries. In addition, project activities seem to change interest of farmers from conventional farming systems to sustainable farming systems.

It can be said that participation level was increased according to change of interests and build incentives on project activities from 2011 to 2013. So, for promoting sustainable farming systems effectively, further project needs to be designed for improving farmers' interests and incentives through various activities and communication between target farmers and project implementer.

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Research article

Cheese in a Suck: Exploring History, Production Area and Production Process of a Typical Herzegovinian Product

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Abstract Traditional and typical products have gained during the few last decades an important role in strategies for the development of remote rural regions. Herzegovina region is widely recognized and well-known for a unique gastronomic product; cheese in a suck. Uniqueness of this product derives from one phase of the production process - the ripening phase. The cheese ripens in sheep skin bags. Justification for choosing skin bag as a container for ripening and keeping cheese lies in history. The present research was carried out as the legal protection of a product with a Geographical Indication requires proofs of the historical existence of that product on a certain territory as well as the description of production technology and the mapping of the geographical area where product is made. The paper is based on an extended secondary data analysis and a field survey. Field research was carried out in 2011 using semi-structured interviews with a sample of 35 producer households - with a particular focus on women and the elderly - in the territory of Herzegovina. A checklist dealing mainly with the product history, the production area and the production technology and process of this typical Herzegovinian product was prepared for semi-structured interviews. Obtained results have proved that cheese in a suck has a long history and dates back to the 14th century in Herzegovina region. Usage of sheep skin bag as a packing material during the ripening process is a unique method itself. Cheese in a suck is a typical product connected with Dinara mountains in Herzegovina. Protection of cheese in suck will foster its contribution to the development of Herzegovinian rural areas.

Keywords cheese in a suck, history, production method, Herzegovina

INTRODUCTION

Among the leading trumps of the development of rural areas during the few last decades stand out high quality products that have age-lasting production history in a certain region. Such products have become a part of identity and cultural heritage of territories of origin. Probably the most famous gastronomic product of Herzegovina territory is cheese in a suck. In 2006 this cheese was inserted in a list of Presidia, products with unique characteristics, promoted by Slow Food.

With the reform of the Common Agricultural Policy (CAP) in 1992 and the introduction of rural development pillar, has been developed for the first time a clear framework and systematic approach for local and traditional products valorization. In parallel with the establishment of legal framework, has been developed academic literature on this topic. As a result of that typical products are no more seen only like foodstuff but, as Giovannucci et al. (2009) state, as a "*particularly interesting model for development*". Some countries have approached very seriously the model of rural areas development based on typical products valorization. This is particularly the case in countries such as Italy, France and Spain.

According to the World Intellectual Property Organisation (WIPO, 2010), a geographical indication (GI) is a sign used on goods that have a specific geographical origin and possess qualities, reputation or characteristics that are essentially attributable to that origin. When GIs are legally registered, they take such forms as Appellation of Origin (AO), Protected Designation of Origin (PDO) and Protected Geographical Indications (PGI) (Belletti et al., 2011).

Products deriving from a limited geographical area undoubtedly contribute to increasing the quality of life, of both producers and consumers. The introduction of an institutional system of protection of Geographical Indications (GI) and valorization of systems in which they exist contribute to faster and sustainable development of rural areas (Bramley, 2011).

Not any product can be considered as a typical one. Marescoti (in Brunori et al., 2006) identified four elements for defining typicality: embedded specific local resources; history and tradition of production; presence of local collective know-how; and a defined geographical area.

From these guidelines it is clear how much is important to collect all historical proofs about existence of some product on a certain territory. Also, it is of crucial importance to justify the reasons for the use of a specific local resource like sheep skin bag in the case of Herzegovinian cheese in a suck. Any product which pretends bearing a legal sign or label of known and protected geographical origin, or to be a Presidium of Slow Food, should comply with some criteria such as: to possess a distinctive quality that is defined by local practices and traditions; to be linked to the memory and identity of a producing group; and to be linked to a specific area. These facts gave a base for carrying out the present research on the elements of typicality for cheese in a suck.

The research was carried out with the purpose to prepare Bosnian-Herzegovinian typical products to be protected with Geographical Indications. The paper aims at providing some insights about the history, production area and production process of cheese in a suck.

METHODOLOGY

In order to protect a product with the name of a geographical area it is necessary, among other requirements, to create a product specification that includes: a) name to be protected, b) description of the product including raw materials, c) definition of the geographical area, and d) description of the production method (Regulation EU No 1151/2012).

The paper is based on an extended secondary data analysis and a field research carried out in 2011 with the members of 35 farmer households - especially women and elders - in eight municipalities of Herzegovina region: Berkovici (7 households), Bileca (1), Konjic (4), Ljubinje (3), Ljubuski (1), Posušje (1), Prozor/Rama (5), and Nevesinje (13). Data were collected by carrying out semi-structured interviews focusing on production history, area of production and traditional production method. Herzegovina (22% of the country area) is the southern region of Bosnia and Herzegovina. It is in general accepted that Herzegovina region's borders are Croatia (southwest), Montenegro (east), the *Maglić* Mountain (northeast), and *Ivan planina* (north).

RESULTS AND DISCUSSION

Cheese in a suck belongs to the group of semi-hard cheeses. It is made from cow, sheep or goat non-pasteurized milk, or milk mixture of these species. Written proofs from the 14th century confirm its presence since then in Herzegovina territory. The main uniqueness feature of this cheese derives from one producing phase, ripening, that is performed in a special sheep skin bag.

History of Production

For centuries the livelihood of inhabitants of Dinara Mountains was mainly based on livestock rising. Nomads used to move with their herds of sheep, cows, horses and other livestock in Dinara Mountains for more than six months per year. Since some centuries ago there were no means of transport or good roads, the main shepherds' and their families' foodstuffs were milk and dairy products. However, even so they did not manage using the whole produced milk. That was a serious problem especially in hot summer months as they had no coolers and other appliances that they could have used to store milk for a long period. So they could only rely on their innovativeness and ingenuity to find a solution to this problem and to avoid loosing milk, which represents one of few resources that they had.

It is commonly known since the earliest times that milk in a sheep skin coagulates by itself due to the action of existing ferments in sheep skin. It is assumed that people in ancient times wanted to use skin bag, not only for coagulation of milk, but also for keeping cheese for a longer period. Sheep skin proved to be a good utensil and was kept up to the present time. Thanks to that cheese in a suck has become a hallmark of Herzegovinian culinary heritage.

Existence of cheese in a suck in Herzegovina is evident in many written records, as well as through oral stories that have passed on through generations. Thus, Sarić (2009) in a study in the framework of "*Protection and valorization of agricultural products of interest for Herzegovina*" project states that there is written evidence of cheese production from the 14th century. According to the same author "*By the end of the 16th century Herzegovina donated cattle to Dubrovnik in unlimited quantities and up to 800 kg of cheese in a suck*". The same author further states: "*The earliest legal act in Turkish text for Branichevo province from 1487/8 listing the mandatory items that each household has to provide to the Bey states: one tent, three ropes, six halter, one cheese in a suck and one sheep....*". In the same text it is also stated: "*Cheese and cream are packed in sheep skin bags and with horses and donkeys brought to the Herzegovinian squares.*"

History bears secrets and gives answers about production technologies and processes chosen by communities at different times of their history. Scarce land resources, severe weather conditions, and ingenuity in subsistence options and strategies are just some of the many hypotheses that explain the emergence and survival of cheese production modes in Herzegovina as well as in the whole Dinaric. About the choice of keeping cheese ("Sir") into a skin bag, the Italian journalist Carlo Macchi (2006) wrote an amazing article entitled "*The Golden Fleece*". Here is a paragraph of the article: "*…I had also found answers to many "mythological" questions. I always wondered why the Argonauts were glad to risk their own lives searching for a golden mutton's skin, and now I know: they were looking for the "Sir" and not for the golden fleece. How much would a bunch of rough soldiers care for a simple, wrinkly (yet precious) skin? They were only looking for something to feast on, please their senses with, and thus feel closer to the gods…*".

Looking at the global level, similar technology for cheese ripening in sheep skin bags was observed only in Turkey specifically in Tulum cheese production area. However, as written evidence proves the presence of cheese in a suck in Herzegovina region before Ottomans empire advent in Balkans (Sarić, 2009), there is no doubt that cheese in a suck is a unique product of Dinara Mountains and as such is unique and inseparable from this geographical area.

Area of Production

Through history the area of production of cheese in a suck was linked to Dinara mountains, which stretches from Croatia through Bosnia and Herzegovina, Montenegro to Serbia. However, the

production of cheese in most of the areas where it was previously produced is almost entirely abandoned. It is now largely concentrated in specific Herzegovinian sites. As Sarić (2009) states: "*The area of cheese production is the whole region of Herzegovina. This area stretches from the border with Montenegro to the east, to the area of Livno and Kupres to the west which are Livano cheese producing areas. To the south the production area borders with Croatia, while on the north side includes Nevesinje, Konjic, Prozor-Rama and Kupres".*

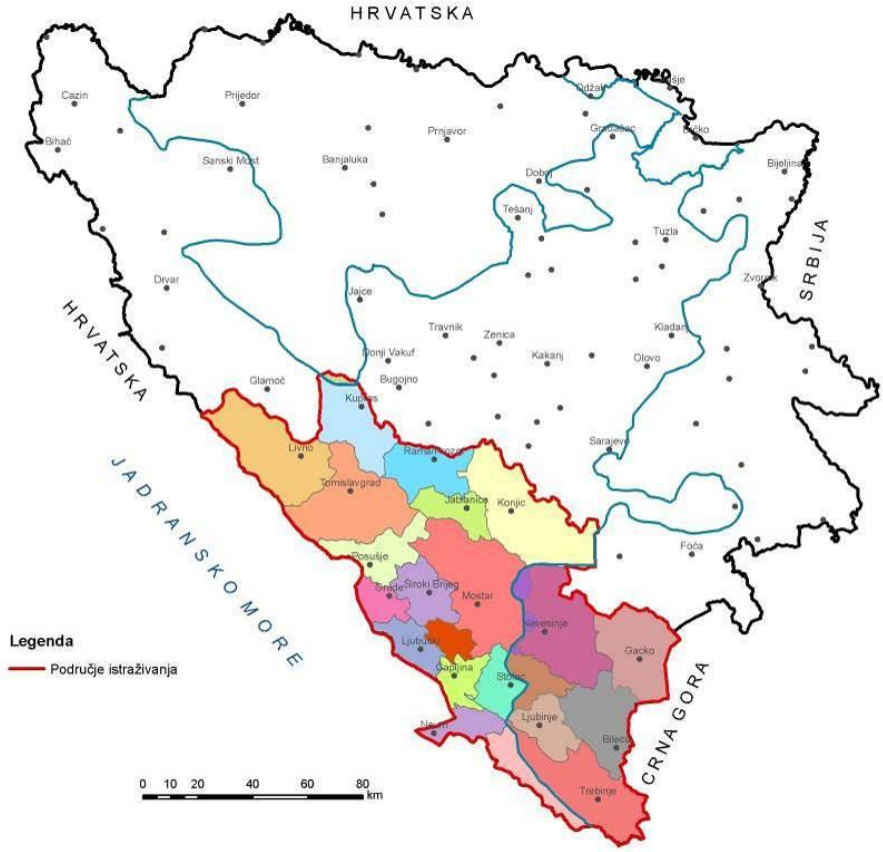

Fig 1 Territory of production

Traditional Method of Production

The main steps of the traditional method for the production of cheese in a suck are the following: preparing sheep skin bag; curdling of milk; whey separation; stacking and salting cheese in the bag; and ripening and storage of cheese (Table 1).

Geographical Indication (GI) products have positive effects on social features of communities from which they derive (Belletti et al., 2011). By improving market access, GIs can lead to higher incomes. But GIs have a further potential income effect through the collective process of value creation (Barjolle and Sylvander, 2000; Barjolle and Salvadori, 2010). The economic benefits of geographical indications come mainly from differentiation (Belletti et al., 2011; Moschini et al, 2008). GI overcome the dimension of pure economic benefit for producers and expands the range of effects on consumers, rural areas, and to entire regions and countries (Bramley, 2011). It is widely articulated that protected GIs may contribute to rural development (cf. Van de Kop et al., 2006; Zografos, 2008). Nevertheless, GI laws cannot by themselves guarantee benefits for rural development (Hughes, 2009; Belletti et al., 2011). These effects depend strongly on the quality of the supply chain governance (Hughes, 2009).

Table 1 Traditional production process

Production step	Description	Illustrations
Preparation of sheep skin bag	As the sheep skin bag is a basic element of uniqueness and typicality of cheese in suck, its proper preparation is of extreme importance for ripen cheese quality. Preparation of the suck is the phase that requires special craftsmanship and attention. After slaughtering sheep, suck is washed together with wool. Thereafter, the wool is shaved and the suck turned so that the inner part goes outside. With strong rope should be shut all holes on the suck, and then the suck is inflated and hanged and smoked for several days. When the suck overnights in smoke, without changing its shape, it means that it is not anywhere perforated and can be safely used for cheese ripening and storage. When the outside part of the suck gets smoked, then holes on the suck should be untied to let smoke get into inner parts. Smoked suck has to be washed properly, then inflated again to the point when easy handling during cheese inserting is possible (usually 1 to 2 days).	 *Prepared sheep skin bag*
Curdling of milk	Immediately after milking, milk should be filtrated through a thick woven cotton cloth and warmed to 35°C. According to producers from Nevesinje, in early cow lactation 10 liters of milk are needed to obtain 1 kg of cheese, while at the end of the lactation period only 5-6 liters are required. Rennet should be added to the filtrated and warm milk. The length of the curdling phase depends of strength of rennet and milk temperature. It can last between 1 and 1.5 hours. During curdling it is necessary to repeatedly stir the cheese mass. Curdling is complete when whey reaches yellow-green color and cheese begins to settle on the bottom of the pan.	 *Curdling of milk*
Whey separation	When cheese is settled on the bottom of the pan, the portion of the whey floating on the surface should be drained out. The remaining mass of cheese and whey should be transferred to another pot on whose surface has been previously put a cotton cloth. Then the edges of the cotton tissue have to be taken and gently squeezed by hands to remove as much whey as possible. After that, the wrapped and shaped cheese block has to be placed under the press e.g. large stone. The cheese remains under the stone for about 12 hours. Pressing should be done properly, as if in cheese pastry remains whey, it may create holes and give bitter, unpleasant taste to the cheese.	 *Separation of whey*
Stacking and salting cheese in the bag	Just before inserting cheese in the bag, cheese blocks should be broken by hands into smaller pieces and salted. To 30 kg cheese should be added 1 kg salt. Once salted, cheese should be left to overnight in order to drain out the rest of whey. Then, the salted and dry small pieces of cheese should be inserted in the skin bag through the "neck" hole of the suck, while all other openings should be closed. Several times during the insertion into the bag, cheese should be pressed with wooden beater or by hand, to avoid any possible formation of air rooms in the suck. When the suck is filled up, the neck should be tied and the suck transferred to the ripening room.	 *Inserting cheese pieces into the suck*
Ripening and storage of cheese	Cheese should be stored in dark rooms, specifically designated for this purpose, where the temperature is between 12°C and 15°C and humidity between 60% and 70%. The sucks are placed on a wooden plank in such a way that they do not touch each other during ripening. Sucks should be turned daily at the beginning of ripening and then less frequently. The ripening takes a minimum of two and a maximum of eight months. During the summer months it is necessary to maintain a consistent room temperature (ideally 12-15°C)	 *Ripening of cheese*
Last stage	At the end of the production process and after the removal of skins, the dry cheese takes the form of lumps of various sizes with a diameter not exceeding 10 cm. Cheese paste is white to yellowish.	

CONCLUSION

Traditional and typical products are the result of complex production systems strictly interrelated with many territorial dimensions. Geographical indications have positive effects on producers and the wider regions of origin. The legal protection of GI products is often conceived as a lever for activating local development dynamics and defending territorial production systems with a high degree of site specificity. However, achieving these dynamics is not a simple process and requires concerted efforts.

Revival and valorization of typical products ensures not only their legal recognition and protection and their economic development but is also a very promising model for the development of the region of origin. At the same time, it provides good benefits to different segments of communities, not just producers. Development advantages range from the provision of new socio-cultural values to the more tangible economic benefits (employment growth, higher incomes). In addition to direct benefits, there is a number of indirect ones (e.g. tourism).

The uniqueness of cheese in a suck makes this product very appealing not only as a foodstuff, but also as cultural heritage admired by all visitors of Herzegovina. The potential that this cheese bears should be utilized as a driver for fostering rural development in Herzegovina region.

One of the practical results of this research is drafting specifications for the production of the authentic traditional Herzegovinian cheese in a suck. This is a very important document for members of the Association of producers. Also, these specifications are intended to be used as a document for application to a protected geographical indication for cheese in a suck.

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Research article

In vitro Cultures and Colchicine-Induced Tetraploidy of Sundew (*Drosera spatulata* Labill.)

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Abstract Sundew (*Drosera spatulata* Labill.) has become a favorite ornamental plant because of their carnivorous nature, the beauty of their glistening traps and their value as medicinal herb. It is also because of their low propagation rate in their natural environment that *in vitro* propagation of carnivorous plants is pursued. The objective of this research was to cultivate sundew *in vitro* to increase its propagation rate. The tetraploid of *D. spatulata* was induced by the colchicine treatment, providing valuable plant material for further breeding programs. Plantlets of *D. spatulata* were cultured on MS agar medium (pH 5.4-5.8), and growth and survival rates were observed. The results showed the highest survival of 100 percent in an MS (pH 5.6) medium. Results observed after nine weeks showed that a 1/3MS (pH 5.6) medium promotes the highest growth with an average plant diameter of 25.95 mm. For tetraploids induction, plantlets were immersed in aqueous solutions of colchicine (6 and 12 mgl^{-1}) for the duration of one week. The effects of different concentrations on survival and growth were recorded. Putative polyploids were identified by stomata density and stomata size. The ploidy level was determined by chromosome counting. The survival rate of treated plantlets decreased in all treatments. The most efficient colchicine concentrations were in the range from 6 to 12 mgl^{-1}. The chromosome number of the tetraploid plants was $2n = 4x = 40$, while that of the control diploid plants was $2n = 2x = 20$. The diameter of the tetraploid plants increased, and the length of the leaves and number of inflorescences were more than those of the diploid. The tetraploid plants derived from exposure to colchicine exhibited variations, such as larger stomata and lower density of stomata.

Keywords *Drosera spatulata*, colchicine, tetraploid, micropropagation, MS media

INTRODUCTION

The genus *Drosera* (Droseraceae), commonly called sundew, is the largest group of carnivorous plants and consists of approximately170 species. *Drosera spatulata* Labill. is one of the most widespread sundews in nature. *D. spatulata* is a carnivorous species native to south-east Asia and Australia (Junipers et al., 1989).It is a rosette-forming spoon-leaved sundew. This species is widely variable, but generally plants are about 4 cm in diameter. Each leaf is attached to the central rosette by a narrow 8 mm long petiole that is only glandular on the upper half. Individual leaf laminae are typically 5 mm long and 4 mm wide. In early summer, plants will produce 8 cm tall erect shapes with around six small white or pink flowers on each one-sided racemose inflorescence. Each flower can be up to 6 mm across (International Carnivorous Plant Society, 2013).

Carnivorous plants are a phenomenon in the plant kingdom and are valued as ornamental plants. They capture their prey by means of specialized trapping devices, which is an additional way to obtain protein - a source of nitrogen that is essential for the proper development of all organisms (Williams and Bennet, 1982). Apart from their ornamental value, the *Drosera* has medicinal significance. Extracts of these plants, containing 1,4-naphthoquinones, are used as antispasmodic agents in the treatment of respiratory tract ailments (Junipers et al., 1989). Due to the pharmacological significance of *Drosera* spp., there is great demand for plant material that has been met mainly through the exploitation of natural resources. As a solution for saving endangered species as well as alternative sources of plant material for pharmacological purposes, *in vitro*

culture of plants from the Droseraceae family has been employed (Jayram and Prasad, 2005).

For *D. spatulata* the chromosome numbers of 2n= 20, 40, 50 and 60 have been reported (Rivadavia and Preto, 2005).Changes in chromosome numbers may be induced via exposure of plant tissue to various chemical preparations and forms of electromagnetic radiation (van Harten, 1998). Colchicine is an alkaloid derived from the bulbous plant *Colchicum autumnale* L. (autumn crocus) (Ranney, 2003; Eigsti and Dustin, 1955). The chemical induces tetraploidy by disrupting the metaphase stage of cellular mitosis through inhibition of the spinder fibers that segregate replicated chromosomes into daughter cells (Eigsti and Dustin, 1955; van Harten, 1998; Recupero, et al., 2005). Colchicine has been found to have a significant effect on polyploidy induction and thus has been widely used for inducing polyploidy in plants. Inducing polyploidy is an effective means for the generation of innovative germplasm resources suitable for selective breeding.

From a single plant cultivated *in vitro*, many genetically identical clonal lines can be obtained through vegetative propagation. This technique allows for an increase in the propagation rate of valuable plant material. *In vitro* micro-propagation offers a means of multiplication of ornamental plants, rare and endangered species, as well as plants that are a source of secondary metabolites. Mitotic polyploidization induced through chemical treatment was also used to increase the genetic variability. Polyploids exhibiting valuable new phenotypic traits can occupy new niches and become agricultural and horticultural importance.

OBJECTIVE

The aim of this research was to develop the *in vitro* micro-propagation of *D. spatulata* through optimization of the culture medium and its pH to increase the propagation rate. The application of colchicine to induce tetraploidy in *D. spatulata* was also determined.

METHODOLOGY

Plant materials and growth conditions: The seeds of *D. spatulata* were surface sterilized and cultured on Murashige and Skoog (1962) for 18 months. Once the cultures were established, these plantlets were used as initial materials in all experiments. The plants were maintained at 25±2 °C under 8 h photoperiods with a light intensity of 3,200 lux. The experiments were carried out during 2012-2013 at the Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi, Pathumthani, Thailand.

Effect of pH levels: The plantlets were cultured on Murashige and Skoog (MS) basal medium, containing 3% (w/v) sucrose and 0.7% (w/v) agar at pH 5.4, 5.6 and 5.8. For each treatment four replications of 16 plantlets were tested. The experiment was repeated two times and data were recorded on survival rate, plant diameter, and the length and width of leaf for 7 weeks.

Effect of different strengths of MS medium: The experiment was carried out in a completely randomized design (CRD) with four replications of 16 plantlets. The plantlets were cultured on the different strengths of MS medium (1/3, 1/2 and full strength) at the optimum pH based on the previous experiment. Their survival rate, plant diameter, and the length and width of leaf over the course of 9 weeks were observed and recorded.

Tetraploid induction: In order to compare the effect of colchicine on *D. spatulata*, the plantlets were transferred to an MS medium for five weeks prior to the tetraploid induction. The experiment was carried out in a completely randomized design (CRD) with three replications of 12 plantlets. For inducing tetraploidy, the plantlets were immersed in aqueous solutions of colchicine (0, 6 and 12 mgl^{-1}) on a rotary shaker at 25±2 °C in the dark for one week. The plantlets were then cultured on an MS medium at pH 5.6. The effects of colchicine on the survival and growth of plantlets were recorded over the course of five weeks. Putative polyploids were identified by measuring the density and size of stomata. The ploidy level was determined by chromosome counting.

Morphological observation of diploid and tetraploid plants: A set of morphological characters were measured. Plant diameter and the length and width of leaf were measured. The width and length of stomata in the lower epidermis of mature leaves were measured using an eyepiece

micrometer. The stomatal density was also observed.

Chromosome preparation: Root tips of ~1.5 cm in length were excised and immersed in 0.002 M 8-hydroxy quinolone at 4 °Cfor 2-3 hours and washed with distilled water before fixing in 3:1 ethanol: glacial acetic acid at 4 °Cfor 24 hours. These were then digested in 10% HCl at 60 °C for 10 minutes and washed 3 times with distilled water. Root tips were stained with basic fuchsine at 4 °C for 30-45 minutes in the dark. Afterwards, the root tips were stained with 2% (w/v) aceto-carmine and squashed. The number of chromosomes was observed under a light microscope (Olympus CX21, Japan).

Statistical analysis: Comparisons of quantitative data between two variable groups were made using student's *t*-test and morphological variation rates were subjected to an analysis of variance (ANOVA) and multiple comparisons; these factors were analyzed using Duncan's New Multiple Range Test (DMRT) or Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Effect of pH Levels

The pH levels had an effect on the plantlets at the second week after cultured in an MS medium. Percentage of surviving plantlets was very low at pH 5.4 (18.75%) and was higher at pH 5.8 (87.5%), while all plantlets survived at pH 5.6. Survival was severely inhibited in more acidic media (pH 5.4).The results showed a highly significant difference on plants diameter and length of leaf, but no significant difference on leaf width after 7 weeks. Plant diameter and length of leaf of *D. spatulata* at pH 5.6 (23.22 and 14.09 mm) were observed to be higher than at pH 5.8 (17.19 and 9.16 mm) (Table 1; Fig. 1). These results were similar to those of Jayaram and Prasad (2007), which found that the highest percentage of shoot proliferation observed in *D. indica* were at pH 5.7. However, the effect of pH levels on nutrient uptake and shoot proliferation has also been reported (Parliman et al., 1982).

Table 1 Effect of pH levels on plant diameter, length and width of leaf in *D. spatulata*

pH	Plant diameter (mm)	Leaf length (mm)	Leaf width (mm)
MS pH 5.6	23.22±0.27[1/]	14.09±0.65	4.79±0.08
MS pH 5.8	17.19±0.97	9.16±0.35	4.84±0.28
sig.(2-tailed)	0.006	0.001	0.798
t-test	**	**	ns

**, ** indicate significant difference by student's t-test at 5% and 1% levels of probability, respectively.*
ns = not significant [1/]Data represent means± S.D. of four replications each.

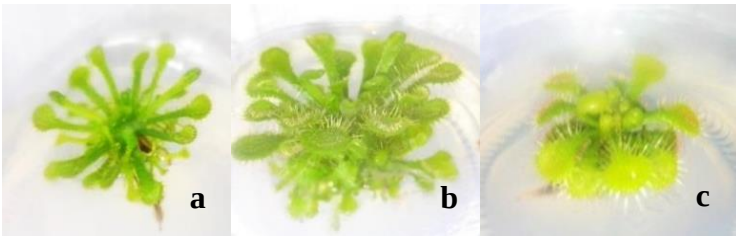

Fig. 1 *D. spatulata* after 7 weeks of culture in an MS medium at pH 5.4(a), 5.6(b) and 5.8(c)

Effect of Different Strengths of MS Medium

The plantlets survived in all strengths of MS medium. Plant diameter and length of leaf exhibited highly significant differences in the fourth week. The results showed no significant difference after nine weeks. Plant diameter and length of leaf were 25.95, 24.61, 25.81 and13.31, 12.84, 13.57 mm after 9 weeks in 1/3, 1/2 and full strength MS, respectively. The width of leaf showed a highly significant difference after 9 weeks. The width of leaf were 5.65, 5.39, 4.50 mm after 9 weeks in

1/3, 1/2 and full strength MS, respectively (Table 2; Fig. 2). The strength of MS medium was not related to the survival rate of *D. spatulata*, but had an effect on growth and development of the plantlets during the first four weeks. According to Kim and Jang (2004), the shoot proliferation and tuber formation of *D. peltata* were most effective on 1/2 MS medium at pH 5.7. Carnivorous plants usually grow in nutrient-poor environments and in poor soils; carnivore, therefore, has evolved as an additional pathway to supplement nutrients such as nitrogen and phosphorus (Adamec, 1997).

Table 2 Effect of different strengths of MS medium on plant diameter, length and width of leaf of *D. spatulata* after 9 weeks of culture at pH 5.6

MS strength	Plant diameter (mm)	Leaflength(mm)	Leafwidth(mm)
1/3MS	25.95	13.31	5.65 [a]
1/2 MS	24.61	12.84	5.39 [a]
MS	25.81	13.57	4.50 [b]
F-test	ns	ns	**
CV (%)	7.61	6.18	7.25

Means in columns followed by different letters are significant difference at 5% level according to DMRT
**, ** indicate significance at 5% and 1% levels of probability, respectively. ns = not significant*

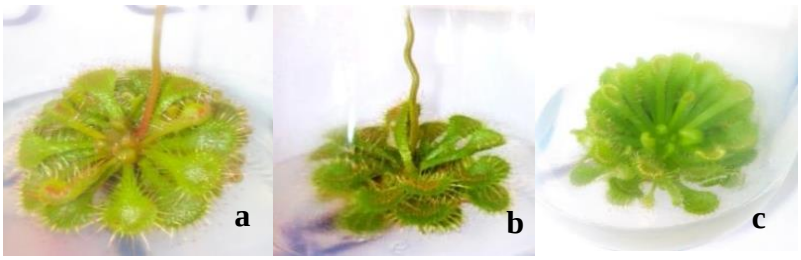

Fig. 2 *D. spatulata* on 1/3 MS (a),1/2 MS(b),and MS (c) after 9 weeks of culture at pH 5.6

Induction and Identification of Tetraploid *D. spatulata*

Twenty-four out of 36 (66.7%) colchicine-treated plants survived after five weeks in all treatments. The plant diameter and length of leaf of colchicine-treated plants (35.48, 35.28 and 20.76, 20.42 mm) were significantly larger than those in not colchicine-treated (30.02 and 17.33 mm) (Table 3). The numbers of stomata of colchicine-treated plants (4.40 and 4.40 cells) were significantly less than those not colchicine-treated (5.22 cells). The width and length of stomata of colchicine-treated plants (38.75, 37.93 and 50.43, 46.37 µm) were significantly larger than those of not colchicine-treated (33.87 and 37.43 µm) (Table 3; Fig. 3). Furthermore, the earlier group matured with 2 or more inflorescences in some colchicine-treated plants. The chromosome number from root tips of *D. spatulata* in non-treated colchicine were 20 chromosomes, whereas 40 chromosomes resulted from treated colchicine at 6 and 12 mg l^{-1}.

Table 3 Effect of colchicine treatment on growth, number and size of stomata of *D. spatulata* on MS medium at pH 5.6 after 5 weeks

Colchicine Concentration (mg l^{-1})	Plant diameter (mm)	Leaf length (mm)	Leaf width (mm)	Survival rate (%)	Number of stomata (cell)	Size of stomata (µm)	
						width	length
0	30.02 [b]	17.33 [b]	4.34	66.66	5.22 [a]	33.87 [b]	37.43 [b]
6	35.28 [a]	20.42 [a]	4.68	66.66	4.40 [b]	37.93 [a]	46.37 [a]
12	35.48 [a]	20.76 [a]	4.81	66.66	4.40 [b]	38.75 [a]	50.43 [a]
F-test	*	*	ns	-	**	*	*
CV (%)	4.87	6.21	7.91	-	7.16	6.83	10.92

Means in columns followed by different letters are significant difference at 5% level according to LSD
**, ** indicate significance at 5% and 1% levels of probability, respectively. ns = not significant*

Hence, the tetraploid induction using colchicine treatment at 6 and 12mg l^{-1} can double chromosomes from 2n=2x=20 to 2n=4x=40 (Fig. 3). Increases in ploidy can affect very specific traits, including plant diameter, length of leaf, number and size of stomata in *D. spatulata*. Key morphological variations observed in tetraploid plants included larger and thicker leaves, darker green coloration, larger stomata, lower stomata across the lower leaf epidermis, increased numbers of chloroplasts in the stomata guard cells and increased pollen diameter (Glowacka et al., 2010).

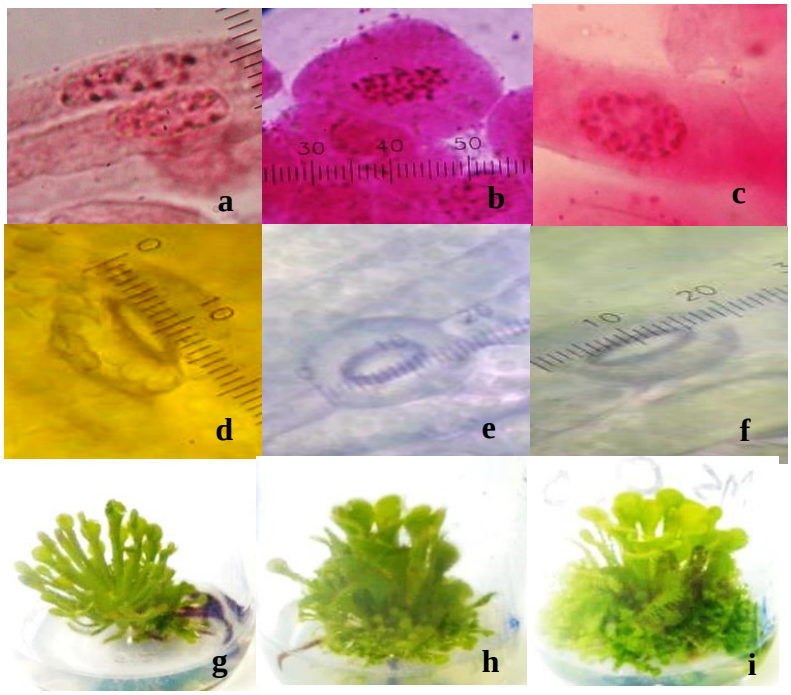

Fig. 3 Effect of the colchicine treatment on chromosome number, size of stomata and growth of *D. spatulata* at 0 (a, d,g), 6 (b, e,h) and 12 (c, f,i) mg l^{-1}after 5 weeks

CONCLUSION

A pH level of 5.4 had a highly significant effect on the rate of survival and growth of the plants. More than 80% died after cultured in an MS medium for 2 weeks. The growth of *D. spatulata* was limited due to sensitivity of low pH levels. The 1/3 MS medium at pH 5.6 was the most effective medium for the micro-propagation of *D. spatulata*. Moreover, the plants exhibited leaves with red color, which are valuable and popular phenotypic traits and have market demand. Tetraploid induction affected plant diameter and length of leaf. A concentration of colchicine at 12 mg l^{-1} gave the maximum plant diameter and length of leaf of 35.48 and 20.76 mm, respectively. The numbers of stomata decreased in all colchicine-treated plants in contrast to the sizes of stomata, which increased. The chromosome number of colchicine-treated plants doubled (2n=40).Successful use of colchicine to induce tetraploids in *D. spatulata* demonstrate an effective means to explore new characteristics by increasing genetic variability for plant breeding in agriculture.

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Research article

Using of Para-rubber to Develop Properties of Concrete Block Mixed with Ethylene Vinyl Acetate Plastic in Masonry

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Abstract The aim of this research is to use Para-rubber (vulcanized latex) as an admixture for improving the properties of EVA plastic waste concrete block. In mix design, cement per EVA plastic waste per quarry dust per water ratio is 1:0.5:4:1.6 by weight, vulcanized latex per cement ratios are 0.00, 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, and 0.45 respectively (by weight of cement), no charge surfactant is 4% (by weight of vulcanized latex). The suitable ratio of vulcanized latex per cement in this testing is 0.15 (by weight of cement). The properties are obtained as follows. 1) The average density in 14 days is 1,169.59 kg/m^3. 2) The average water absorption in 14 days is 9.33%. 3) The average compressive strength in 28 days is 25.74 ksc. 4) The coefficient of thermal conductivity is 0.1527 W/m.K. 5). The sound absorption coefficient at 2,000 hertz is 0.38. 6) The noise reduction coefficient is 0.3. It can be seen that many properties are better than normal EVA plastic waste concrete blocks.

Keywords vulcanized latex, EVA plastic waste, concrete block, thermal conductivity

INTRODUCTION

Ethylene Vinyl Acetate (EVA) is the one of light weight garbage, ex. slippers, sport shoe sole, plastic cones etc. Even though the EVA can be reused by melting, the recycle product's quality is dropped more than the previous product. Then the additives need to be used in products so that the products quality will be better. That affects to the costs in the industry, for example shoe products that produced in Thailand as the fifth largest exporter in the world. Because of low density, sound absorption and thermal insulation properties of the EVA, the researcher did an experiment by mixing the small crushed the EVA in concrete block. Then the result showed that the EVA with proper size and strength had good adhesion with cement. The concrete could hold together tightly as single mass. Therefore this concrete had higher properties than the general concrete; their weight is only 3 kg per piece and the density is 640 kg/m^3, while the general concrete has weight about 8 kg per piece and the density is 1,700 kg/m^3. That is similar as light weight concrete and this concrete could be used together with plaster as same as general concrete block. However the concrete block with the EVA will be complete and could be worked properly, if their properties about low water imperviousness and tension and bending were developed by mixing with the Para-rubber (vulcanized latex) (Khamput, 2007a). Then the using Para-rubber to develop the properties of concrete block mixed with plastic EVA scraps is the wall construction innovation which has many outstanding properties as the user requires. Moreover, this innovation is friendly with environment, suitable price and could be produced to concrete block.

OBJECTIVE

The objective of this research is to study about the physical properties, mechanical properties, and thermal insulation properties of the EVA, plastic waste concrete block mixed with the Para-rubber.

METHODOLOGY

Materials and Equipments

The materials and equipments are used as follows. (1) Vulcanized latex tense 60% preserved with high ammonia (HA). (2) Ethylene Vinyl Acetate scraps from shoe factories, crushed by plastic grinder with sieve size no.4 (4.75 mm) as Fig. 1. (3) Sieved quarry dust from sieve no.4 (4) Normal Portland cement (type 1) (5) Tap water (6) Nonionic Surfactants or Alkyl phenol polyethylene glycol ether. (7) Weighing apparatus (8) Solid concrete block mold size 1.5x30x30 cm^3. (9) Solid concrete block mold size 7.5x20x60 cm^3. (10) Hollow concrete block mold size 7x19x39 cu.cm. (11) Automatic concrete mixer (12) Plastic grinder with sieve no.4 (13) Hydraulic Compactor (as same as producing the general concrete block) (14) Temperature testing room (size 1x2x2.5 m^3). 2 rooms, walls lined with thermal insulation 5 sides in front of the wall using Acrylic and inside set up heat sources (1,000 watt spotlight) temperature, humidity measuring tool, and stopwatch.

Fig. 1 Crushed EVA plastic scrap

Fig.2 EVA concrete block

Mixture Ratio Specification

Specify the ratio of EVA concrete block mixed with vulcanized latex by considering the proper vulcanized volume per concrete block as Table 1.

Table 1 Ratios of EVA concrete block mixed with vulcanized latex for testing (by weight)

Ratio	Cement	EVA	Quarry dust	Water	Pre-vulcanized latex (dried latex weight)	Nonionic surfactants substances
NOR	1	-	10	0.9	-	-
P0.00	1	0.5	4	1.6	-	-
P0.05	1	0.5	4	1.6	0.050	0.002
P0.10	1	0.5	4	1.6	0.100	0.004
P0.15	1	0.5	4	1.6	0.150	0.006
P0.20	1	0.5	4	1.6	0.200	0.008
P0.25	1	0.5	4	1.6	0.250	0.010
P0.30	1	0.5	4	1.6	0.300	0.012
P0.35	1	0.5	4	1.6	0.350	0.014
P0.40	1	0.5	4	1.6	0.400	0.016
P0.45	1	0.5	4	1.6	0.450	0.018

Note: The ratio of civil engineering principles by considering to civil engineer who utilize from this research by comparing from cement weight 1 part and dried latex weight tested from percent test of total solid content (TSC).

Concrete Block Forming

For forming of EVA concrete block mixed with vulcanized latex is focused on the forming process as same as production process of general concrete block at most following. (1) Measure the mixture of concrete block by a predetermined ratio. (2) Divide water for mixing to 3 parts and specify 2 parts from 3 parts mixed with vulcanized latex and nonionic surfactants substances. (3) Prepare the concrete mixer which could preserve the fresh concrete in the damp condition. (4) Divide the cement (binder) to 3 parts and bring the binder part 1 and water (without mixed with vulcanized latex and nonionic surfactants substances) in the mixing drum respectively. (5) Add the quarry dust and EVA scrap about half of the total and mixed well. (6) After that add the rest of quarry dust and EVA scrap with cement part 2 and spray the liquid (mixed with vulcanized latex and nonionic surfactants substances) about a half of total liquid. (7) While mixing all materials add gradually the rest of cement and spray the last liquid too. (8) Mix mixture well not more than 10 minutes (9) Do forming the concrete block by hydraulic compaction machine. (10) Remove the concrete block from mold and incubate the forming concrete in the air and indoor.

Property Test

The physical and mechanical properties of EVA concrete block mixed with vulcanized latex is tested according the TIS standard 58-2533 (TIS, 1990) and ASTM (ASTM, 2010) (10 samples per test) following. (1) Enlarge image by Scanning Electron Microscope (SEM) at period age 28 days. (2) Density test at period age 14 days (3) Compression test at period age 7, 14, 21 and 28 days, test 30 examples per a ratio. (4) Water absorption test at period age 14 days (5) Drying shrinkage or length changing test at period age 14 days (6) Thermal coefficient test by forming the concrete block with size 15x30x30 cu.cm at period age 14 days according to ASTM C177-10 (ASTM, 2010) (7) Thermal insulation test with room size 1x2x2.5 cu.m. 2 rooms the walls are made of plywood and zinc lined with thermal insulation 5 sides in front of the wall using Acrylic and inside set up heat sources (1,000 watt spotlight), temperature-humidity measuring tool, and stopwatch. (8) Burning rate test at period age 14 days according to ASTM D635-10 (ASTM, 2010) (9) Sound absorption test at period age 14 days according to ASTM C423-10 (ASTM, 2010).

RESULTS AND DISCUSSION

Enlarging Image

Enlarging image by Scanning Electron Microscope (SEM) magnificent x 2,000, as in Fig. 3 that aggregates and chemical bonding of concrete block as mortar, EVA plastic scraps, quarry dust were coated and inserted in the cavity or gap by Para-rubber film (Ohama, 1987). As a result of the film plate and rubber were inserted in the concrete block which affected to the reducing gap of EVA concrete block.

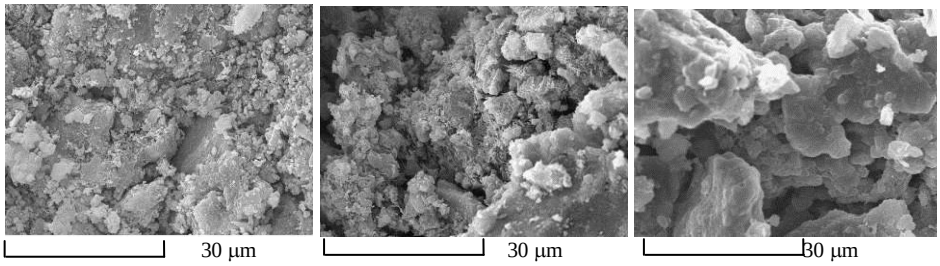

Fig. 3 Enlarging image of EVA concrete block mixed vulcanized latex

Density Test

From the Fig. 4, the vulcanized latex which was mixed in the EVA concrete block effected to the reduced density. The EVA concrete block mixed much vulcanized latex had the low density. The EVA concrete block mixed with less vulcanized latex or without vulcanized latex had the high density. The density of EVA concrete block mixed with vulcanized latex in the highest volume had the low density about 1,150 kg/m^3 while the EVA concrete block without mixing of vulcanized latex had the high density about 1,250 kg/m^3. Because the Para-rubber or film plate from vulcanized latex had the density much lower than the concrete (Ohama, 1987), the Para-rubber was binding as a big lump. When the mixing volume of vulcanized latex in concrete was high, there was much gap in the tract of concrete block.

Water Absorption Test

The results of water absorption of EVA concrete block mixed with the vulcanized latex in the various volumes could be summarized as Fig. 5. The adding of vulcanized latex volume in EVA concrete block affected to the reduced water absorption. The EVA concrete block without mixing of vulcanized latex showed the value of water absorption about 13%. When the vulcanized latex was added about 0.20 of the weight of the cement, the water absorption would be reduced about 9%. Because the film plate from the reaction of cement and vulcanized latex was inserted in the texture of EVA concrete block, this film plate was the water denser material (Ohama, 1987). However, from the testing of the water absorption all types of EVA concrete block had the water absorption lower than TIS standard 58-2533. This limitation was not more than 25% in all conditions.

Drying Shrinkage Test

From the Fig. 6, the vulcanized latex could help to reduce the drying shrinkage value which was occurred due to humidity loss through a capillary pore (Aly and Sanjayan, 2010). That affected to changes of the length and volume of concrete block. Normally the EVA scrap was the water absorbing material. Then the EVA concrete block had the drying shrinkage lower than normal concrete block. When the vulcanized latex, whose characters were as film plate inserted in the concrete block, was used for mixing in the concrete block, the water in concrete block was difficult to lose. Therefore the drying shrinkage from water loss (Khamput, 2007b) was quite nearly happened less than the concrete block without mixing the vulcanized latex. The particle of rubber film inserted as film plate in various gaps could help for the difficult shrinkage and expansion.

Compression Test

From the results of the compression or compressive strength test of EVA concrete block mixed with vulcanized latex that could be summarized by division of mixtures ratio as Fig. 7. The proper mixing of vulcanized latex in EVA concrete block could develop the various properties. The compression property was reached to TIS standard 58-2533. That was defined not more 25 ksc. The highest limit of mixing the vulcanized latex was not more than 0.15 of cement weight and their compression was still higher than 25 ksc because the mixing of vulcanized latex could make the compression reduced (Khamput, 2007b). Because the Para-rubber film were the polymer material which were cohesive, high flexible, not sturdy like aggregates, so the space for compressive strength was reduced due to mixing of vulcanized latex in high volume.

Thermal Conductivity Test

The result of thermal conductivity, coefficient of EVA concrete block mixed with vulcanized latex according to ASTM C177-10 (ASTM, 2010) operated the testing by Department of Science Service,

Ministry of Science and Technology Thailand presented as Fig. 8. The vulcanized latex could help to reduce the thermal conductivity coefficient of EVA concrete block by adding the highest vulcanized latex volume. That was the best way for reducing the thermal conductivity coefficient; from the mixing of vulcanized latex about 0.20 of cement weight. Their thermal conductivity coefficient was lower than the adding of vulcanized latex volume at 0.05 of cement weight and without mixing of vulcanized latex. Because the rubber film was the good material for the thermal insulation (McCrum et al., 1997), and while mixing the vulcanized latex in concrete block produced the air bubble in the flesh of concrete block (Khamput, 2007b), that made the density and the thermal conductivity, coefficient reduced.

Thermal Insulation Test

From the result of thermal insulation test in Fig. 9, the EVA concrete block mixed with vulcanized latex could reduce the temperature in the testing room lower than the EVA concrete block without mixing the vulcanized latex about 1 degree Celsius. That was lower than general concrete about 2 degrees Celsius which were related with the result of the thermal conductivity coefficient test.

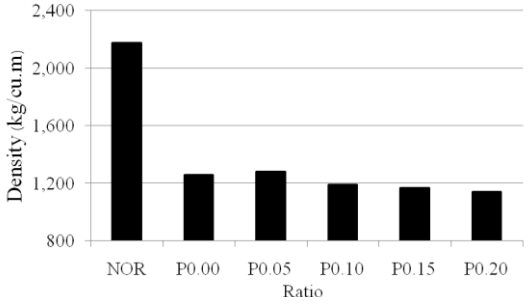

Fig. 4 The results of density

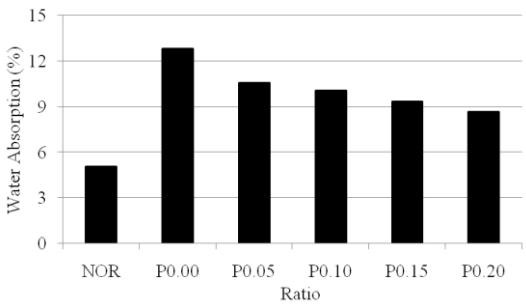

Fig. 5 The results of water absorption

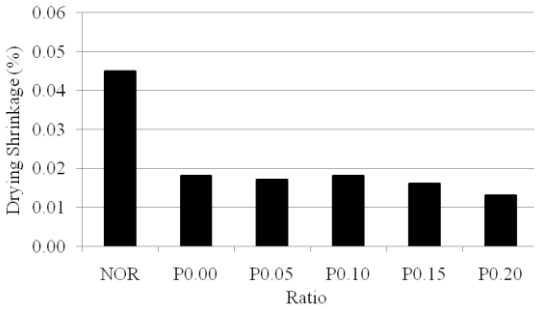

Fig. 6 The results of drying shrinkage

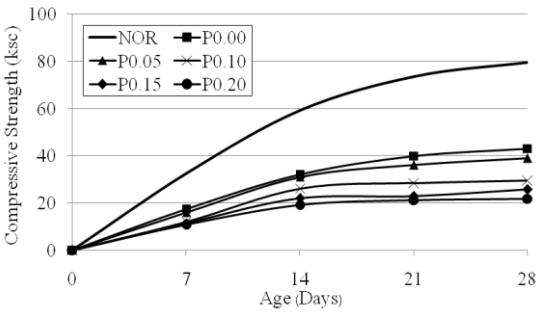

Fig. 7 The resuls of compressive strength

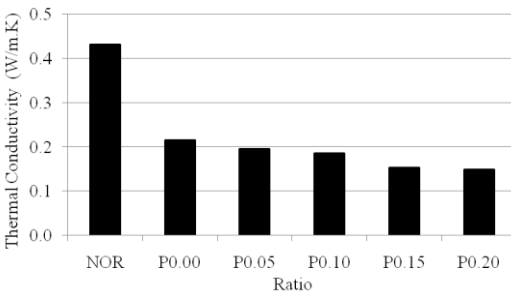

Fig. 8 The results of thermal conductivity

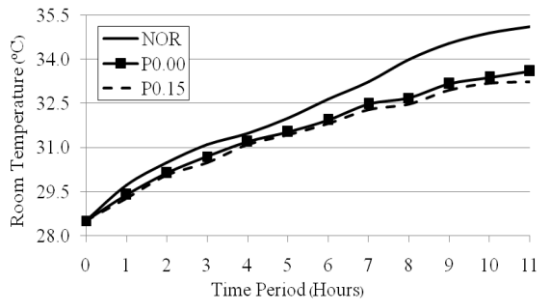

Fig. 9 The results of thermal insulation

Burning Rate Test

From the test of fire according to ASTM D635-10 (ASTM, 2010) to find out the burn rate value, the EVA concrete block mixed with vulcanized latex had no fire property because the most tract of concrete block was not easy flammable. The vulcanized latex and EVA scrap inserted in the flesh of concrete block was not melt continuously, then that was not flammable and could be used usual. The concrete block was practically used by laying brick wall and plastering with thick mortar about 1-2 cm. The flammability was difficult to happened because that depends on 3 factors; heat, fuel and air. The plastering was the thermal and air insulation for the concrete block while burning.

Sound Absorption Test

From NRC of various concrete blocks as Table 2 that showed the efficacy of EVA concrete block to prevent the noise on the medium level. The process to develop the efficacy of sound absorption was the adding of much vulcanized latex volume because of the flexibility of polymer inserted inside in concrete block; EVA scraps, rubber and film plate could help to absorb the sound energy as good as compared them with using the thick carpet as sound absorbed materials.

Table 2 Results of sound absorption coefficient and the noise reduction coefficient

Thickness(cm)	Ratio	Sound absorption coefficient				
		250	500	1,000	2,000	NRC
	NOR	0.044	0.054	0.097	0.082	0.07
7.5	P0.00	0.17	0.19	0.36	0.38	0.28
included	P0.05	0.19	0.25	0.36	0.37	0.29
gaps	P0.10	0.21	0.24	0.36	0.37	0.30
	P0.15	0.22	0.25	0.36	0.38	0.30
	P0.20	0.23	0.26	0.35	0.38	0.31

CONCLUSION

Vulcanized latex could help to develop some property of the EVA concrete block; reducing of density, water absorption, drying shrinkage and thermal conductivity coefficient and adding some property of sound absorption, thermal insulation and non flammability. Nevertheless the mixing of vulcanized latex overmuch could make the compressive strength reduced and the costs of EVA concrete block would be higher. The vulcanized latex volume about 0.05 of cement weight (ratio P0.15) had a good property reached TIS standard 58-2533 (TIS, 1990) and the cost was not so high. After comparing with the wall materials in the construction market; concrete block and light weight, block the EVA concrete block mixed with vulcanized latex had better property than the general concrete block. This EVA concrete block had similar property with light weight block but their costs were less than light weight block. Moreover the vulcanized latex could reduce water absorption problem. That made the EVA concrete block easy to plaster and mortar.

ACKNOWLEDGEMENTS

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Research article

Fundamental Solutions to the Process of Labour Restructuring in Svay Rieng Province, Cambodia

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Abstract This paper explores the current labour restructuring in Svay Rieng province which is basic for proposing main solutions to stipulate the process of labour restructuring of the study area. Results show that labour is the decisive factor in the organization and effective use of sources of capital, natural resources and technologies. If it is not based on the high development of physical labor, level of education, technical knowhow and management experience, it can lead to a waste of money or depletion and destruction of other resources. The province of Svay Rieng has the advantage of an abundant and young workforce. However, in recent years the use and promotion of the workforce for economic development has not really proved effective. One of the factors leading to this situation is that the province's labour restructuring is not identical with the provincial economic restructuring; therefore, Svay Rieng province should take measures to take actions that impacts on the processes of labour restructuring, marking contributions to the effective use of this workforce and the improvement of the province's socio-economic development.

Keywords labour restructuring, economic restructuring, human resources, socio-economic development, effective use of labour

INTRODUCTION

Svay Rieng province is located on Cambodia's south-eastern border with Vietnam. It's 125km from Phnom Penh. In recent years, Svay Rieng province has made great achievements in its socio-economic development. The province's GDP has continuously increased over the past few years. In 2012, its GDP was valued at 5.080 billion riel, nearly 1.57% higher than in 2007, an average increase of 8.6% per year (Svay Rieng Administration, 2012). However, compared with the whole country, Svay Rieng remains a poor province as its GDP per capita is still low. This indicates that the use of existing resources including the labour force in the province is not really effective. At the present, Svay Rieng province has an abundant young workforce. In 2012, there were approximately 585,571 labourers throughout the whole province. Nevertheless, its current labour restructuring is still irrelevant in comparison with the economic restructuring, and this has caused negative effects to the processes of socio-economic development in recent years.

OBJECTIVES

The objectives of research are: 1) to identify the situation of labour restructuring in Svay Rieng province in recent years; 2) To determine the basic solutions to promote labour restructuring in Svay Rieng province.

METHODOLOGY

The research was done by using both all available secondary data from Provincial Department of Planning and Provincial Department of Agriculture and its related information with direct observation in the research area. This was in order to understand overall situation and propose fundamental solutions to the process of labour restructuring in Svay Rieng province.

RESULT AND DISCUSSION

Situation of Labour Restructuring in Svay Rieng Province in Recent Years

Economic restructuring is always associated with the processes of Labour restructuring. There is a young and abundant workforce in Svay Rieng province. In recent years, although the structure of labour has transformed more appropriately than before, the speed of labour restructuring has not kept pace with economic restructuring; and high efficiency in the process of economic development has not been achieved (comparing between Fig.1 and Fig.2).

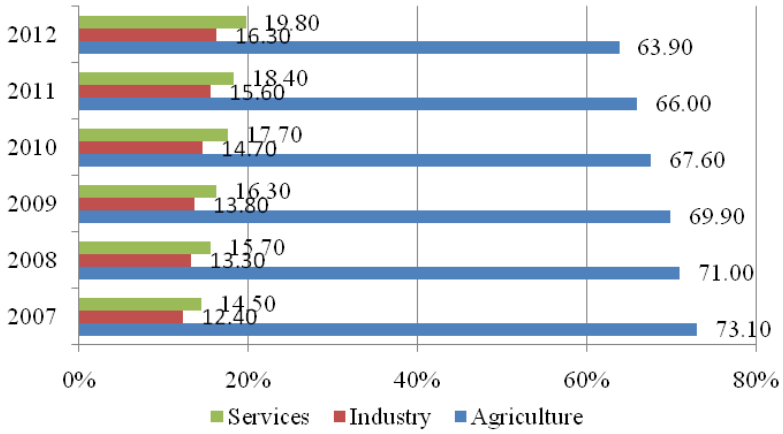

Fig. 1 Labor restructuring distributed in terms of sectors over the past years

Labour restructuring has shifted with an increase in the number of works employed in the sectors of service and industry. In 2012, by the economic growth rate, the service sector accounted for 19.8%, an average increase of 0.64% or 3,747 labourers per year, the sector of industry accounted for 16.3%, an average increase of 0.56% or 3,279 labourers per year, and the sector of agriculture accounted for 63.9%, an average decrease of 0.27% or 1,581 labourers per year (Svay Rieng Province, 2007-2012).

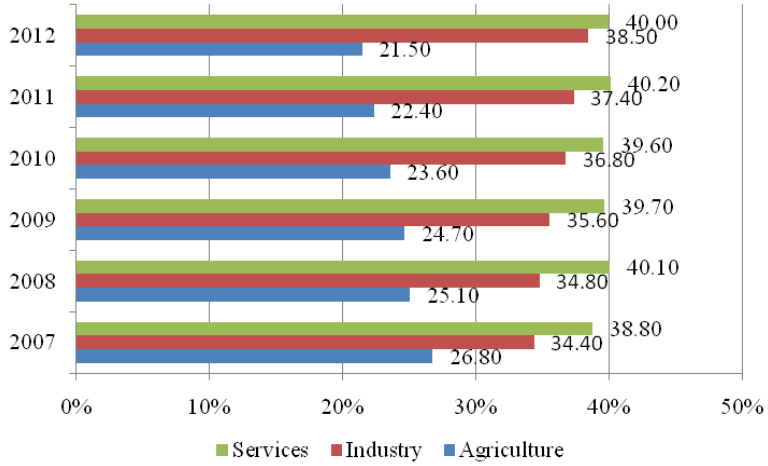

Fig. 2 Restructuring in economic sectors over the past years

Economic restructuring has shifted with an increase in the proportion of services and industry. In 2012, services accounted for 40% by the economic growth rate, an average decrease of 0.06% per year, industry accounted for 38.5%, an average increase of 0.23% per year and agriculture accounted for 21.5% an average decrease of 0.43% per year. It can be seen that the economic restructuring and labour restructuring of the province have shifted, with an increase in the scale and proportion, towards industry and services. However, the labour restructuring and economic restructuring is not identical; i.e, the structure of labour is ranged as follows: Agriculture - Services - Industry, but the economic structure is Industry - Services - Agriculture. In 2012, agriculture productivity in Svay Rieng was valued at 6,080 million riel (at the comparative price and this was also the sector that had the lowest productivity); however; 61.2% of the workers were employed in this sector and its scale increased due to the effects of population size. This resulted in a shortage of workforce in industry and services, but a surplus of labour in agriculture. In this way, disproportionate factors between labour restructuring and economic restructuring have affected the socio-economic development of Svay Rieng province over the past few years. The main reason for this disproportion is that:

- The majority of Svay Rieng's labourers live in the countryside so that they are influenced by rural ways of living and working with agriculture styles; hence, their adaptability and working manners in new environment is restricted. The province's labourers have low educational and professional levels, so they face difficulties in production when employed in the industrial sectors that require high professional and technological levels.
- The use of labour in economic sectors is not really effective. Even though industry and services have created more jobs and attracted more workers than before, the labourers employed in these sectors are largely in the form of unskilled workers, and small traders. Consequently, there is low labour productivity. Svay Rieng's agriculture is still in rural practices and it has a large number of labourers. For this reason, there are still excessive labourers and low efficiency in production.

Basic Solutions to the Promotion of Labour Restructuring in Svay Rieng Province

The Public Investment Program, 3-year-rolling 2013-2015, of Svay Rieng province has brought towards the target for 2015, labour restructuring will consist of more than 48% industry and services and less than 20% agriculture (Provincial Department of Agriculture, 2012). To implement that goal, the sectors of industry and services must improve, attract and use more workforce than ever before, accelerating industrialization and modernization. For this reason, agricultural productivity can be improved and the number of labourers can be reduced in this rural area.

Efficient Use and Attraction of Labour in Industry and Services

Rapid development of industries leading to job creation and efficient use of labour: Most of the industrial production in Svay Rieng province is currently focusing on product processing, which is considered to be a low-value sector. While the materials and inputs generate, the greatest value are mainly imported from abroad. In recent years, those factors have been undergone large fluctuations; therefore, Svay Rieng's Industries have low value and stability. This significantly influences the labourer income and productivity in this economic sector. In the future, Svay Rieng province should focus on:

- Developing additional key industries and create more jobs for workers; The current key industries in the province include automobile assembling and manufacturing of windshield glass but these industries have not met the requirements of the development of industrial production in Svay Rieng province. The province should use investment capital for key projects in proportion to the developmental trends of an industrial province. The concrete manufacturing sectors includes textile industry, manufacturing of machinery for agriculture, industry and services and production of high-quality tiles and construction materials. These projects can generate "kernels" to attract investment as they will create advantages for investors to invest in the projects that province inputs for the "kernel" projects or the projects that use the outputs of those project. As a result, investment

opportunities for many related projects in different sectors will be created and more jobs can be generated, leading to an attraction to the workers from different sectors in the promotion of labour restructuring.

- Expanding the development of small and medium industrial parks; To quickly deploy and develop small and medium industrial parks, the province should focus on making a rapid and detailed planning and investment in the construction of infrastructures for these industrial parks. There should be specific details for each industrial park so that specialization and enhancement in the productive cooperation of industrial enterprises can be ensured so as to save investment costs and reduce business operation costs. Normally, the units that intend in the construction of facilities in the industrial parks are mostly small and medium enterprises with limited investment capital, so, they are unlikely to invest in modern technologies for hi-tech goods production.

Therefore, in order to create favorable condition for encouraging all private economic sectors to invest in these industrial parks, Svay Rieng province should plan its industrial development which encourages only investments in hi-tech and large-scaled projects with new breakthroughs and in the sectors that the province's small and medium enterprises can handle. As to the investments that do not require high technologies and a great deal of capital, priority should be given to the investment in small and medium industrial parks.

- Developing supporting industries in order to serve the key industries in Svay Rieng province; The province should promote the development of new manufacturing sectors such as production of materials of garment processing industry (zippers, buttons, high-taper necks, liners, labels), manufacture of parts and some detailed and complex accessories for machinery, automobile assembling (types of screws and bolts, wires, rubber, plastic and machine parts) for the development of industry in the Svay Rieng province. In addition, Manhattan Special Economic Zone is adjacent to Tai Seng Special Economic Zone, so the development of supplementary industries for refinery industry is also an orientation that needs to be invested in.

- Development processing industry; The promotion of processing industry in the province in particular can rely not only on the availability of local raw materials but also on the resources of raw materials in other localities. However, there is now a popular tendency that each locality is trying to set up the plans that can use its available local materials, even though there is some restricted ability to provide large amounts of materials in each locality. In this way, most of the processing factories are based on small-scaled production, so they are inclined to use cheap and backward equipment and unable to resort to modern technologies. Moreover, since material resources are subdivided, the competition in the consumption of materials has become severe. It is for this reason that the cost of production increases and production quality declines, so the businesses in the region lose their advantages over competition and acquire low efficiency in investment. To solve this problem, the province should, apart from promoting regional development of materials by changing the models of production and increase its investment in science and technology to improve crop yields and livestock in a land area due to the rapidly increasing the supply of raw materials. The province should immediately make a number of policies to restrict the entry of some specific sectors, whose efficiency is significantly influenced by the scale of production so as to help the remaining businesses to operate more effectively.

Expanding absolute supply of raw materials is an appropriate orientation in terms of the current distribution of material resources. In this way, the province's processing enterprises should invest in advanced technologies and equipment to ensure the penetration of products into the most difficult markets. At present the businesses in Svay Rieng will establish active links with the enterprises in other localities, which are unable to use advanced technologies and modern equipment and that they have no advantages over production scales. The province can entice these organizations to engage in a system of suppliers of primary products, semi-finished products and even raw materials for provincial enterprises.

Intensive Development of Services

Mass and efficient utilization of workforce: The Svay Rieng province has two history cultural heritages: Prasat Temple and the old lake of Prey Basac with typical cultural values of humanity.

The natural aspects combined with the cultural heritages, historical traditions of Svay Rieng are extremely valuable resources which create favourable conditions for the development of tourist industry; however, the promotion of this potential has been so far limited and the advantages in the province have not yet been fully developed. The province should expand and develop high-quality tourism, which attracts and employs more labourers and more skilled workers than before. In the future the province should focus on:

- Improving the environment to promote the development of high-quality tourist services; Tourist environment is a major concern. As for each business, it cannot manage itself, but it requires the strong support from the functional agencies of the province in creating a tourist environment that attracts not only investors but also visitors. Such a tourist environment must ensure social order and security, good environment, beautiful urban landscapes and high-quality goods with reasonable prices… All the activities conducted at the tourist points have not been really well prepared by the tourist authorities in recent years. Now it is time to pay much attention to the improvement of tourist environment because it is the survival and development of national tourism in general and of the tourist points with international standards in particular. Through mass media, the image of tourist in Svay Rieng can be propagated, the need for this type of service can be realized and the investment in various types of services with appropriate quality can be conducted so that this can make contributions to the development of local tourism.
- Promoting the export of goods; Apart from the attraction of investment and the access to modern technologies, Svay Rieng province has to focus on the improvement of administrative procedures reform in the export sector, creating extremely favorable conditions for businesses by shortening tax payment time and, especially, clearance time for imported raw materials used in the production and processing of exports. The province also have to deal with researches on production as well as export markets and hold training sessions to extent the international commitments so that enterprises can have accesses to export markets. It should depend on the national budget to enhance the vocational training, especially job training for export processing workers. The province should improve trade promotion activities for production, export and businesses, focus on supporting businesses to conduct market research and take part in domestic and foreign trade fairs and help them improve the quality management system in accordance with the ISO standards and create trademarks online and the province's export website so as to propagate, introduce products and expand export markets, especially for the handicrafts, fine art products and agro-products which are dominant in the province.

The province should gradually establish brands for the province's key exports on the market. It is also important to increase the competitiveness and efficiency of provincial export. To overcome the shortage of capital for enterprises, the government has made policies in lending terms and created favorable conditions for businesses to have an eligible access to preferential credit loans offered by the Government. The commercial banks and credit unions in the province should create favorable conditions for enterprises to borrow money to invest in production and businesses for export.

- Shifting the structure of labour in the service sector; Hindrance should be made to the infiltration of child labour in the form of small traders, street traders. In the coming years, Svay Rieng will need policies for investment attraction for development of large-scaled commercial and service centers all over the province in order to persuade domestic and foreign businesses and large entrepreneurs with modern trading style to engage in businesses. This will gradually attract customers to shopping centers. The development of modern commercial and service centers, on the one hand will create conditions for the number of young workers who enter the labour markets annually have the opportunity to participate in the trade and services sectors on condition that they have been given needed professional training.

Internal Labour Restructuring, Efficient Use of Labour, Industrialization and Modernization in Agriculture

Efficient use of labour contributes to the acceleration of industrialization and modernization in agriculture: With urbanization, industrialization and modernization and rural agriculture, a

certain number of agricultural labourers, especially young workers will lose employment opportunities in agriculture due to the limitation of land, the main production factor in agriculture. They are the major objectives that need to be shifted to other sectors in the future. There should be some solutions to this problem. The basic measures taken can be reasonable investments, application of technologies and new production methods in agriculture to improve the productivity yield per unit of cultivated area, creating more jobs and attracting more workers.

A contradiction that arises in the process of transformation is that the transition will lead to the fact that a number of young workers will shift from the agricultural sector to other economic sectors. This phenomenon can lead to an old workforce, affect the application of scientific and technological progresses to agriculture, slow down the process of industrialization and modernization in rural agriculture and finally cause negative impacts to economic restructuring. To settle this contradiction, the province should, in one hand, adopt policies to encourage educated and skilled workers in return to serve in the fields of agriculture, forestry, and on the other hand, create a mechanism that serves the interests of these qualified workers who have made achievements in agricultural production, thus the attraction of new workers will have positive impacts on the acceleration of industrialization and modernization in agriculture.

Transforming the structure in cultivation and animal husbandry: The concerning agencies should complete the planning of agricultural production and rural village trades in the province as soon as possible on the basis of investment orientation, reorganition of production and arrangement of plants and animals in proportion to each region and sub-region to ensure more efficient production. In the planning, it is necessary to combine production with preservation, processing and consumption of products and to synchronize between objectives, policies and measures. Also an immediate concern is to review and inspect the implementation of planning and production plans in each sub-region so as to have appropriate adjustment and control in respect to the actual situations. Only approved plans can be strictly implemented and production must be banned with spontaneous plans carried out in the past.

Concentrating on mobilizing investment resources to build irrigation systems, ensure irrigation for crops, intensive cultivation and crop rotation and increase the number of crops, productivity and livestock. Svay Rieng province should apply and replicate production models to achieve effective and appropriate results in local production. The province should gradually shift the cultivation workforce with low productivity, high risk and time-consuming labour and long crops, low efficiency and difficulties in technological application due to fragmentary production to the sector of animal husbandry which has high productivity and high value in accordance with a long-term trend and that this sector does not rely on extensive use of land.

CONCLUSION

In the final analysis, in the course of economic and social development, effective use of resources is a very important issue and workforce is the most important and decisive resource in the course of provincial development. With the current disproportionate factors in Svay Rieng province's labour structure, a requirement for labour restructuring is an inevitable phenomenon. For this reason, the implementation of the measures proposed in view of influencing the process of labour restructuring must be quickly and effectively carried out in the province.

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Research article

Variation of Important Nutrients Proportion on Phytoplankton Distribution in Bang-tabun Bay, Phetchaburi Province, Thailand

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Abstract Bang-tabun Bay, the estuarine area is situated close to the Phetchaburi river mouth, Phetchaburi Province. Petchaburi River flows in the west of the Kingdom and exits into the Gulf of Thailand. This research study was conducted with sample collection of aquatic environmental quality from September 2011 to May 2012. The results indicated the increasing level of NH_4^+, NO_2^-+NO_3^-, $Si(OH)_4$ and PO_4^{3-} in this area, which lead to the phytoplankton bloom phenomenon, thus, implied the mesotrophic to eutrophic status of the area. Three phyta and 54 genera of phytoplankton were discovered in the river mouth. The dominant groups were diatoms (*Thalassionema*), cyanobacteria (*Trichodesmium*), and dinoflagellates (*Ceratium*). In this study, *Ceratium* was classified to be the dominant group. Analysis of DIN:P and Si:P molar ratios of surface water were applied to examine the factors influencing the abundance of phytoplankton in the estuarine systems. Thus, the change of phytoplankton abundance should be considered to assess the water quality, and thereby more efficient aquatic environmental conservation of Bang-tabun Bay further.

Keywords nutrient proportion, phytoplankton, and Bang-tabun bay

INTRODUCTION

Bang-tabun Bay is located in the western part of the Gulf of Thailand. Petchaburi River is approximately 118 kilometer in length with the catchment of 6,219 square kilometer. Runs from Petchaburi province and flows toward the lower plain before discharging into the Gulf of Thailand (REO8, 2011). Pollution problems in the gulf can occur according to untreated municipal and industrial wastewater, eutrophication, trace metals contamination and petroleum hydrocarbon (Cheevaporn and Menasveta, 2003). Eutrophication can be defined as excessive by algae growth when high concentration of nutrients, particularly phosphates and nitrates enrich in the water body (Tantanasarit et al., 2013). The term 'harmful algal bloom' covers two characteristics that are caused by microalgae and negative impact on anthropogenic activities (Zingone and Enevoldsen, 2000). Regional Environmental Office 8 (REO8, 2011) reported that utilization of land along the

Petchaburi River was estimated to be 58% forest and 29% agricultural areas, in Phetchaburi province, respectively. Here, the river supports a resident population about 466,079 people or 1,772 people per square kilometer that related to the deterioration of water quality induced mainly by sewage, domestic discharges, and agricultural utilization (REO8, 2011). Those activities could be contributed to phytoplankton bloom phenomena along the coastal zones of this area.

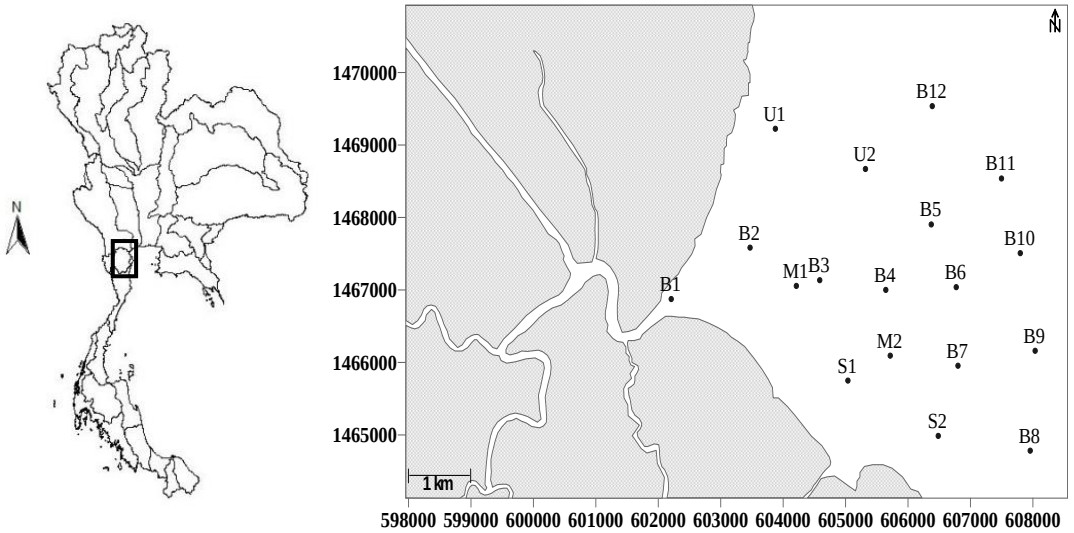
OBJECTIVE

This study aims to assess the aquatic environmental factors and related impacts by utilization to the variation of phytoplankton. The findings could be used to estimate a dissolved inorganic nutrient ratio that achieves levels for serious consideration of nutrient criteria for water resources conservation management and thereby sustainable utilization of this area.

METHODOLOGY

Sampling Sites and Survey Plan

The surveys were conducted at 18 sampling stations covered Bang-tabun Bay, the stations of which were grouped into two different characteristics: sub-tidal channel (B1-B12) and bivalve culture flat areas in the upper (U1 and U2), middle (M1 and M2), and lower (S1-S2) areas, spanning from September 2011 to May 2012 (Fig.1). According to the rainfall patterns, Thailand is under the influence of monsoon winds (TMD, 2012). The seasons can thus be divided into rainy season (May- September), and winter season (October-February).



sub-tidal channel (B1-B12) and bivalve culture flat areas in the upper (U1 and U2), middle (M1 and M2), and lower (S1-S2)

Fig. 1 Survey stations of 18 major stations within two different characteristic of Bang-tabun Bay, Petchaburi Province, Thailand

Sample Collection and Analysis

The general water quality factors, namely temperature, dissolved oxygen (DO), salinity, and pH were measured with a multi-parameter probe (YSI-6600 Sonde instrument) at the sampling sites. Samples of surface water (30 cm deep) were pre-filtered through GF/F (Whatman) and then stored at 4^{o}C before transporting to the laboratory for analysis of nutrients, including ammonium (NH_4^+), nitrite and nitrate (NO_2^-+NO_3^-), silicate ($Si(OH)_4$), and orthophosphate (PO_4^{3-}), with a SKALAR

segmented flow analyzer. The samples for chlorophyll *a* (Chl *a*) and total suspended solids (TSS) measurement were analyzed by the spectrophotometric method and the freeze-dried technique, respectively. Phytoplankton samples were collected and preserved in formaldehyde buffered solution before being classified and enumerated with a Sedgewick-Rafter counting chamber under a light microscope.

Data Analysis

Comparisons of water quality in terms of temperature, salinity, DO, pH, Chl *a*, and TSS among the sampling periods and zones were performed using average levels and distribution characteristics. Least Significant Differences (LSD) or Tamhane's T2 of Post Hoc test of the one-way analysis of variance (ANOVA) was used for the environmental variation comparison, and the level of confidence greater than 95% ($p < 0.05$) was considered to indicate a statistically significant impact. The Mann-Whitney test was used where a normal distribution was not observed. The relationships between nutrients as dissolved inorganic nitrogen (DIN; NH_4^++NO_2^-+NO_3^-) and orthophosphate phosphorus (P), Chl *a*, and total phytoplankton density were analyzed using the Spearman rank correlation coefficient (r_s). In this study, a confidence interval of more than 95% ($p < 0.05$) was considered to indicate a statistically significant impact.

RESULTS AND DISCUSSION

Environmental Factors

The results indicated that freshwater runoffs had influence on water quality in the Bang-tabun Bay, which in turn contributed to varying water quality by seasonal variation. Water temperatures was slightly decreased with the seasons ($p < 0.05$), and low level of salinity was detected during September 2011 due to the large freshwater discharges into the Bang-tabun Bay. The pH level varied from 7.22 to 8.67 for the entire study area. DO varied and was markedly decreased to unsuitable levels (< 4 mg/l) during the rainy season. Levels of TSS and Chl *a* were between 5.40 to 147.65 mg/L and 3.58 to 29.64 μg/L, respectively, with the both of highest levels in May 2012. Thongdonphum et al. (2011) reported that Chl *a* of approximately 10 μg/L has been regarded as the initial level for eutrophication in the estuarine zone. The Mae Klong River (in the eastern part), had Chl *a* levels 1.34 to 14.69 μg/L (Thongdonphum et al., 2013), while the Tha Chin Estuary, located closely to the study area, had a very high levels of Chl *a* in excess of 20 μg/L and reached 535 μg/L when *Noctiluca* red tide outbreak is occurred (Meksumpun and Meksumpun, 2008).

Table 1 Water quality (mean±SD) in the Bang-tabun Bay during the study periods

Parameters	Study periods		
	September 2011	December 2011	May 2012
Temp (^oC)	30.65 ± 0.95	25.27 ± 0.64	30.92 ± 0.63
Salinity (psu)	18.17 ± 5.17	21.70 ± 1.11	21.64 ± 2.96
DO (mg/L)	6.03 ± 2.74	7.79 ± 0.95	3.41 ± 0.58
pH	7.89 ± 0.31	8.49 ± 0.15	7.47 ± 0.13
Chl *a* (μg/L)	11.98 ± 4.92	10.39 ± 5.07	12.31 ± 5.83
TSS (mg/L)	20.45 ± 16.37	15.68 ± 13.34	78.98 ± 45.67
NH_4^+ (μM)	30.71 ± 11.25	43.25 ± 13.98	40.98 ± 8.82
NO_2^-+NO_3^- (μM)	6.01 ± 4.17	2.78 ± 2.62	8.00 ± 2.84
$Si(OH)_4$ (μM)	126.65 ± 52.07	68.15 ± 28.47	137.98 ± 32.88
PO_4^{3-} (μM)	2.77 ± 1.58	2.00 ± 1.29	3.53 ± 0.78

The levels of NH_4^+ and NO_2^-+NO_3^- varied significantly ($p < 0.05$) with seasons. Levels of NH_4^+ varied from 13.89 to 71.86 μM, with the highest level found in December 2011. NO_2^-+NO_3^- concentrations ranged between undetectable to 15.82 μM. High concentration levels were found in

September 2011, which was probably the results of land utilization of agriculture, of which rice fields and aquaculture areas that covering the river mouth (REO8, 2011). $Si(OH)_4$ concentrations ranged from 24.94 to 241.72 μM with high concentration levels particularly in the rainy season ($p < 0.05$). PO_4^{3-} levels ranged from 0.63 to 5.65 μM with noticeably higher levels than the recommended level of 0.48 μM from the ASEAN marine water quality (Chongprasith et al., 1999).

Phytoplankton Distribution

Phytoplankton community variation was related to local nutrient loads and hydrographic condition, turbulence and human impact (Álvarez-Góngora and Herrera-Silveira, 2006). The phytoplankton community consisted of 54 genera, namely 4 Cyanophyceae, 7 Chlorophyceae, 33 Bacillariophyceae (diatoms), 1 Dictyochophyceae, and 9 Dinophyceae (dinoflagellate). The amount of phytoplankton varied from 180 to $1.37x10^5$ unit cells/L with the highest density in December 2011. The results showed that dinoflagellate was the most dominant group. Other species, such as *Trichodesmium* sp., *Protoperidinium* sp., and *Noctiluca scintillans*, were also found, while *Ceratium* sp. was dominant species when the red tide phenomenon is occurred. The results of statistical analysis implied that dissolved inorganic nutrients had influenced on phytoplankton density. Spearman rank correlation coefficient (r_s) indicated that phytoplankton density highly significant ($p < 0.01$) received enhancement from $NO_2^-+NO_3^-$, $Si(OH)_4$, and PO_4^{3-} (r_s = -0.762, -0.745, and -0.484, respectively). Those nutrients play the key roles of phytoplankton blooming, while NH_4^+ concentration were surplus for phytoplankton growth in this area.

Nutrients Proportion for Phytoplankton

The results of nutrient proportion were calculated for dissolved inorganic nitrogen (DIN; $NH_4^+ + NO_2^- + NO_3^-$), orthophosphate (P; PO_4^{3-}) and silicate (Si; $Si(OH)_4$) and compared with Redfield ratios of N:Si:P (16:16:1) based on the work of Brzezinski (1985). The results of DIN:P and Si:P molar ratios varied by season and were mostly higher than Redfield ratios, especially in December 2012 when there is an accumulation process in the water column. In this study, the levels of DIN:P ratios had related to phytoplankton density with the power function of $Y = 828.1e^{0.109X}$ in which $r^2 = 0.344$, when Y = phytoplankton density and X = DIN:P levels (Fig. 2). Such variation reflected high load of nutrients that involved the natural runoff and agricultural land uses which was consequentially influence such nutrient loads (Thongdonphum et al., 2011). Thus, PO_4^{3-} levels could be monitored and used for managing water quality.

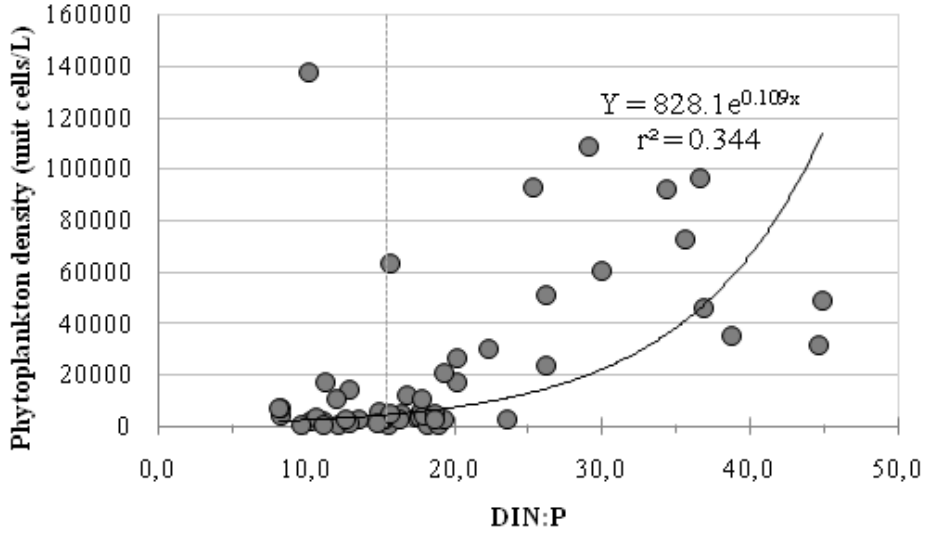


Fig. 2 Relationships between of DIN:P ratios and phytoplankton density found in the Bang-tabun Bay during study periods

CONCLUSION

This study has revealed that phytoplankton can play an important role in nutrients, particularly phosphate from the water column as the crucial influencing factor of phytoplankton growth. DIN levels were surplus for the Bang-tabun Bay. The levels of phosphate could be used to monitor and manage eutrophication and/or red tide phenomenon. The study results could be applied to estimate the level of phytoplankton density for more efficient management of water resources and utilization.

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Research article

Public Participation on Water Resources Management in Lao PDR: Case Study Banhome Village, Hadsayfong District

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Abstract The public participation on resources management in Lao PDR: case study Banhome village, Hadsayfong district, Vientiane. This area is very important for promoting sustainable agricultural production, and tends to accelerate human health such as the activation of financial securities, water supplies and how to avoid flood and droughts in the future by introducing environment friendly policies close to the conservation area. The purpose of this study was to determine the level of public participation and factors affecting participation of farmers in water resource management in Vientiane, Lao PDR. The participation of villagers was very useful. This survey research was carried out by using randomized model practices in relation to voluntary participation and the Government to the water resource management and cooperative in rural development. Data were collected by questionnaires and descriptive statistics were used to analyze the data. The results found that the level of public participation involved in water resource management was low. Recommendations from this research are that the Government and community should cooperate together to manage water resources and allow farmers to join all processes of water management and solving problems. Information and activities were promoted directly to people via well-selected media in order to create a positive point of view in water resource management participations. Moreover, in this area, the point of view for water resource management should be improved starting with changing the ways that farmers make decisions.

Keywords public participation, water resources management, Lao PDR

INTRODUCTION

The water resources are an important sector in Lao People's Democratic Republic (Lao PDR). Lao PDR government planned to develop, modernize and industrialize in order to achieve a high quality of life. The water resource management, one of which policy issue at the society-natural interface, pose governance challenge of Lao PDR and throughout the world. The estimated inland water resources area totals approximately 723,500 ha, which 200,000 ha are from Mekong River region; 54,000 ha from other main rivers; 57,000 ha from reservoirs, 1,500 ha from swamps; 406,000 ha from rice fields; and 5,000 ha from fish ponds. The rivers outside the Mekong River basin the Nam Ma, Nam Sam and Nam Neune flow through Viet Nam into the South China Sea.

Public participation in integrated water resource management (IWRM) is needed to reach decisions involving socio-economic and ecological groups, IWRM users, stakeholders and the general public. The public participation is necessary because it decreases political tensions,

promotes decision making by consensus and assists in finding reasonable and acceptable solutions. The comprehensive management of the river basin is a new concept of WRM.

This study was designed to examine the public participation in the rural water resource management project and to determine the problems and obstacles including flood, droughts, water quality and other emergencies. But the biggest water management trend observed is the development of all Lao PDR's rivers for social-economic development and a reduction in poverty. The Country's status should rise to developed country status by 2020. However, the study is vulnerable, the problem is the lack of time the community has and acknowledges that the government support is low towards public participation for WRM in the focus area.

METHODOLOGY

Study area: The study was conducted case study Banhome villages, Hadsysong district, Vientiane city, Lao PDR. (Figure.1). It is a plain region area of Vientiane capital. The total area of Hadsayfong district is 25.8 hectare, of which approximately 17.2% is covered by forest, 57.61% is covered by semi natural and agricultural ecosystems (arable land, orchards, rice production, cassava, organic agriculture and another land) and 24% is covered by settlements and surface-covering infrastructures. As for the location of surveys to determine the zoning of agricultural and forestry "SDZAF and NAFRI" reference points, 31% is found in cultivated lands, 14.56% is water resource, while 31% in other agricultural areas by annual cropping. Whereas water resource management has historically used the river or lake basin as its unit of management, the growth in population and urbanization has placed increasing pressure on water resources across multiple basins a 495 Ha and total 2,752 Ha of the areas (Lao government, 2012).

Sample determinations and research methods: Local residents in the study (2,531 households) and local water resources 495 Ha in areas are regarded as the core interest groups. Banhome village was the focus area used to conduct the survey. Data was collected during August and September 2013 using a structured questionnaire and interview process. SPSS software was used to analyze the results of the personal factors including gender, age, educational background, income and main occupation. Membership of government organization is related directly with people participating in water resource management in this questionnaire.

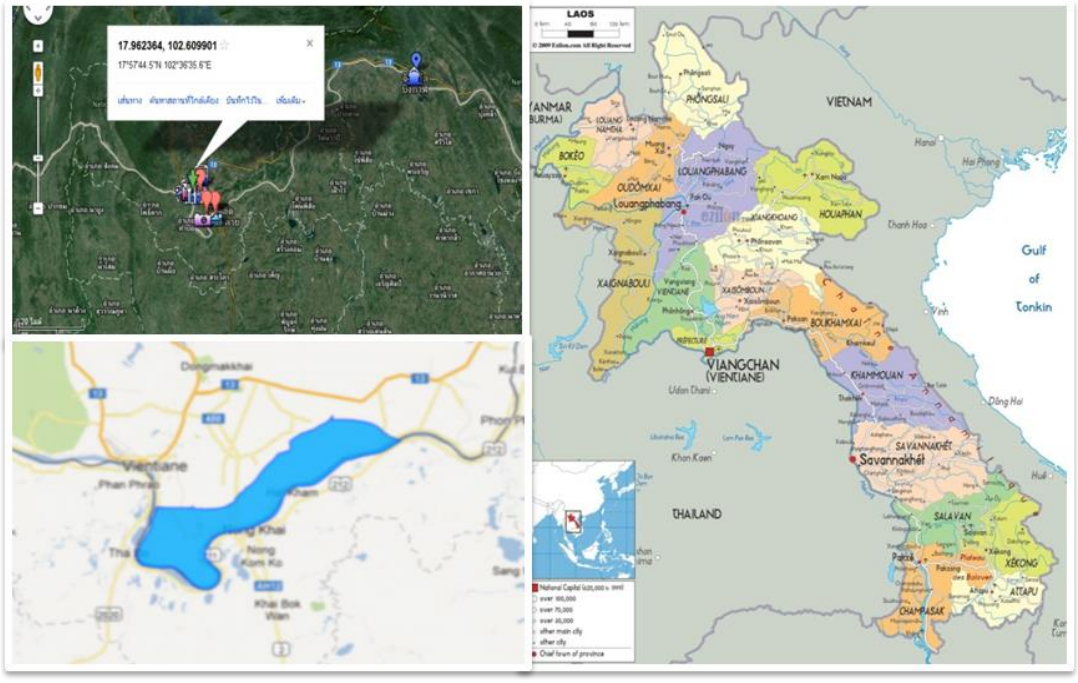

Fig. 1 Study area of Hadsayfong district, Vientiane city, Lao PDR

RESULTS AND DISCUSSION

Descriptive Statistic

The characteristics of the samples showed that the heads of the households were mainly male. The age of samples ranged from 29 to 69 years with a mean of 44 years and the range of family size was from 3 to 6 persons with a mean of 4.3 persons. The most education background was elementary school and diploma. 80% of respondents in this study are farmer while, 13.3% and 6.7% are government employer and business. The range of income was from lower than 150 to more than 400 US dollars per month. There were randomized 15 samplings of households, for details see Table 1.

Table 1 Basic characteristic of the samples

Sampling number	Gender		Education level				
	Male	Female	Elementary school	Junior high school	High school	diploma	degree
15	14.0	1.0	5.0	2.0	2.0	5.0	1.0
Percentage (%)	93.3	6.7	33.3	13.3	13.3	33.3	6.7

Sampling number	Income					Occupation		
	<150	151-200	201-300	301-400	>400	Government employer	Farmer	Business
15	2.0	2.0	6.0	2.0	3.0	2.0	12.0	1.0
Percentage (%)	13.3	13.3	40.0	13.3	20.0	13.3	80.0	6.7

Public Participation in Water Resource Management

Public participation is known as the most effective way in promoting and achieving sustainability of rural development projects, particularly in developing countries (Livingstone and McPherson, 1993). In this study area, it has been recognized that the water resource management project users or beneficiaries do not appreciate the projects since the projects are provided by the government for free of charge that related to lack of sense of ownership and sharing responsibility to the projects. Furthermore, the participation rate of water resource management in this area also was low. In all stage of a project development such as project decision making process, project construction, operation and maintenance, monitoring and evaluation, the local stakeholder participation was low which lead to water resource management project failure (Table 2).

Table 2 Stakeholder participation in water resource management: n, *N*=15

Statement	High (%)	Average (%)	Low (%)
Stakeholder's participation in water resource situation, cause and water demand of village	20.0	40.0	40.0
Stakeholder's participation share the opinion in decision making about water problem and resolve water problem	13.3	26.7	60.0
Stakeholder's participation in water resource management lead to effective decision plan/project	13.3	26.7	60.0
Stakeholder's participation in monitoring and evaluation of water resource management project	0.0	33.3	66.7

Therefore, for success project, government should be increase the rate of stakeholder participatory approach have been evidence through a series of consultative and discuss among project related stakeholders (Uraiwong and Watanabe, 2012). The promoting of water resource management knowledge and information is also important which the result found that the level of channel obtaining water resource management project information was low (Fig.2). All television, radio and newspaper media, which average's to higher than 66.7 percent and government work

reports, were not able to gain more stakeholders understanding and participation. The education function of the media in rural areas may be the cause for the lack of opportunity to obtain water resource information (Liu et al., 2010).

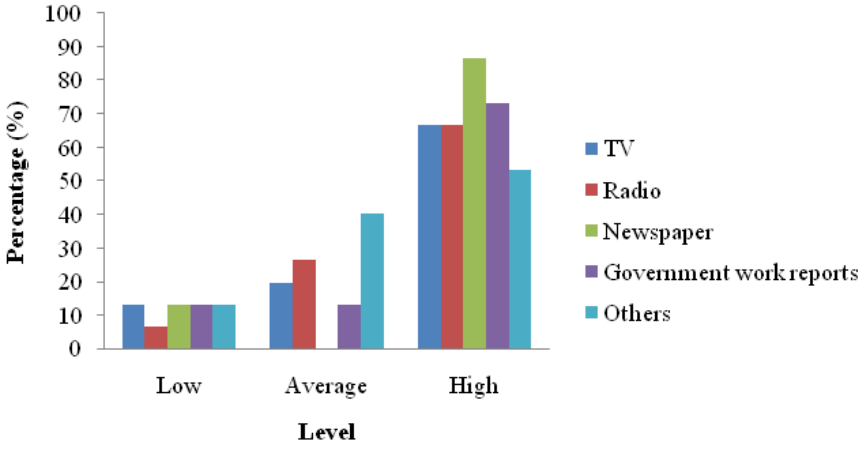

Fig. 2 Source of media and level of obtaining the information on water resource management

Problems and Obstacles in Water Resource Management by Public Participation in Lao

As shown in Table 3, the respondent rated eight items as problems or obstacles of their village. The stakeholders do not know the goal of participation in water resource management project leads to lack of understanding in the project. Therefore, the water resource management project development should be considered as demand driven and identified by the local stakeholder who involved in all stages of a project development (Uraiwong and Watanabe, 2012).

Table 3 Problems and obstacles for publics' participation in water resource management

Problems and obstacles	No (%)	Yes (%)
Ignorance on the goal of projects	20.0	80.0
Incompatible with others	40.0	60.0
Contrary to the community culture and traditional	100	0
Afraid of the self-troublesome	100	0
Lack of time	93.7	6.3
Lack of chance to public participation attending	86.7	13.3
Lack of knowledge	73.3	26.7
Lack of government support	60.0	40.0

Note; N=15

CONCLUSION

The overall objective of this study was to explore the areas where people's awareness and general knowledge on the scheme were low due to lack of ownership and responsibility on the water resource management program. Also as an income source it is still limited. Thus, lower income households are unaware of the program. The result from group analysis shows the statement of stakeholder's participation in the water resources situation, cause and water demand of the villagers are low, sharing in the opinion that decision making and water problem issues is low, due to the low rate of attention, acceptance and feedback of water resource management information. Therefore, publicity on water management knowledge should be strengthened and the government activities should be given the chance to expand in rural participation from the start.

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Research article

Potential of Native Phosphate Solubilizing Bacteria Isolated from the Rhizosphere of Economic Crops and Vermicast in Northeast Thailand to Solubilize Insoluble Phosphates under *in vitro* Conditions

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Abstract Although soils generally contain a large amount of total P, only a small proportion is immediately available for plant uptake making it a major constraint on crop production in many tropical countries. Free-living bacteria and fungi can mobilize orthophosphate from either organic or inorganic P sources such as Phosphate Rock (PR). These phosphate-solubilizing microorganisms (PSM) are characterized by their capacity to solubilize precipitated forms of P, the main P ingredient in PR and could be good bio-fertilizers for improving phosphorus plant nutrition. The present study examined phosphate solubilising bacteria (PSB) isolated from cassava, groundnut, rubber tree, sunchoke, rice, rice-soybean, rice-soybean-corn and rice-chili fields and vermicast of earthworm varieties in Northeast of Thailand, where soils are mainly sandy and P-deficient. PSB isolates were tested by using different P sources [Tri-calcium Phosphate ($Ca_3(PO_4)_2$), Ferric Phosphate ($FePO_4$) and Aluminium Phosphate ($AlPO_4$)] on specific culture media (National Botanical Research Institute Phosphate Growth Medium, NBRIP). Our results showed that five of the PSB isolates from economic crops and vermicast of earthworm varieties solubilised a significantly ($P \leq 0.01$) higher amount of $AlPO_4$ and $FePO_4$ over the uninoculated control. The highest activity of solubilization was achieved for $AlPO_4$ followed by $FePO_4$ which are the main forms of insoluble phosphates in acidic sandy soils. We found that PSB isolated from vermicast of earthworm varieties *Pheretima posthuma* and *Eudrilus eugeniae* were able to solubilize both $AlPO_4$ and $FePO_4$ at relatively high rates (up to 1,918.49 mgP/l), in contrast, PSB isolated from cassava, rice-soybean and groundnut field soil tended to have lower solubilisation rates for $FePO_4$. None of the isolates tested were able to solubilize $CaPO_4$. Finally, IAA production was observed only in PSB isolated of *E. eugeniae* vermicast and rice-soybean field soil. These results highlight variability of specific PSB isolates from different rhizospheres and vermicast of earthworm varieties and provide essential information for the management of soil fertility.

Keywords crop productions, phosphate solubilization, phosphate-solubilizing bacteria, vermicast

INTRODUCTION

Phosphorus (P) is an essential element in plant development. Photosynthesis, changing sugar to starch, genetic inheritance, nitrogen fixation, flowering, fruiting seed production (Mehrvarz et. al., 2008) and resistance to plant diseases are the attributes associated with phosphorus nutrition (Khan et al., 2009). Although soils generally contain a large amount of total P, only a small proportion is immediately available for plant uptake. Phosphorus deficiency is the main problem to plant growth in tropical and subtropical areas (Bonser et al., 1996). Especially, in the Northeast Thailand the soil are acidic with highly reactive of Fe^{3+} and Al^{3+} (Gyaneshwar et al., 2002), low phosphorus contents in the parent material and low soil moisture affects the availability of phosphorus (Karmakar et al., 1997; Raychaudhury et al., 2003). To meet the crop demand, farmers apply up to 3-4 times the required amount of P to crops, causing a substantial increase in production costs. There are strong evidences showed soil bacteria are capable of transforming soil P to the forms available to plant.

Recent studies reported that plants and microorganisms play a key role in soil P dynamics which catalyze the hydrolysis of organic phosphate esters to orthophosphate anions by using phosphatases. Free-living bacteria and fungi can mobilize orthophosphate (predominantly as HPO_4^{2-} and $H_2PO_4^-$) from either organic or inorganic P sources for improving P availability. Phosphate solubilizing bacteria (PSB) become a source of P to plants upon its release from their cells. The phosphatase efficiency is related to the microbial fauna, the soil temperature and humidity as well as the associated bacteria communities (Zahran, 1999). Other factors that can play a significant role are the physiological state of the plant, the type of rooting system, the age of the plant and the location of ectomycorrhiza on the root (Antibus et al., 1997).

Vermicast, also called worm manure originates from the breakdown of organic matter by earthworms. Its microbial activity is 10 to 20 times higher than in the soil (Chaoui, 2010). Vermicast contains reduced levels of contaminants and a higher saturation of nutrients than organic materials do before vermi composting (Ndegwa et al., 1998). Moreover, vermicast is also believed to contain hormones and enzymes which it acquires during the passage of the organic matter through the earthworm gut. The hormones and enzymes are believed to stimulate plant growth and discourage plant pathogens (Gajalakshmi and Abbasi, 2004). The analysis of the ability of bacterial isolates to solubilize insoluble P form to available P form will enable to create a highly valuable basis for the use of these isolates as bio-inoculums or bio-fertilizer to increase crops yield and for sustaining crop production. The objectives of this research were to isolate phosphate-solubilizing bacteria (PSB) from cassava, groundnut, rubber tree, sunchoke, rice, rice-soybean, rice-soybean-corn and rice-chili fields and vermicast of earthworm varieties in the Northeast of Thailand where soils are mainly sandy and P-deprive.

MATERIALS AND METHODS

Sampling Site and Soil Sample Collection

The experiment was conducted within Khon Kaen, Mahasarakham and Roi Et provinces, Northeast Thailand. Northeast Thailand is characterized by a tropical climate with an acid sandy soil. Soil samples (20 points) were collected from cassava, ground nut, rubber tree, sunchoke, rice, rice-soybean, rice-soybean-corn and rice-chili fields while those plants were growing from the soil surface at a depth of 10 cm. Collected soil samples were preserved in plastic bag at 4 °C for phosphate solubilizing bacteria isolation.

Isolation of Phosphate Solubilizing Bacteria by Enrichment Culture

To extract PSB from soil, 5 g of soil samples and vermicast of earthworm varieties were transferred to the NBRIP growth medium. Per liter, this growth liquid medium contains 10 g glucose with 5 g $MgCl_2 \cdot 6H_2O$, 0.25 g $MgSO_4 \cdot 7H_2O$, 0.2 g KCl and 0.1 g $(NH_4)_2SO_4$. Additionally, modified NBRIP media, containing either $FePO_4$ or $AlPO_4$ or $Ca_3(PO_4)_2$ as the sole source of insoluble P, were also

used for the initial screening step. The pH of the agar medium was adjusted to 7.0. The sources of insoluble P were autoclaved separately and the other sterile ingredients were aseptically mixed after autoclaving. Erlenmeyer flasks containing 50 ml of the medium with inoculants were incubated for 7 days at 30 °C on incubator shaker at medium speed (150 cycles min^{-1}). For the following week, 5 ml of this incubated medium with inoculants were transferred into 50 ml Erlenmeyer flasks again with new liquid medium for 7 more days at 30 °C on incubator shaker at medium speed (150 cycles min^{-1}). At the end of each week in NBRIP growth liquid media, aliquots of each dilution were spread on NBRIP medium and incubated at 30 °C for 14 days. After PSB isolation for 6 weeks, colonies were selected from the plates on the basis of the appearance of a clear halo; the clones were further purified on minimal medium based on each insoluble phosphate forms. Once purified, each isolate was stored as a glycerol stock at -20 °C.

Mineral Phosphate Solubilization Assays

The phosphate solubilizing (PS) activity of each of the isolates was determined by molybdenum-blue method (Land Development Department, 2005). The isolates were grown in NBRIP liquid medium containing different insoluble forms of phosphate ($AlPO_4$, $Ca_3(PO_4)_2$ and $FePO_4$) for 3-7 days at 30 °C on incubator shaker at medium speed (150 cycles min^{-1}). The solubilization efficiencies were determined by reaction with ammonium molybdate for phosphorus compounds as ammonium phosphomolybdate and reduced with a compound ascorbic acid to molybdenum blue. Then, the isolates were incubated for 30 min at room temperature for color development. Finally, the absorption of light in the wavelength range 880 nm was measured by Shimadzu UV-120-01 Spectrophotometer.

Indole Acetic Acid Production

Selected PSB strains based on their ability to solubilize P were analyzed for IAA production (Nuntagij, 1997). The selective bacterial strains were grown in 45 ml of Lysogeny Broth medium (LB) contains 10 g/l Tryptone with 5 g/l NaCl and 5 g/l yeast extract at 30 °C for 2 days. The 5 µl PSB solution were determined by reaction with 1 ml of Tris-TMRT reagent contains 10 g/l D-manital, 0.2 g/l yeast extract, 0.2/l $CaCl_2$. $2H_2O$, 0.2 g/l $MgSO_4.7H_2O$, 1.21 g/l Tris-base and 0.061 g/l L-Tryptophane 28 °C for 10 days. The 2 ml mixture was determined by 0.01 M $FeCl_3$ in 35% $HClO_4$ for 30 min at 25 °C in the dark. The positive isolated were showed red color for indole acetic acid production.

Statistical Analysis

An analysis of variance was done on data obtained from each parameter in each treatment. All analyses were carried out using Statistical analysis version 8.0. Least significant differences (L.S.D.) were calculated at $p < 0.05$ and Duncan's multiple-range test was used to test significant differences between treatments. Standard deviation was also calculated for the variance.

RESULTS AND DISCUSSION

Isolation of PSB from the Rhizosphere and Vermicast of Earthworm Varieties

The screening strategy employed during this research enabled the identification of PSB colonies on NBRIP medium containing different insoluble forms of phosphate ($AlPO_4$, $Ca_3(PO_4)_2$ and $FePO_4$) as sole P source. No colonies exhibiting a clear halo were observed on agar plates supplemented with $AlPO_4$, $Ca_3(PO_4)_2$ and $FePO_4$ for rubber and cassava from Roi Et, rubber tree, cassava and rice from Mahasarakham, sonchoke, rice-soybean-corn and rice-chili from Khon Kaen provinces and from vermicast of *P. peguana* and *E. foetida* (not shown). Five bacterial isolates from cassava and rice-soybean field at Khon Kaen province, ground nut field from Mahasarakham province and from

vermicast of earthworm varieties showed clear halos of $AlPO_4$ and $FePO_4$ solubilization (Table 1 and Fig. 1). Some obvious differences in the size of the halos of different isolates were observed (not shown). This preliminary observation suggests the existence of bacterial isolates exhibiting different degrees of PS efficiencies in the soil samples and vermicast of earthworm varieties collected. This preliminary observation suggested the existence of bacterial isolates exhibiting different degrees of PS efficiencies in the soil samples collected (not shown). Yahya and Azawi (1998) reported that in general high abundances of PSB are found in agricultural and rangeland soils. Furthermore, Kim *et al*. (1989) showed that the cultural activities and different soil properties such as soil physical and chemical properties, organic matter and soil phosphorus content all play roles in determining the abundance of PSB in soils.

Table 1 Phosphate solubilizing effectiveness of tested bacteria, 10 days after inoculation

Isolate	Solubilized phosphate (mgP/l) from		
	$Ca_3(PO_4)_2$	$FePO_4$	$AlPO_4$
Cassava (Khon Kaen)	0	959.53b	1,860.00 a
Rice-Soybean (Khon Kaen)	0	682.13b	1,789.71 a
Groundnut (Mahasarakham)	0	741.17b	1,605.09 a
Eudrilus eugeniae	0	1,582.46a	1,834.96 a
Pheretima posthuma	0	1,405.00a	1,918.49 a

Efficiency of Phosphate Solubilization by NBRIP

To confirm this observation, the 5 purified isolates were tested following the protocol of Land Development Department (2005), a method previously shown to be a reliable and qualitative indicator of the PS activity of different bacterial isolates. Table 1 shows the OD880 nm shift of the culture supernatants of each of the 5 PSB isolates after a 3-7 day cultivation period in NBRIP medium. Indeed, some isolates did not show any significant change in the absorbance of the supernatant while others exhibited OD880 nm changes in the absorbance. After evaluating their P solubilization capacity, the results showed that all of the 5 isolates can solubilize $AlPO_4$ and $FePO_4$ better than $Ca_3(PO4)_2$ especially the PSB isolates from the vermicast of earthworm varieties (Table 1). Moreover, PSB isolate from the cassava and rice-soybean at Khon Kaen province and groundnut at Mahasarakham province, look interesting for solubilizing $FePO_4$ and $AlPO_4$, which are the main forms of insoluble phosphates in acid sandy soils.

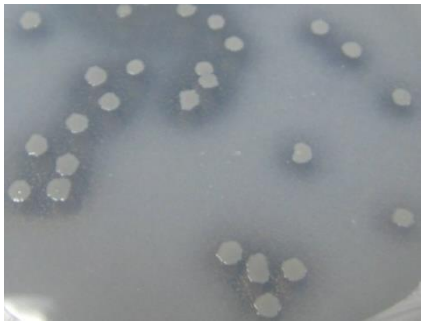

Fig. 1 Appearance of a clear halo from PSB isolates

Indole Acetic Acid Production of PSB Isolates

The plant growth promoting effect of selected PSB was evaluated by analyzing IAA production (Table 2). The IAA production was observed from the isolates of rice-Soybean field and vermicast of *E. eugeniae* (Fig. 2), indicating that these strains could utilize l-tryptophan as a precursor for growth. Phosphate solubilizing bacteria isolated from rice-Soybean field and vermicast of *E. eugeniae* showed the highest IAA production (111.30-111.34 mg/L). Generally, bacteria can enhance plant growth directly or indirectly by increasing available P, fixing nitrogen, sequestering

iron by siderophores, producing antibiotics and plant hormones (Glick et al., 1998 and Mantelin and Touraine, 2004). This group of bacteria is known as plant growth promoting bacteria (PGPB). Moreover, PSB have been widely used as inoculants to increase P uptake and crop yield (Chen *et al*., 2008). IAA production contributes to phytostabilization by increasing root and shoots biomass (Liphadzi et al., 2006). In the context of sustainable agriculture with bio-fertilizers (phosphate solubilizing bacteria) to supply phosphorus at a favorable level for enhance plant growth by providing nutrients in a readily absorbable form. The application of inoculants provided from these microorganisms seem to increase an abundant population of active and effective microorganisms to the root activity zone which increases plant ability to uptake more nutrients.

Table 2 Plant growth promoting properties of isolates

Isolate	Phosphate solubilization	IAA production
Cassava (Khon Kaen)	+	-
Rice-Soybean (Khon Kaen)	+	+
Groundnut (Mahasarakham)	+	-
Eudrilus eugeniae	+	+
Pheretima posthuma	+	-

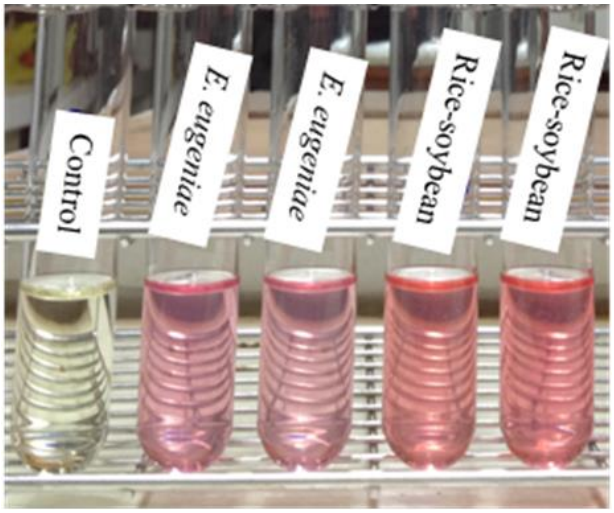

Fig. 2 IAA production from PSB isolates

CONCLUSION

The native PSB isolated from cassava, rice-soybean and groundnut field soil, vermicast of *P. posthuma* and *E. eugeniae* seems to have the capacity to solubilize insoluble forms of $AlPO_4$ and $FePO_4$ which are the main forms of insoluble phosphates in acid sandy soils. The PSB isolates from vermicast of earthworm varieties *P. posthuma* and *E. eugeniae* show the highest P solubilization capacity in vitro conditions follow by the PSB isolated from cassava and rice-soybean field soil from Khon Kaen province and groundnut field soil from Mahasarakham province. However, the PSB isolates from vermicast of earthworm variety *E. eugeniae* and rice-soybean field soil from Khon Kaen province look interested for IAA production. This work provides a first step towards by using bio-fertilizers (phosphate solubilizing bacteria) for improving plant nutrient uptake, soil fertility and sustainable crop production in nutrient poor systems.

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Research article

Effect of Storage Duration in the Quality of Vermicompost

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Abstract A trend of demand for organic products in both domestic and international has dramatically grown in both rate and expansion. Organic agriculture does not only provide rich nutrition and toxic free soil but is also have low in production cost. The use of vermicompost is an alternative way to add organic material in farming and alter the soil properties in a positive way; for instance, by increasing the soil nutrient availability. To make use of vermicompost efficiently, it is important to recognize that the quality of the vermicompost may change due to the duration of its storage. This study utilized vermicompost, which had been maintained for different periods (0, 1 and 3 months) to study changes in its biological and chemical qualities. The study found that the amount of living bacteria and fungi when storing the vermicompost at a 1 month period and the storage would remain stable until the third month. The changes in soil chemistry indicated that the pH and EC values decreased during storage in the first month from 8.53 to 7.50 and from 1.25 ds/cm to 0.84 ds/cm respectively, and increased again during storage in the third month, which were 8.33 and 2.18 ds/cm respectively. The changes in amount of nutrients indicated that nitrogen (TN) and calcium (Ca) were not different throughout the storage period of three months. On the other hand, the amounts of potassium (TK) and magnesium (Mg) decreased during storage in the first month and increased in the third month whereas the amount of phosphorus (TP) increased during the first month of storage period and stabled in the third month. The changes in both biological and chemical parameters proved that the vermicompost could be kept up to 3 months with good quality.

Keywords vermicompost, storage, chemical, biological

INTRODUCTION

The trend of demand for organic products in both domestic and international agriculture has increased by a 20 growth rate of percent per year due to the fact that manufacturers and consumers in turn pay much more attention to hygiene, safety, and environmental pollution (Somkhit, 2006). Organic agriculture is a farming system that uses the principles of the ecological balance of natural application to manage agricultural production by incorporating biodiversity of crops, livestock, forestry, fisheries etc. in a supportive and renewable resource in the ecosystem for maximum benefit and by avoiding using inputs imported from outside the farm. This includes the use of synthetic chemical inputs such as fertilizers, pesticides, hormones, antibiotics, etc. In addition, organic agriculture provides high yielding soil, rich nutrient and non-toxic together with low production cost. Using vermicompost is another alternative input in organic farming. The use of vermicompost in the planting phase will result in better soil structure and is also efficient with water and air drainage, greater moisture retention and creates incoherency in soil so that plant roots can thread and spread widely (Edwards et al., 2011). Vermicompost provides a greater variety of microorganisms than in other normal compost. These microbes act to decompose detritus into useful organo-nutrients for plant growth. Compost and worm tea have humic acids which contain nutrients that are essential to many plants such as phosphorus (P), potassium (K), calcium (Ca), iron (Fe), and copper (Cu) and will be released when needed by plants.

Production of vermicompost is a simple technological process, which uses a mixture of organic sludge with earthworms to change the composition of the waste and produce the bio-modified materials that are useful for crops (Iwai et al, 2013). Vermicompost possesses a moldy-grain, fine, brown, and light characteristic material; but its quality inevitably changes with time. In order to obtain optimum efficiency, it is thus important to know how the quality of vermicompost may change due to different storage times.

OBJECTIVE

The aim of this study is to follow and understand the change in quality of vermicompost due to the duration of its storage

METHODOLOGY

The study was conducted at the Center for Learning and Development of Earthworms for Agriculture and Environment Faculty of Agriculture Khon Kaen University. To explore the scope of vermicomposting and sampling vermicompost, the vermicompost produced from *Eudrillus eugeniae* worm species commonly called the African Night Crawler were fed a blend of cassava waste, soil, and cow dung at 7:2:1 ratio. The vermicompost was filled into polypropylene woven bags which were bound tight. The bags were kept in room at a temperature range of 24°C to 35°C with no humidity control, for storage periods of 0, 1, and 3 months, for 3 repetitions each before sampling for analysis of chemical and biological properties. The completed randomize design experiment is used for analysis of variance of the data (analysis of variance) and analysis of the difference between the mean by DMRT (Duncan's Multiple Range Test)

Table 1 Chemical properties of individual blend based used in vermicomposting

Properties	Cassava waste	Cow dung	Soil (sandy soil)
pH	4.95	9.20	5.0
EC (mS/cm)	0.67	3.57	0.35
Organic Matter (OM %)	78.88	54.25	0.45
Total nitrogen (% N)	0.24	1.35	0.021
Total phosphorus (% P)	0.025	0.664	0.008
Total potassium (% K)	0.36	0.495	0.121

Analysis of Chemical Properties

The study of some chemical properties was carried out in the laboratory at the Development and Monitoring Crop and Inputs Group, the Office of Agricultural Research and Development Region 3 Khon Kaen province has analyzed the chemical properties. The pH was measured using a pH meter with a 1:2 ratio of fertilizer to water, electrical conductivity (EC) by using an electrical conductivity meter, total of nitrogen (total N) by using the Kjeldahl method, total phosphorus (total P_2O_5) by using the spectrophotometric molybdovanadophosphate method, total of potassium (total K_2O) by using the flame photometric method and the total calcium (Ca) and magnesium (Mg) by using atomic absorption spectroscopy.

Analysis of Biological Properties

Fungi: The samples of vermicompost are put into the Erlenmeyer flask with 90 mL of sterile distilled water before shaking off the microbes and leaving the sediments to settle. Concentration of the samples is 10^{-1}. The samples are further diluted with sterile distilled water to obtain 10^{-2} and 10^{-3} concentrations. The diluted soil solution is then taken for a spread plate technique on the rose Bengal-streptomycin agar supplemented with streptomycin antibiotic of 30 μg/ml concentration. The dilution is made 3 times with repetitions of each before being fermented at 30 °C for 5-7 days

and counting all organisms.

Bacteria: Ten grams of vermicompost samples are put into the Erlenmeyer flask with 90 mL of sterile distilled water before shaking off the microbes (mixed with sterile distilled water) and leaving the sediments to settle. Dilution of water samples with sterile distilled water is carried out to obtain 10^{-3}, 10^{-4}, and 10^{-5} concentrations. The diluted solution is then taken for a pour plate technique by using the soil extract agar. The dilution is made 3 repetitions each before being fermented at room temperature for 3 days and counting all microorganisms.

RESULTS AND DISCUSSION

Chemical Quality Changes at Different Storage Periods

The vermicompost has the following retention periods: 0 (new fertilizer), 1 and 3 months. The results of chemical analysis are shown in Table 2 below.

Acidity and alkalinity (pH): The pH values decreased in the first month and increased in the third month. The decrease in the first period may be caused by the activities of microorganisms, which are greater in number and relatively to its increasing population. These activities cause acid to occur such as via the nitrification process or mechanism for changing potassium into a soluble form. However, again, the increase in the third month is because of higher amounts of calcium and potassium.

Electrical conductivity (EC): The EC values provided the same analysis results as the pH. The decreased in the first month from 1.25 to 0.84 and again increasing in the third month period from 0.84 to 2.18 may be due to the amount of increasing microorganisms which was affected to the decomposition of organic matter results in an increasing of ion causing the EC values to rise.

Total of potash (T-K_2O): The total of T-K_2O provides a decrease in the first month but increasing in the third month as observed for pH and EC. The increase of EC from 0.63 to 1.13 may be due to the amount of increasing microorganisms. Some groups of microorganisms may produce microbial acid which is the proper pH value in primary mechanism for changing potassium into the soluble form (Payal et al, 2005).

Total of phosphorus (T-P_2O_5): The amount of T-P_2O_5 increased in the first month from 0.30 to 0.66 due to pH value being in the proper range for changing into soluble form. However it decreased in the third month from 0.66 to 0.30 which is to the same at new fertilizer. The reduction may be due to the immobilization. Amount of increasing microorganisms in the compost takes phosphorus in greater quantities for growth.

Total of nitrogen (TN): The TN values slightly increase from 0.33 to 0.47 but not differ statistically during the study. However increased value indicates that there is nitrogen fixation, a process of combining atmospheric nitrogen with other elements to form useful compounds. In nature, nitrogen is fixed by some microorganisms and by lightning, so the greater number of microorganisms in the third months made TN values rise.

Magnesium (Mg) and calcium (Ca): The amount of magnesium decreased in the first month from 0.27 to 0.22 but increased later in the third month period from 0.22 to 0.31 like Ca slightly increased in the third month from 0.65 to 0.68. The changing of values is an affected of greater number of microorganisms, relate to nutrient release from organic matter (mineralization).

Table 2 Chemical properties of vermicompost at various storage periods

Periods of storage	pH	EC (ds/cm)	TN (%)	T- P_2O_5 (%)	T- K_2O (%)	Ca (%)	Mg (%)
0 (New fertilizer)	8.53 a	1.25 b	0.33	0.30 b	0.97 b	0.65	0.27 b
1 month	7.50 c	0.84 c	0.43	0.66 a	0.63 c	0.65	0.22 c
3 monthes	8.33 b	2.18 a	0.47	0.30 b	1.13 a	0.68	0.31 a
F-Test	**	**	ns	**	**	ns	**
Coefficient of variation %	0.58	4.8	19.86	7.89	6.34	8.17	3.73

Note: Mean (n=3) in the same column followed by the same lower case letters are not significantly different at p≤0.05

Biological Quality Changes at Different Storage Periods

The results from analysis of biological properties showed that the number of fungi and bacteria has increased more in the first month of storage. This may be due to microbial activities that are still on going after fermentation ends. However, when stored for a period of three months, the amounts of fungi and bacteria do not differ from the first month. This may be a result of the activity called extracellular enzyme when storing or fermenting the vermicompost. The first step was characterized by a decrease in microbial populations, which resulted in a reduction in the synthesis of new enzymes. The second step was the degradation of the pool of remaining enzymes (Manuel et al, 2007) as shown in Table 3.

Table 3 Biological properties of vermicompost at various storage periods

Periods of Storage	Number of microorganisms (cfu/g)	
	Bacteria	Fungi
0 (New fertilizer)	2.67×10^6 b	2.67×10^2 b
1 month	4.00×10^6 a	4.00×10^2 a
3 monthes	4.00×10^6 a	4.67×10^2 a
F-Test	**	**
Coefficient of variation %	9.38	12.48

Note: Mean (n=3) in the same column followed by the same lower case letters are not significantly different at $p \leq 0.05$

CONCLUSION

The study on the quality change of vermicompost is the study of changes in chemical and biological properties of vermicompost preserved in different periods (0, 1 and 3 months). It was found that the chemical properties of the vermicompost are changing differently, and yet there is no clear trend in the changes of pH, EC, total potash and magnesium. Magnesium decreased in the first period of storage and increased again in later periods while the total nitrogen and total calcium were not significantly different throughout the study. For biological properties, it was found that the numbers of fungi and bacteria were greater in the new stored compost. However, there is no difference in the amount when storing at 1 and 3 months. These results showed that microbial activities had still continued. Therefore, it can be concluded that the fertilizer stored for 3 months is still in the good quality.

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Research article

The Effect of Heating on Vitamin E Decomposition in Edible Palm Oil

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Abstract Currently, palm oil is popular in consumption, and vitamin E in palm oil has been used to indicate the quality. In addition to complexity processing of crude palm oil to edible oil that loses vitamin E, the use of high-heat for cooking, can cause vitamin decay. Therefore, this research aims to study the limit of how much heat affects on vitamin E decomposition; and this result will bring useful information to apply in cooking. This investigation was performed with oil having vitamin E concentration at 80 mg l^{-1} to be heated. Samples were collected when the oil was heated and started smoking and samples were collected every 15 minutes. Then, the samples were analyzed for the vitamin E through the extraction process of a solid phase extraction (SPE), which uses C18 as solid sorbent and dichloromethane as eluent Gas chromatography equipped with flame ionization detector (GC- FID) was operated under the temperature programming mode for quantitative analysis. The results show that the percentage of vitamin E degradation would continuously increase in temperatures ranging from 210 ℃ to 278 ℃ and this degradation rate still constant after a half of hour expansion for oil heating at 278 ℃. So, it's concluded that longer time used in the heating process could affect less to the vitamin E decomposition than increasing the temperature.

Keywords edible palm oil, vitamin E decomposition, SPE, GC - FID

INTRODUCTION

Vitamin E under the term of α - tocopherol is a powerful biological antioxidant. The major biological role of vitamin E is to protect unsaturated fatty acids contained in vegetable oils from oxidation by free radicals (Gordon and Kourimska, 1995). It's believed to reduce the risk of cardiovascular diseases and of certain types of cancer. The main sources of vitamin E in the human diet are vegetable fats and oils. Due to that palm oil contains more saturated fatty acids (up to 50%) and is rich in vitamin E, it can be resistant to the high heat and is resistant to oxidation (Burton and Traber,1990). So for this reason, palm oil is currently the most consumed edible oil in the world. The refining process of edible palm oil industry affects the breakdown of vitamins, so industrial palm oil has added vitamin E before bringing it to the market (Clegg, 1973). Although, vitamin E is relatively resistant to heat and insoluble in water, the high heat cooking such as frying oil can cause a loss of vitamin E. In addition the cooking time and cooking method affect loss vitamins E as well.

Sample treatment for vitamin E analysis often includes saponification, of an isolated lipid fraction. Saponification prior to the extraction is classically performed by heating with potassium hydroxide in ethanol or methanol and analyzed directly. Solid phase extraction (SPE) is a well established method for the concentration and extraction of matrices in various samples. In addition,

the use of SPE has also proven to be an efficient technique for simplifying sample clean- up (Bonvehi, Coll and Rius, 2000).

The tocopherol content of oil and fat can be determined by a wide range of analytical techniques such as spectrophotometer, chromatographic techniques such as supercritical fluid chromatography (Manninen, Laakso and Kallio,1995), gas chromatography (Lechner, Reiter and Lorbeer,1999; Demirkaya and Kadioglu,2007), high performance liquid chromatography (Rupe´rez and et. al., 2001; Schwartza and et. al., 2008). Gas chromatography with flame ionization detection (GC-FID) has been used at a lesser extension to determine vitamin E compare with high performance liquid chromatography. The GC analysis of tocopherols normally implies warm saponification prior to the chromatographic injection (Rupe´rez and et. al., 2001).

This research aims to study the limit of how much heat affects vitamin E decomposition and this result will bring useful information to apply in cooking.

OBJECTIVES

The objectives of this study are;
1. To determine Vitamin E from heated oil using SPE and GC-FID
2. To identify of how much temperature affects vitamin E decay

METHODOLOGY

Reagents and Standard Solutions

Vitamin E (DL- α – tocopherol), n - hexane, methanol and dichloromethane were purchased from Merck (Darmstadt, Germany). Standard stock solution of vitamin E was prepared in hexane to a concentration 500 mg l^{-1} and stored in the dark under refrigeration. Working standard solutions at 30, 40, 50, 80, 100 and 120 mg l^{-1} concentrations were prepared freshly by diluting with hexane. Commercially edible palm oil sample was bought from the local market.

Sample Preparations

Due to the complex composition of edible oil, it was necessary to eliminate large molecular compounds via saponification method for investigation of the performance of analysis method. For saponification, 21.25 g of edible palm oil was placed in an Erlenmeyer flask to which the mixture of 15.5 g l^{-1} 800 ml ascorbic acid solution and 10% w/v potassium hydroxide in 200 ml ethanol were added. After heating the mixture solution to 70 °C in oven for 30 min, the saponification solution was allowed to cool down and 25 g NaCl was added to accelerate phase separation. The upper layer was extracted repeatedly with n–hexane and an aliquot of n–hexane was spiked of 70 mg l^{-1} vitamin E before analysis method that included of SPE followed by GC–FID.

For the study of heat affect to vitamin E decomposition, 0.3333 g. of vitamin E was directly added to 500 ml of edible palm oil (approximately 80 mg l^{-1} concentration). The oil sample was heated until start to smoke and immediately collected 1.2 ml of oil and then diluted to 10 ml. with hexane. Thereafter the sampling was done in the same manner by continuing to keep every 15 minutes until the oil temperature remains constant and the sampling continued for another 3 times then each sampling oil was analyzed method for vitamin E determination.

Instrumentation and Analytical Conditions

Chromatographic analysis was carried out on Varian CP 3800 gas chromatography system equipped with a flame ionization detector. ZB - 5 capillary column (30 m x 0.25 mm I.D. x 0.25 µm. film thickness, USA) was used. H_2 gas was used as carrier gas at a flow–rate of 4 ml min^{-1} and splitless injection was used. The injector and detector temperatures were 255 °C and 300 °C. The oven temperature set at 200 °C held for 1 min then increase to 300 °C at rate 25 °C min^{-1} and held

at 300 °C for 5 min. Quantitative analysis of vitamin E in edible palm oil was performed using standard addition technique, from the standard curve of peak area vs. concentration.

In all SPE experiments, C18 cartridges were conditioned with 6 ml of distilled water, methanol, isopropanol and dichloromethane, respectively. The amount of 1 ml of edible oil solution with 70 mg l^{-1} of vitamin E concentration was twice loaded to SPE cartridge (1 ml per each) and soaking for about 5 minutes and then letting it flow out under the atmospheric flow rate. After loading oil sample, the cartridge was dried under vacuum, to elute vitamin E from cartridge with the same manner as in loading step except soaking time was performed at 30 min. Then this solution was injected to GC – FID for analysis.

RESULTS AND DISCUSSION

Validation of the Analysis Method

For GC - FID analysis, the chromatogram show the retention time of vitamin E in standard solution at 5.735 min. The linearity of the peak area response versus concentration was obtained in the concentration range between 30 to 120 mg l^{-1} (r^2 = 0.995). Precision was determined both within-day and between-day. Repeatability or within - day precision was tested by 7 times analysis of 100mg l^{-1} standard vitamin E solution. The intermediate precision (between – day) was set 3 times analysis of the same concentration as above. The repeatability express as relative standard deviation (% RSD) was 3.11% and the intermediate precision (% RSD) was 2.84%. The limit of detection (LOD) was determined from the intercept of the regression line of the calibration graph using a 30 to 120 mg l^{-1} concentration range. The LOD was set equal to three times the standard deviation of the area at the intercept and illustrated approximately 8.01 mg l^{-1}.

For the evaluation of the extraction recovery, palm oil was spiked with 70 mg l^{-1} vitamin E. The recovery was calculated by comparing the quantitative results obtained by SPE - GC analysis and actual spiked concentration. The percentage recovery was found between 80.1- 86.9% with relative deviations 3.1 (n=5). The results of recovery and validation values are shown in Table 1. Quantification of Vitamin E in edible palm oil was determined via standard addition method and the vitamin E content found in oil was 25.36 mg l^{-1}.

Table 1 Linearity, precision (%RSD), LOD of GC – FID analysis and %recovery of the analysis SPE – GC-FID analysis

GC – FID analysis				SPE – GC-FID analysis	
Concentration range of Linearity(mg l^{-1})	% RSD Within – day (n=7)	% RSD Between – day (n =3)	LOD (mg l^{-1})	% Recovery	% RSD (n= 5)
30 - 120	3.11	2.84	8.01	80.1 – 86.9	3.1

Heat Affecting Decomposition of Vitamin E in Edible Palm Oil

The results of vitamin E decomposition on heating oil was found that the first sampling of oil sample start at 210 ºC. Vitamin E was reduced approximately 6.38% compare with the amount of vitamin E before heated. The heating oil sample still collected continuity every 15 minutes until reach to constant temperature (278 ºC). At this temperature, the sample was further collected for 3 times (15 minutes/each). The decay rate of vitamin E increased rapidly up to 60.70% at the highest temperature (278 ºC) and the decay rate of vitamin E did not significantly increase after expansion of heated time (Table 2). Fig. 1 shows the vitamin E concentration at various heating temperature and sampling time. This result illustrated that oil heated to 278 ºC is not sufficient to completely decompose vitamin E. From the previous research, thermal decomposition of vitamin E in edible oil was completely at about 773 K (500 ºC) (Arora, Bagoria, and Kumar, 2010). It can be noticed that the heating temperature is a more significant factor than the heating time. Generally, the most of food cooking needs high heat, which influences the breakdown of vitamin E during the cooking

process.

Table 2 Heating time, heating temperature and Vitamin E decay after heated

Sampling number and time(min)	Temperature (°C)	Vitamin E concentration (mg l^{-1})	Concentration of vitamin E decay (mg l^{-1})	% Vitamin E decay (mg l^{-1})
1 (Spiked solution)	30	79.9	0	0
2 (0 min)	215	74.8	5.1	6.4
3(15 min)	255	64.1	15.8	19.8
4 (30 min)	261	46.7	33.2	41.6
5 (45 min)	278	31.4	48.5	60.7
6 (60 min)	278	30.9	49	61.3
7 (75 min)	278	30.3	49.4	61.8

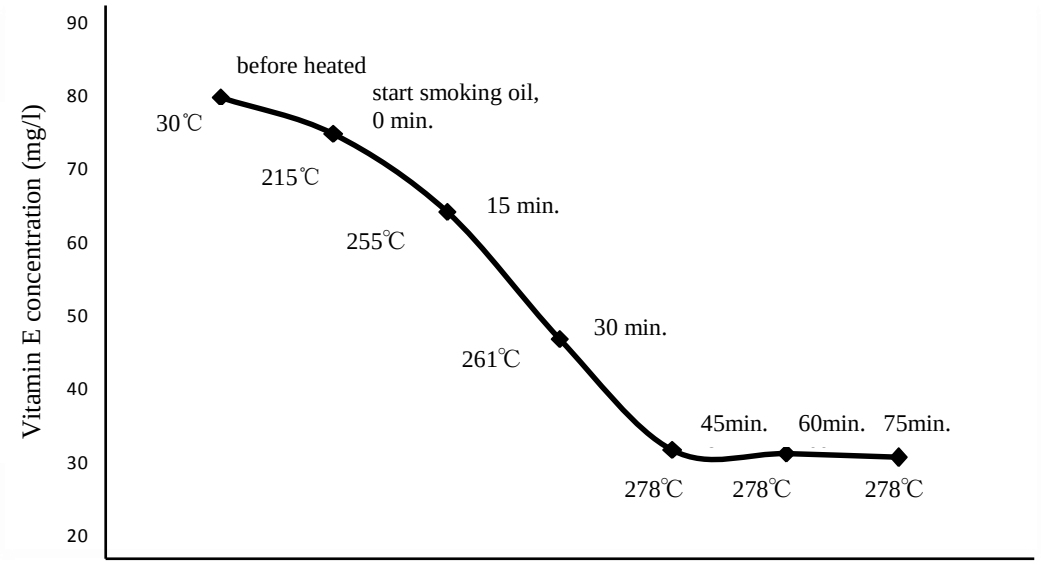

Fig. 1 Vitamin E concentration at various heating temperature and sampling time

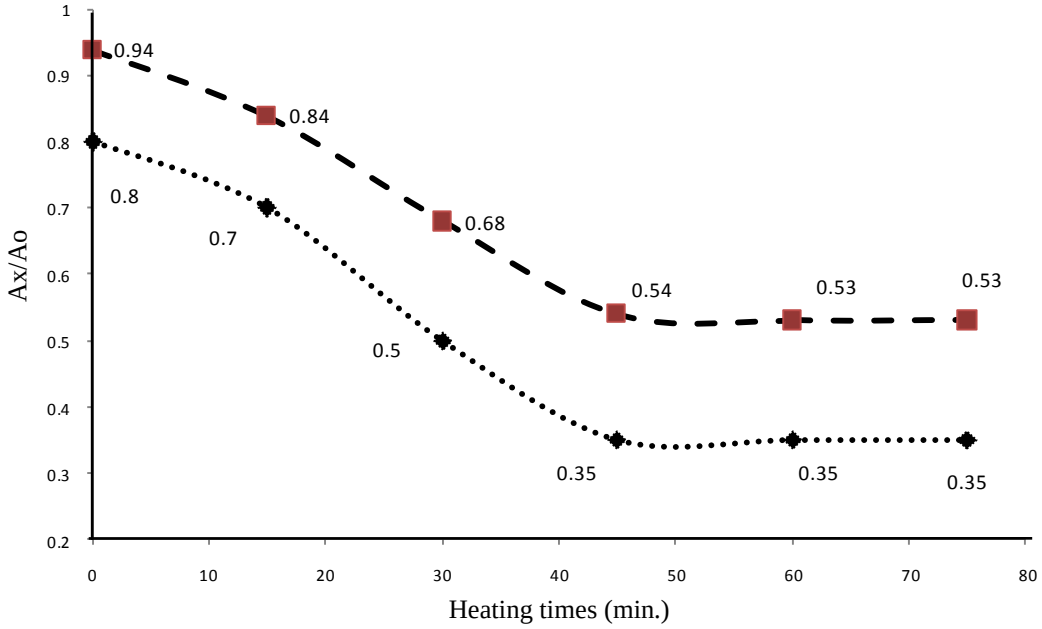

Fig. 2 Comparison of the ratio of the peak area of vitamin E in oil after heated (Ax) to a peak area of vitamin E in oil before heated (Ao) of oils with and without vitamin E added

This work was created in the trial to confirm that vitamin E that is already present in edible palm oil has degraded as well by heating palm oil samples without added vitamin E. The results were expressed by using the ratio of the peak area of vitamin E in oil after heated (Ax) to a peak area of vitamin E in oil before heated (Ao) of both oils (with and without vitamin E added). Those of experiments were shown in Fig. 2 and it can be noticed that vitamin E decay rate of oil with and without vitamin E added were similar.

CONCLUSION

In conclusion, the analysis method to determine vitamin E in edible palm oil was completely validated by using linearity, precision, limit of detection and accuracy in term of percentage of recovery. Vitamin E in edible palm oil can be decomposed during high heat cooking process and the time used to heat oil was less affect to vitamin E decomposition than temperature increasing.

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Research article

Acute Toxicity of Tea Seed Cake on Climbing perch (*Anabas testudineus* (Bloch))

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Abstract Tea seed cake is common used in fish and shrimp farms in Thailand for controlling pond predators such as fish, shellfish or tadpole due to its applicable and affordable price. Climbing perch (*Anabas testudineus* (Bloch)) is one of several problems in aquaculture because it can lead to threatening diseases, the displacement of native species, causing changes to the water quality. Moreover they may effect as destroy or decrease of the productivity. So, acute toxicity of tea seed cake on climbing perch was studied. Statistic bioassay method (48-hr LC_{50}) was a technique to determine the median lethal concentration of the tea seed cake to kill climbing perch within 48 hours. The results showed that limitation of the 48-hr LC_{50} concentration at 95% confidence of tea seed cake on climbing perch (size of approximately 5±2 cm) was 33 (31.16-36.10) ppm. The slope function was 1.361(0.88-2.11) ppm and safe concentration was 1.65 ppm. This result can be used to apply for controlling of fish predator as fish which have accessory respiratory organs for farming application.

Keywords acute toxicity, tea seed cake, climbing perch

INTRODUCTION

Fish predator is one problem of aquaculture farming because it can lead to bring about disease, the displacement of native species, and causing changes quality of product. Similarly, it can cause of decreasing of the production due to raise or mortality. Climbing perch (*Anabas testudineus* (Bloch)) often found in the shrimp pond or fish farming. It is an omnivorous species (Trung, 1999) and consumes various kinds of food such as detritus, aquatic plants, crustaceans, worms, mollusks and insects. Thus, it has been described as carnivore or an insectivore and plays a role of predator (Yakupitiyage et al, 1998). In addition, it is a fast growing species which is able to live in deep or shallow water and can survive in low oxygen condition (Khatune-Jannat et al., 2012). It is also able to migrate between ponds (Trieu and Long, n.d.). Therefore, large numbers of climbing perch in ponds cause slow growth rate or decrease in average productivity. The farmers have tried to eradicate climbing perch with chemicals but many are harmful to the products and also users. Tea seed cake is the residue of *Camellia* sp. seeds after oil extraction that contains 5.2-7.2% of saponin (Minsalan and Chiu, 1986) which is a toxin giving haemolysis of blood. Owing to the eradicable effectiveness of the tea seed cake, many farmers apply it to eliminate predator fishes, shellfish or tadpoles in the fish and shrimp ponds. The effective dosage of crude saponin for eradicating predatory fishes depends on the proportion of body weight, pond's salinity level (Terazaki et al.,

1980) and fish species. In order to provide a guidance of using the tea seed cake, the study of its acute toxicity on climbing perch (*A. testudineus* (Bloch)) is useful for farming application.

OBJECTIVE

An objective of the study was to determine the median lethal concentration of tea seed cake that would result in the eradication of climbing perch (*A. testudineus* (Bloch)) at 48 hours.

METHODOLOGY

Animal preparation: One thousand climbing perch (*A. testudineus* (Bloch)) (size of approximately 5 ± 2 cm) were transported from climbing perch farm in central Thailand to laboratory. They were reared in 500 liter fiber glass tanks that was contained treated fresh water and added aeration for 7 days to acclimatize before bioassay testing. Food did not add over for 24hr before the experiment and throughout testing period.

Chemical preparation: Power tea seed cake that contains saponin 12% as active ingredient is used in the experiment. The tea seed cake solution was prepared in distilled water to dilute concentration for range finding test and definitive test. Each tea seed cake concentration was added one time at the beginning of each test.

Acute toxicity of tea seed cake to climbing perch: Static bioassay method was used to assess the tea seed cake concentration that caused 50% death of climbing perch within 48 hr test period (48-hr LC_{50}) which consist range finding test and definitive test (Rand, 2003).

Range finding test was the determination of the range concentration from the lowest that 100% of test animals dead to the highest that 100% of test animals survived. Variation of the tea seed cake concentration was added at 8 liter of water into 10 liter glass tanks which stocked 10 random selected test animals, and then each treatment was run three replications. Fish were observed and recorded the number of mortalities for 48 hr when they did not have operculum movement and did response while touching with a glass rod. The result of concentration in the first step was used to determine the further concentration in the next step. The experiment for the definitive test was determination of concentration range from the result of previous step on logarithmic scale. The behavioral response and mortality of climbing perch were recorded within 48 hr. Dead fish was immediately removed after recorded.

Temperature, pH and dissolved oxygen were determined with YSI 550A and Sartorius Basic pH Meter PB-11 before and after toxicity test.

Data analysis: 48-hr LC_{50} values and slope function were calculated at 95% confidence limits according to Litchfield and Wilcoxon (1949). Data were plotted on logarithmic-probability paper.

RESULTS AND DISCUSSION

No mortalities were observed in controls and concentration of 19 ppm concentration of tea seed cake during the 48 hr test period. However, mortalities started within 18 hr in the concentration of 25.69 and 34.74 ppm. Meanwhile, the 47 ppm caused mortality of test fish approximately 10.00±1.00% after 6 hr exposure and 100% after 48 hr in all replications. The mortalities were observed increasingly in the high concentration during almost the end of experiment (Table 1). In addition, the 33 ppm (31.16-36.10) was calculated as the 48-hr LC_{50} with 95% of confidence limit for climbing perch (*A.* (Bloch)) of size approximately 3-7 cm in the tea seed cake (Table 2). The result showed high concentration when it was compared with general concentration for usage in fresh or low saline water at 25-30 ppm (Hongkanarat et al., 2011). This is probably due to the tolerance levels of climbing perch in the hard conditions that is an ability to survive in a wide range of chemicals and temperatures owing to its accessory respiratory organs such as a labyrinth organ. The slope function and safe concentration showed that 1.361 (0.88-2.11) and 1.65 ppm, respectively.

Table 1 Accumulative mortality percentage of climbing perch (*A. testudineus* (Bloch)) (mean±SD) after tea seed cake exposure

Duration of exposure to tea seed cake (hr.)	% Accumulative mortality				
	0 ppm	19 ppm	25.69 ppm	34.74 ppm	47 ppm
0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
6	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	10.00±1.00
12	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	16.67±0.58
18	0.00±0.00	0.00±0.00	3.33±0.58	30.00±0.58	36.67±1.15
24	0.00±0.00	0.00±0.00	10.00±0.58	36.67±1.15	83.33±1.15
30	0.00±0.00	0.00±0.00	13.33±0.58	40.00±1.15	96.67±1.53
36	0.00±0.00	0.00±0.00	16.67±0.58	40.00±0.58	96.67±0.00
42	0.00±0.00	0.00±0.00	20.00±0.58	43.33±0.58	96.67±0.00
48	0.00±0.00	0.00±0.00	23.33±0.58	43.33±0.58	100.00±0.00

Table 2 48-hr LC_{50} values and slope function with lower and upper limit of 95% of tea seed cake on climbing perch (*A. testudineus* (Bloch))

48-hr LC_{50}(ppm)	slope function
33 (31.16-36.10)	1.361(0.88-2.11)

In addition to the mortality, exposed climbing perch to the tea seed cake also showed increase in excretion and released more mucus in high concentration treatment. The nearly died fish has an opaque body color compared with normal fish and slow response or movement. For those of mortality experiencing, no movement of fin and operculum at all and they were observed at the bottom of the ponds. The response is in agree with El-Murr et al. (2014) that is likely due to reflection increase of oxidative stress that showed revealed normocytic normochromic anemia and significantly increases level of SOD and CAT activities and gene expression. The damaged of general tissues in various organs was also detected with high doses of tea seed cake (El-Murr et al., 2014). According to Boyd (1990), saponin compound in tea seed cake could destroy erythrocytes and was highly toxic to fish. Also saponin acts chiefly with lowering the surface tension between water and gills of fish and induces haemolysis, so preventing oxygen uptake by fish and leading to slow dead by oxygen deprivation (Lamba, 1970). Moreover, Roy and Munshi (1989) reported that the perch *A. testudineus* that were exposed for 24 hr with 2-5 mg/l saponin showed increasing of 20% oxygen uptake and increased its number of erythrocyte, amount of hemoglobin and hematocrit.

Temperature and pH in all treatments are not different before and after test. Meanwhile dissolved oxygen showed optimum level before the test and decreasing later after the test (Table 3). Nevertheless, these parameters are not likely a cause of climbing perch mortality because the fish can thrive well in deficient dissolved oxygen waters. Moreover, it has better ability of breathing due to its special organs and tolerance of adverse environmental conditions (Trieu and Long, n.d.). For this reason, the fish mortality in the experiment is more likely caused by the tea seed cake toxicity.

Table 3 Temperature, pH and dissolved oxygen levels before and after toxicity test

Concentration of tea seed cake (ppm)	Temperature (°C)		pH		Dissolved oxygen (mg/l)	
	Before	After	Before	After	Before	After
0.00	28.1±0.00	28.3±0.10	7.7±0.00	7.5±0.00	5.08±0.29	2.69±0.16
19.00	27.9±0.00	28.3±0.06	7.7±0.00	7.5±0.00	5.01±0.25	2.48±0.09
25.69	27.9±0.00	28.3±0.06	7.6±0.00	7.5±0.00	4.95±0.09	2.21±0.06
34.74	27.8±0.00	28.2±0.06	7.7±0.00	7.5±0.00	5.33±0.27	2.17±0.08
47.00	27.9±0.00	28.2±0.06	7.7±0.00	7.6±0.00	5.07±0.14	1.27±0.19

However, different fish species showed different tolerances. The species as highest mortality in 24 hr of tea seed cake exposure was observed in *Puntius gonionotus,* followed by *Cyprinus carpio, Gambusia* sp. and *Clarias* sp., whereas tea seed cake toxicity ended after 12 hr

(Chiayvareesajja et al., 1997). Terazaki et al. (1980) reported that the toxicity of saponin weakened with time. In agree with, Hongkanarat et al. (2011) reported that 48-hr LC50 of tea seed cake on Pacific white shrimp (*Litopenaeus vannamei*) post larvae 10 (PL10) was 416.14 ppm at salinity of 30 ppt that showed less toxicity to shrimp larvae. The results of this experiment showed that tea seed cake could be use to control climbing perch in farms. Further study is suggested to study more on the toxicity to other aquatic species for farming application.

CONCLUSION

The study indicates that tea seed cake is a natural product that can be used for eradication of climbing perch (*A. testudineus* (Bloch)) in aquaculture farming. The solution is very applicable control of fish having accessory respiratory organs. Moreover, it is environmental friendly used when apply it following the guideline and thus, giving sustainable utilization.

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Research article

Land Degradation Assessment in El Jicaral Village, Mixteca Region, Mexico

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Abstract Mixteca Region's land resources are being affected by several degradation processes caused by mismanagement of farming systems, deforestation and cattle overgrazing. For assessing the land degradation conditions in a local level, this study was carried out in El Jicaral Village based on the analysis of several variables observed on topographical maps and satellite images. To confirm the reliability and accuracy of the analysis, in the present study a land degradation assessment was carried out through field observation. Along with the assessment, a questionnaire survey was conducted for understanding more the local situation. The questionnaire survey consisted of 24 questions which were divided into three sections: the basic information of local farmers, the application of agricultural chemicals and the current problems in the farming systems. There were 69 households interviewed. Although the results of both assessments were compared, significant difference was not observed between the remote and the field assessments. In addition, it was considered that land degradation information obtained through the remote assessment may be useful for small areas as an alternative method when a field assessment is not possible to be conducted. According to the remote assessment as well as the survey in the research area, it may be concluded that El Jicaral Village is facing a serious land degradation process due to land use conditions in the village, such as crop cultivation under steep slope conditions, deforestation and cattle overgrazing. Furthermore, no soil conservation practices are applied and chemical products are being used without understanding of their negative effects. Due to these conditions, land degradation is a continuing process in El Jicaral Village.

Keywords local farming, land degradation, Mixteca, Mexico, field survey

BACKGROUND AND OBJETIVES

Mixteca Region is one of the poorest regions in Mexico with land degradation and water scarcity situation. The Ministry of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT) estimated around 500,000 hectares in the region presented high levels of land degradation in 1998 (SEMARNAT-CP, 2003). Mixteca Region is located in Oaxaca State in the southern part of Mexico, with a surface of 15, 600 km^2 (INEGI, 2005) and around 450, 000 habitants (INEGI, 2010).

Land degradation is a natural and socioeconomic cause-effect phenomenon (Hammad, 2012). Demand on the land for economic development from an increasing population is driving unsuitable land use changes; hence land degradation through soil erosion, nutrient depletion, salinity, water scarcity, soil pollution, disruption of biological cycles and loss of biodiversity. The causes are multiple and complex, such as the expansion of cattle raising, the over-exploitation of forest resources, deforestation through slash and burn for agricultural practices and for energy needs (UNEP, 2010). Severity of land degradation has been increasing in many parts of the world, where more than 30% of forests, 20% of all cultivated areas and 10% of grasslands are undergoing

degradation (Bai et al., 2008).

In order to assess the land degradation conditions in a local level, a study was conducted in El Jicaral Village based on the analysis of several variables observed on topographical maps and satellite images (May and Mihara, 2013). The results of this assessment showed that more than 35% of the study area was under severe land degradation. To confirm the reliability and accuracy of the remote assessment, in the present study a land degradation assessment was conducted by means of field observation. At the same time a questionnaire survey was carried out for understanding more the local situation. Accordingly, the objectives of this study are to evaluate the viability of the land degradation assessment based on remote assessment compared with the field assessment and to understand better the causes of land degradation through the results of a questionnaire survey on land degradation assessment.

METHODOLOGY

Land Degradation Assessment

According to Kapalanga (2008) soil erosion represents the most extensive areas of degraded land worldwide, as more than 83% of the areas have been affected. In the classification of the land degradation, the processes of soil erosion dominated for rating the degree and extent of the land degradation. Based on this statement, land degradation assessment was conducted in El Jicaral Village through the field observation in the study area divided into a mesh of 50 meters by 50 meters, the same mesh used in the previous study for the remote assessment (May and Mihara, 2013) covering an area of around 0.5 km^2 (Fig. 1). The results of land degradation assessment through this field observation were compared with that through the remote assessment carried out in the previous study.

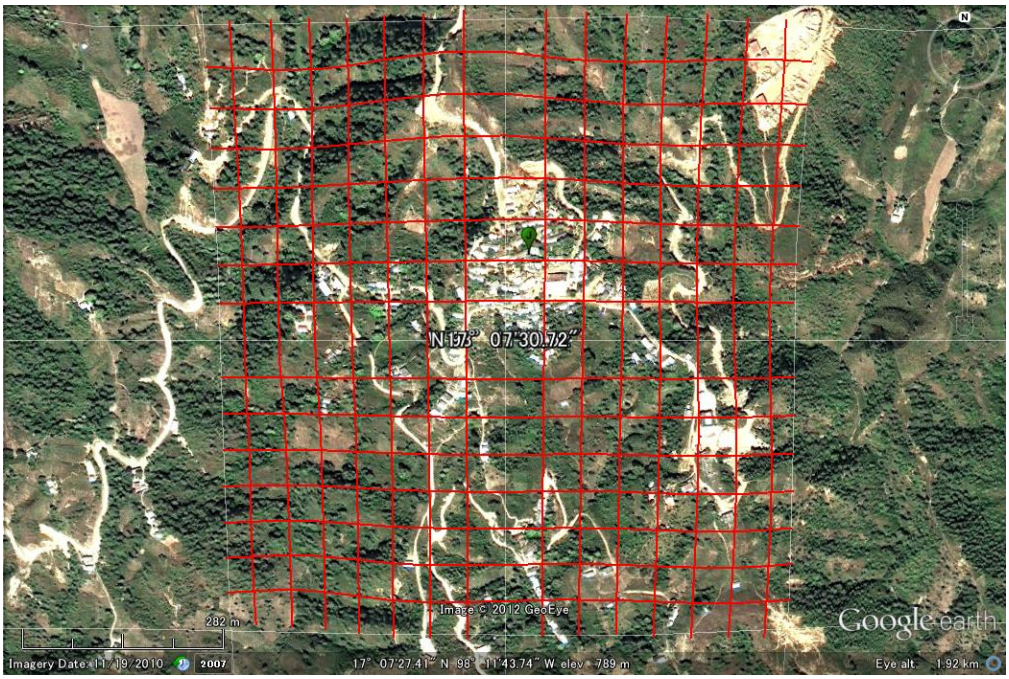


Fig. 1 Land degradation assessment in the study area

In the field assessment, GPS was employed for clarifying the location in every cell. Then detailed observation was conducted based on Morgan Coding System (Morgan, 1995) with rating a value from 0 to 5 at the assigned cell. The Morgan Coding System constituted with several parameters developed for integrated soil erosion appraisal in the field as shown in Table 1. After obtaining a value based on Morgan Coding System for each mesh, a comparison was done between

the field assessment and the remote assessment done in the previous study. For the comparison, statistical method using a correlation analysis was employed.

Table 1 Coding system for soil erosion appraisal in the field

Code	Indicators
0	No exposure of tree roots; no surface crusting; no splash pedestals; over 70% plant cover (ground and canopy)
1	Exposure of tree roots, formation of splash pedestals, soil mounds protected by vegetation, all to depths of 1-10 mm; slight surface crusting; 30-70% plant cover
2	Tree root exposure, splash pedestals and soil mounds to depths of 1-5 cm; crusting of the surface; 30-70% plant cover
3	Tree root exposure, splash pedestals and soil mounds to depths of 5-10 cm; 2-5 mm thickness of surface crust; grass muddied by wash and turned downslope; splays of coarse material due to wash and wind; less than 30% plant cover
4	Tree root exposure, splash pedestals and soil mounds to depths of 5-10 cm; splays of coarse materials; rills up to 1-8 cm deep; bare soil
5	Gullies; rills over 8 cm deep, blow-outs and dunes; bare soil

Questionnaire Survey Conducted in Study Area

Along with the field assessment, the questionnaire survey was conducted in El Jicaral Village, Coicoyán de las Flores Municipality, Mixteca Region, Mexico as additional information for the land degradation assessment. This village was chosen because the degree of poverty is high, as well as it locates in the most land degraded region of the country (PNUD, 2008). El Jicaral Village is an indigenous community with around 1,000 inhabitants, in which people speak in Mixtec, ancient language in the area. The main crops in the village are rain-fed corn, chilly and bean. It locates in the coordinates 17º 07’ 34.6” Latitude North and 98º 11’ 48.9” Longitude West. The questionnaire survey consisted of 24 questions, divided into three sections such as ‘Basic information of local farmers’, ‘Application of agricultural chemicals’ and ‘Current problems in farming systems’ as shown in Table 2.

Table 2 Questionnaire survey for land degradation assessment

Basic information of local farmers	Application of agricultural chemicals	Current problems in farming system
Name, Age, Gender	Application of chemical fertilizers, formula, quantity	Main problems in the farming system
Number of family members working in agricultural sector	Amount of money expend for chemical fertilizers	Soil erosion awareness
Crops, area cultivated, destination of production	Application of pesticides and herbicides	Attendance to soil conservation workshops
Water source, breeding of animals	Application frequency	Concrete information about crops

Fig. 2 Workshop and survey conducted in El Jicaral Village

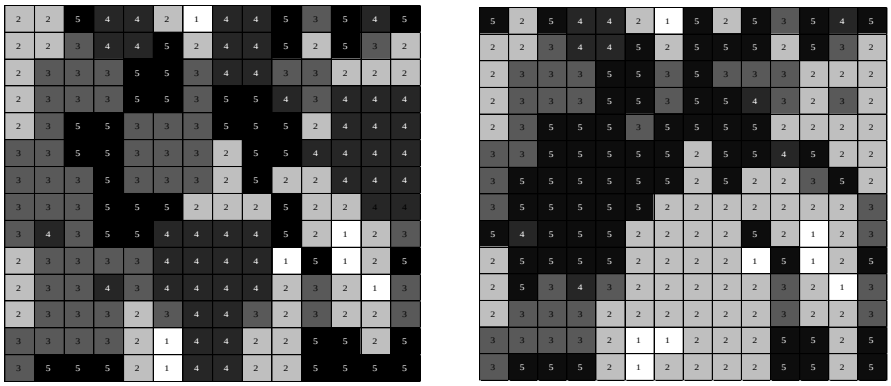
The survey was conducted in July, 2013 in the village with the assistance of a Spanish-Mixtec translator at the workshop on 'Soil conservation for sustainable agriculture' (Fig. 2). The targets were local farmers, being older than 18 years old, who have been conducting agriculture in the village. From one household, only one representative was invited to attend the workshop. There were 69 household interviewees in the workshop and it counted 35% of all 200 households in the village. Due to their local customs, the survey must be divided into several times for each group with around 10 persons.

RESULTS AND DISCUSSION

Land degradation assessment: Field observation, based on the coding system for erosion appraisal, was conducted in the study site. The observation was supported by the use of GPS, in order to make the evaluation inside every cell (Fig. 3)

Fig. 3 Land degradation assessment in the field

The results of the field observation were summarized in the map called "field assessment". On the other hand, there was the map made with "remote assessment" (May and Mihara, 2013), where the identification and classification were carried out based on several variables, such as steepness, slope, vegetation density and land use. In the process to make the map with "remote assessment", these variables were integrated for evaluating land degradation as shown in Fig. 4.



Field assessment **Remote assessment**

Fig. 4 Comparison between land degradation assessments by remote and field methods

After obtaining the land degradation maps with both methods; "field assessment" and "remote assessment", a confidence interval at 99% significant level was selected for evaluating the correlation between both assessments (Fig. 5).

The results of statistical analysis indicated that there was the correlation between both assessments at 99% significant level. It means that the remote assessment based on several variables, such as steepness, slope, vegetation density and land use may be enough for assessing the land degradation in a small scale. This technique is useful when the land degradation assessment is necessary in small areas and not possible to conduct an on-site assessment.

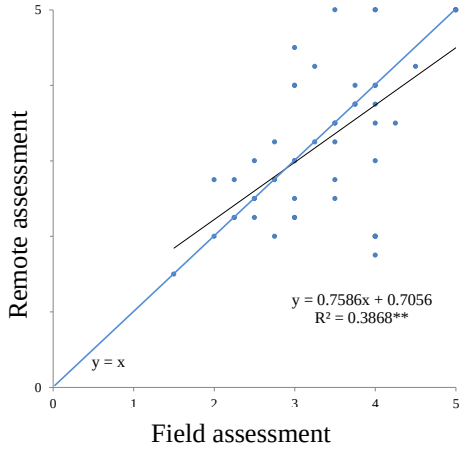


Fig. 5 Correlation between land degradation assessments

Outcomes from questionnaire survey: The results of the questionnaire survey in the village are summarized in the following charts as shown in Fig. 6.

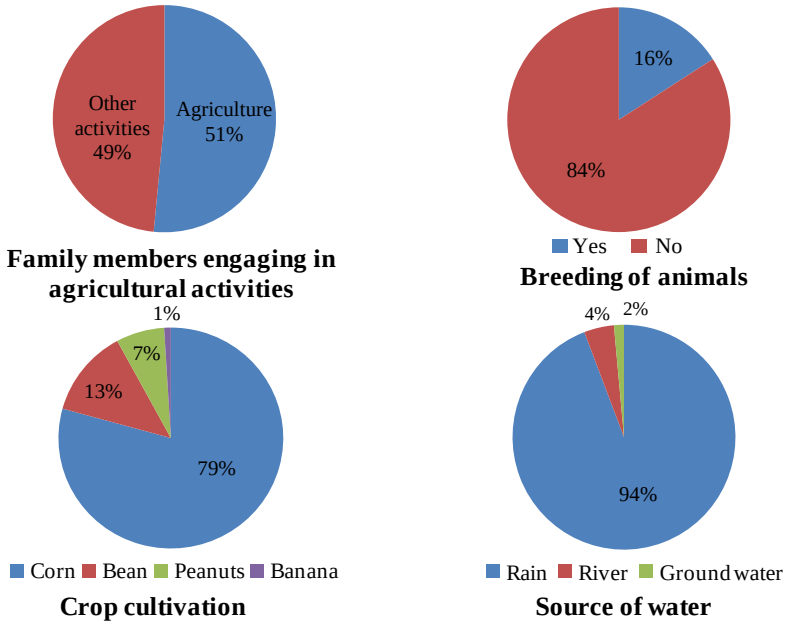


Fig. 6 Basic information of local farmers

It was observed that 35% of the interviewed households dedicated to agricultural activities were between 31 to 40 years old and that 65% was female, this is due to the strong social phenomenon of migration for male. Also, around half of all members at interviewed households were engaged in agricultural activities. The interviewed households at 84% did not breed animals,

and the main crop was corn. It counted at 79% of all cultivated areas hold by interviewed households, followed by beans at 13%. In addition, the main water source for the crop cultivation was rain water at 94%, and followed by river and ground water.

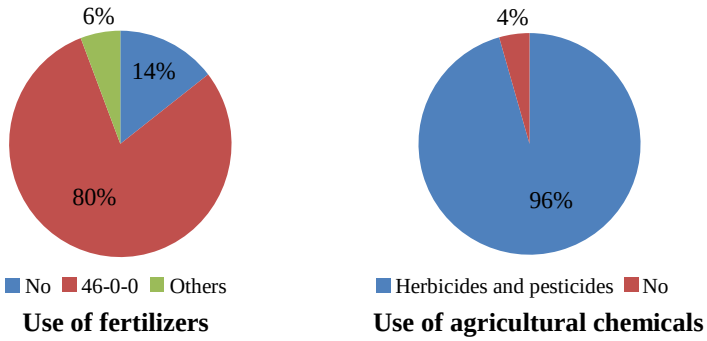


Fig. 7 Application of agricultural chemicals

Concerning the usage of agricultural chemicals, 80% of the interviewed households applied chemical fertilizers and 96% applied herbicides and pesticides to their farmlands as shown in Fig. 7. Some parts of these products are promoted in the Mexican governmental programs.

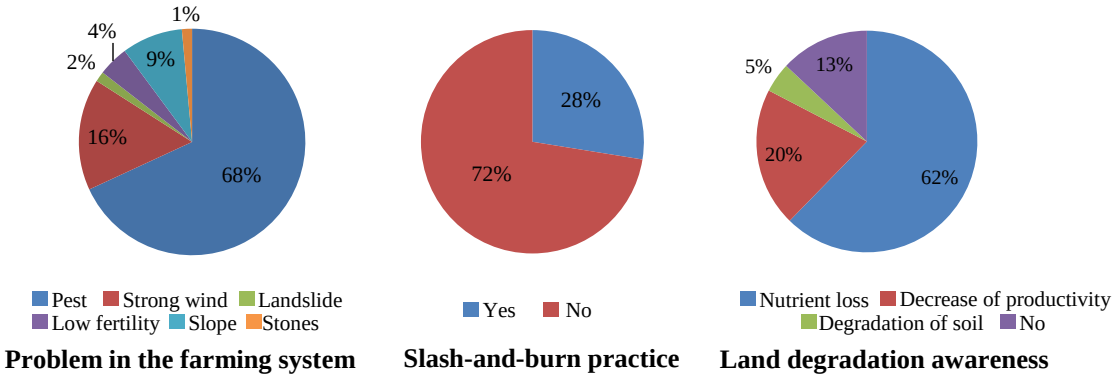


Fig. 8 Current problems in farming systems

Among the problems that farmers face in the village, the main one is pest problem that 68% of the interviewees responded. Especially, the damage by worms like 'gusano cogollero' (*Spodoptera frugiperda*) is severe in the village. The main insecticide applied for the worm is chlorpyrifos. Also, for controlling weeds, the herbicide entitled Paraquat is the most common in the village. However in the village, slash-and-burn farming is not common, as only 28% of the interviewees have been conducting.

Also, the results of questionnaire survey for land degradation assessment indicated that the interviewees had certain awareness on land degradation as well as nutrient loss associated with soil erosion. They also know that the processes of land degradation cause low in land productivity (Fig. 8).

The results of questionnaire survey also indicated that farmers have a perception on land degradation accelerating in the village. Nevertheless, under the current conditions of poverty and less knowledge on sustainable agriculture or land conservation, the farmers have no other alternatives of farming systems. They just continue the same farming even in sloping upland fields for obtaining short-term benefits to survive.

All the interviewed farmers are willing to join land conservation program for sustainable agriculture if there are any opportunities.

CONCLUSION

This study dealt with land degradation assessment through field observation, in addition to remote assessment based on topographical maps and satellite images. Along with the assessment, a questionnaire survey was conducted for understanding more the local situation. According to the remote assessment as well as the field observation through the survey in the research area, it may be concluded that El Jicaral Village is facing a serious land degradation process due to land use conditions in the village, such as crop cultivation under steep slope conditions, deforestation and cattle overgrazing. Furthermore, no soil conservation practices are conducted and chemical products are being used without understanding of their negative effects. Due to these conditions, land degradation is a continuing process in El Jicaral Village.

Although farmers have a perception on land degradation accelerating in the village, they have no other alternatives of farming systems, but just continue the same farming even in sloping upland fields for obtaining short-term benefits to survive. All the interviewed farmers in the village are willing to join land conservation program for sustainable agriculture if there are any opportunities.

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Research article

Mega Construction in Panglao Island, Philippines: The Magnitude of the Possible Biodiversity Losses

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Abstract To support the needs of the booming ecotourism of Bohol province, construction of an international airport across four island villages was to commence in the latter part of 2013. The mega structure would reduce into concrete some 233 hectares of natural habitat and displace its dependent fauna in the impact zones. A biodiversity assessment is one of the requirements in securing the Environmental Compliance Certificate (ECC). This study primarily aimed to assess the biodiversity status in the site. Data were gathered through field surveys employing purposive sampling techniques. The global positioning system (GPS) device was used to get the exact location and elevation of the 350 floral plots and faunal sampling stations. Faunal surveys involved mist-netting and light traps. Ecological parameters analyzed included species diversity, dominance and evenness. Floral results yielded a total of 167 species of plants in 136 genera and 41 families in the project site. Out of 167 plant species, 76 were trees species; 28 shrubs; 24 herbs; 18 grasses; 14 vines; 6 sedges and 1 fig species. Threatened species include *Vitex parviflora* and *Diospyros pilosanthera*. Some 51 species of weeds belonging to 42 genera under 16 families were identified. Results showed a total of 26 avifauna species, 4 bats species and 6 anurans. Of the 26 birds, 20 were endemics. The arthropods survey yielded a total of 84 insect species in 14 Orders and 49 families. It was concluded that species diversity of both flora and fauna was moderate to high. There is an urgent need of an enrichment tree planting of indigenous trees in the rest of the island to harbor the fauna that would soon be displaced from the "wipeout zone".

Keywords biodiversity, endemic, species diversity, species richness / evenness

INTRODUCTION

The Philippine Environmental Impact Assessment (EIA) System requires projects to secure an Environmental Compliance Certificate (ECC) prior to its implementation. It involves a comprehensive EIS (Environmental Impact Statement) that would assure the ecological feasibility of the proposed project. Among the information needed are the biodiversity status of the area and the realistic possible impacts of the proposed project to this natural life-support system.

Municipality of Panglao is composed of ten villages where four of these are part of the proposed 233-ha international airport. The proposed airport site has plain to slightly rolling topography and is largely comprised of Maribojoc limestone, the youngest of the limestone units found in the western area of Bohol. All sites have scrubland type of vegetation characterized with low shrubs, mixed with grasses, herbs, and geophytes. The sites were a mixture of pioneer species and remnants of advanced vegetation. The presence of so many stumps and the coppicing growth of trees/shrubs are evident of the massive cutting during the last decade and a half.

What would be the magnitude of the species and ecosystem biodiversity losses that will be affected with the construction and ensuing operation of the new airport? More importantly, what mitigating plans can be proposed to save the remnant species and their habitats?

OBJECTIVES

This study sought to determine the species composition and assess the diversity, dominance and status of flora and fauna of the proposed Bohol Airport Site in Panglao, Bohol which covers the four villages of Bolod, Danao, Lourdes and Tawala; and to recommend several activities to be included in the environmental management plan of the proposed project.

METHODOLOGY

Flora: Purposive (preferential) sampling technique was employed to obtain quantitative information on the structure and composition of terrestrial plants in the project area. Data collected include plant species names, number of individuals and growth habit. Basal diameter, total height, crown diameter, and the plant's current stature were taken in plots established in scrubs and wooded areas

A total of 120 plots (with a dimension 10 m x 10 m each) were established along the proposed runway across the 4 villages. These were laid mostly on dense scrub thickets where varied species of plants are evident. Some plots were also laid in areas with few scattered small trees and shrubs to have a total picture of the whole area. A 1m x 1m subplot was also established within each plot to assess the associated undergrowth plants.

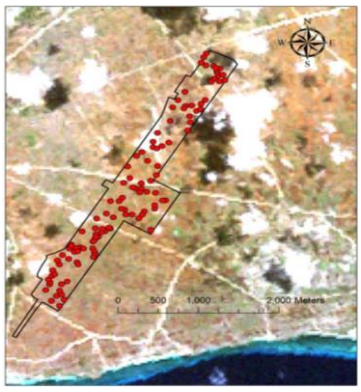

Fig. 1 Sampling plots for higher vegetation

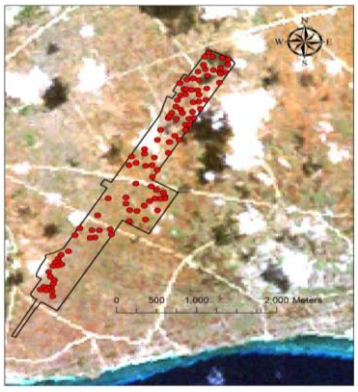

Fig. 2 Sampling plots for weeds assessment

Ecological parameters: Species dominance was determined by computing the species importance value (IV). Importance value considers, not only the density per unit area of a certain species of plants like in the usual faunal assessment, but also includes frequency and cover/basal dominance of all species recorded. It is the sum of the relative density, relative frequency and relative dominance combined as one. The IV was derived using the following formulas:

$$Density = \frac{Total\ number\ of\ a\ species}{Total\ area\ sampled} \tag{1}$$

$$Relative\ Density = \frac{Density\ of\ a\ species}{Total\ densities\ of\ all\ species} \times 100 \tag{2}$$

$$Dominance = \frac{Basal\ area\ of\ a\ species}{Total\ area\ sampled} = \frac{Relative\ percent\ cover\ of\ a\ species}{Total\ area\ sampled} \tag{3}$$

$$Relative\ Dominance = \frac{Dominance\ of\ a\ species}{Total\ dominance\ of\ all\ species} \times 100 \tag{4}$$

$$Frequency = \frac{Number\ of\ times\ a\ species\ is\ encountered}{Total\ number\ of\ plots\ established} \times 100 \tag{5}$$

$$Relative\ Frequency = \frac{Frequency\ of\ a\ species}{Total\ of\ frequency} \times 100 \tag{6}$$

$$Importance\ Value\ (IV) = Rel.\ Density + Rel.\ Dominance + Rel.\ Frequency \tag{7}$$

Indices of species diversity and dominance: Diversity indices were also determined using the richness and dominance computation following the formula of Magurran (1988). Richness measures include Shannon diversity index (H') and Evenness index (E). The former assumes that individuals are randomly sampled from an indefinitely large population. It equally considers that all species are represented in the sample. The latter is the ratio of observed diversity to maximum diversity. Dominance measure, on the other hand, weighs towards the abundances of the commonest species rather than providing a measure of species richness. This, in particular, is computed by the Simpson's index (D). Simpson's index gives the probability that any two individuals drawn at random from an infinitely large community may belong to different species. Species diversity (H'), evenness (E) and Simpson's dominance (D) were assessed using the following formulas:

$$Species\ Divesity\ (H') = -\sum pi\ (\ln pi) \tag{8}$$

where: $pi = \frac{IV\ of\ a\ species}{Total\ IVs\ of\ all\ species} = \frac{number\ of\ individuals\ of\ a\ species}{Total\ number\ of\ indiduals\ of\ all\ species}$

$$Evenness\ Index\ (E) = H^{'} / \ln s \tag{9}$$

where: $s = number\ of\ species$

$$Simpson's\ Index\ (D) = \sum pi^{2} \tag{10}$$

The species diversity index is the ratio between the number of species or importance values that may be expressed as the number of individuals, biomass productivity and the like. A high index value usually means a large number of rare species – "rare" in the sense that, it is represented by a low number of individuals as opposed to high counts for a few common species.

The index of dominance expresses the degree to which the dominance is concentrated in one, several, or many species (Odum, 1971). This is measured using several factors such as the number of individuals, biomass, productivity and others.

Arthropods: The techniques employed in arthropod assessment were pan and light trapping. Twenty-four (24) pan trapping sites were set for eight hours during the day while four light trapping sites at night in the four areas were laid out.

Table 1 Ordinal classification of species richness and dominance indices (adopted from Fernando, et al. 1998)

Relative Values	Species Diversity	Evenness	Dominance
Very high	3.50 – 4.00	0.75 – 1.00	0.75 – 1.00
High	3.00 – 3.49	0.50 – 0.74	0.50 – 0.74
Moderate	2.50 – 2.99	0.25 – 0.49	0.25 – 0.49
Low	2.00 – 2.49	0.15 – 0.24	0.15 – 0.24
Very low	1.00 – 1.99	0.05 – 0.14	0.05 – 0.14

Agricultural crops: Most farms were given up or abandoned a decade ago when the lands were expropiated for the Project. A few remained and these were just listed and given a a cursory inspection.

RESULTS AND DISCUSSION

Flora

Floral results yielded a total of 167 species of plants belonging to 136 genera under 41 families in the project site. The most represented families were Fabaceae, Poaceae, and Euphorbiaceae with more than 10 species and genera. Out of 167 plant species, 76 were trees species; 28 shrubs; 24 herbs; 18 grasses; 14 vines; 6 sedges and 1 strangling fig species. The shrub-layer contained 90 species of plants under 77 genera and 33 families while the undergrowth had 92 plants, belonging to 78 genera and 31 families. *Threatened* species include *Vitex parviflora* and *Diospyros pilosanthera*. *Buchanania arborescens* was found to be the most common in the shrub layer. This was followed by *Glochidion lutescens* and *Myrsine philippinensis*, all are indicators of a karst environment including *Vitex parviflora*. *Chromolaena odorata* and *Imperata cylindrica* were the common undergrowth species. *Bambusa blumeana* (kawayan-tinik) dominated based on its cumulative basal diameter. *Imperata cylindrica* dominated the undergrowth. The diversity and dominance values in the shrub-layer showed a moderate to high species diversity. Its species dominance was very low. The undergrowth had very high species diversity values and consequently a low species dominance.

The implication of moderate and high species diversity and evenness in the shrub layer of the wooded thickets means that there were many species of plants recorded in the sampling plots. The result of the analysis was expected since all types of plants (trees, shrubs, vines and herbs) were noted as long as the shrub-layer minimum limit of 1 meter in height is met. Many literatures also attested to the fact that early succession forests and scrubs similar with the wooded thickets in the project area definitely have high species diversity and consequently have low species dominance. The wooded thicket undergrowth also had very high species diversity and evenness values and low species dominance value since most of the trees, shrubs and vines had dispersed their seeds which now flourished in the floor in addition to several species of grasses and broadleaves which normally grow under partial shade provided by the canopy of trees.

For the weeds, some 51 species belonging to 42 genera under 16 families were identified. Family *Poacea*e (grass family) was the most represented group. *Chrysopogon aciculatus* (amorseko) was the most dominant weed followed by *Imperata cylindrica.* The mean diversity value for weeds in the entire project site is moderate while evenness was high. On agricultural crops, a total number of 23 agricultural crop species belonging to 21 genera under 19 families were

identified. The major agricultural crop species under cultivation were coconuts and bananas. Coconuts, through copra sales, yielded the most family income among the crops grown. The species diversity of the agricultural crops in the project site was very low due to a few species that dominated in the count.

Fauna

Faunal survey results revealed a total of 26 avifauna species, 4 bats species and 6 anurans. It was very remarkable that out of the 26 birds, 20 were endemics. Distribution status was mostly *Common.* The most commonly bird species observed were *Lonchura jagori* and *Aplonis panayensis.* The *Lanius nasutus* (Long-tailed Shrike) birds made an adaptation to the degraded environment by like building their nests on the ground grasses due to the absence of higher vegetation. The bats were the only conspicuous wildlife mammals in the area. The degraded vegetation and habitat conditions could not support the presence of other mammals like monkeys, tarsiers, civet cats, flying lemurs and squirrels. All the six anuran species identified were under the status of *Least Concern* based on the IUCN status list. Two were endemics. A land crab under family *Gecarcinidae* was encountered during the search for anurans in Barangay Bolod.

Anurans: All the six (6) species caught in the entire study area are under the status of *Least Concern* based on the IUCN status list. However, *Limnonectes leytensis* is one of the two endemic anurans which usually thrive in a good habitat like forests with water bodies. The other endemic species, *Kaloula picta,* is commonly found in cultivated agricultural lands. Although the species had the highest number of capture, still, the figure did not indicate a good population of the sites.

Avifauna: Out of the 26 species identified, it was very remarkable that 20 were endemics which suggest an urgent need for conservation through habitat rehabilitation. The most commonly bird species observed were *Lonchura jagori* and *Aplonis panayensis* which are commonly known to thrive in marginal areas like the scrubby study sites. There were endemics like *Lanius nasutus* (Long-tailed Shrike) species which were also common and had made peculiar adaptations like building their nests on the ground grasses due to the absence of higher vegetation.

Mammals: Only bats were conspicuous in the area. The kind of existing vegetation could not support the presence of other mammals like monkeys, tarsiers, civet cats, flying lemurs and squirrels. Out of the four (4) fruit bat species captured, two were endemics. *Cynopterus brachyotis,* a *Widespread* species and most commonly caught, is believed to mainly roost in or near the study sites. This was evident with the observed "leaf-tent" formation that served as roosting place. There were insect bats in the area but were not captured due to their ability to echolocate and easily evade the mist nets. The bats need higher vegetation for roosting and food source.

Arthropods: The arthropods survey yielded the following data: a total of 84 insect species belonging o 14 Orders and 49 families; 6 arachnids belonging to 1 order (Araneae) and 6 families; and 1 *Diplopod* were positively identified. Identification is still to be made with 17 insects and 3 arachnids. The diversity, evenness and dominance varied with different sites from very low to low. However, for nocturnal arthropods, 3 of the 4 sites had high diversity. The dominant species in all sites were the *Hymenopterous* insects which include the ants, wasps and the bees which mostly useful as pollinators, predators, decomposers, parasites and predators of insect pests.

CONCLUSION

From the results, it was concluded that species diversity was moderate to high in terms of higher vegetation (trees and shrubs), undergrowth and weeds. *Buchanania arborescens* dominated the scrubby layer while *Chromolaena odorata* and *Chrysopogon aciculatus* dominated the weeds. Arthropods' diversity varied from low to very low in the sites. Avifauna or birds dominated the faunal component. Species diversity was low among the birds, anurans and bats, but there was high endemicity among the birds. Of the arthropods dominant species in all sites were the *Hymenopterous* insects which include the ants, wasps and the bees which are important pollinators. Coconuts and bananas dominated the plantation and agricultural crops.

RECOMMENDATIONS

There should be an enrichment planting of high vegetation (trees) and shrubs to cover the inevitable losses of species and species populations during the airport development. Other indigenous tree species endemic to the island should be planted to save the affected faunal species which are in dire need of food sources and roosting places. Dipterocarps which are native to the island-province like narig, white lauan, apitong, yakal, manggachapui, manggasinoro, palosapis and mayapis can be used. These are already known to thrive in open plantations in the island like in the neighboring town of Dauis, as well as tree endemics like bagalunga, dao, kalumpit, bitanghol, aniam-gubat and many others can be used too. For food sources, in addition to the existing shrubs, fruit trees like antipolo, breadfruit (kolo), mangoes, Ficus spp. (balete), manzanitas and others can also be planted. The existing molave and sineguelas should be sustained. A minimum of a 20-m wide tall vegetation (with dense crowns) should be established as noise barrier in the immediate periphery of the airport.

Special conservation sites and/or wildlife sanctuaries maybe established away from the noisiest part of the airport. Furthermore, the people particularly the farmers as well as the technicians of the municipality should be ready to understand and prepare for the massive transfer or swarm of the arthropods to the different routes which may include their farms. Conservation and utilization of the plant species already growing in the area like bignay, molave, pandakaki and more should be considered to make sure that the food and host plants will still be available and accessible to the species. These plant species can be used in the avenue planting along the road network within the Panglao island like “bignay boulevard” , “molave avenue” or pandakaki grove”. The municipal local government unit s of Panaglao and Dauis through their respective Municipal Agriculture Office should prepare a pest management plan for the island a year ahead of the New Airport project implementation.

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