Research article

Physical-Chemical Properties of Earthworm Casts in Different Earthworm Species

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Abstract Abstract Earthworms play important role in the soil ecosystem influencing soil properties regulating underlying ecosystem functions such as soil organic matter (SOM) decomposition and soil erosion and quantifying their influence on SOM cycling in tropical ecosystems. The casts produced enhance microbial activities in soil that promote nutrient cycling and help in aggregate formation and stability in soil. The aims of this paper are to study focuses on the dynamic of physical and chemical properties of earthworm casts in different species of earthworm and aging of earthworm. The oven-dried weight of casts has been quantified in laboratory. The soil parameters pH, electrical conductivity (EC), bulk density, porosity, organic matter and exchange capacity were analyzed. The results found that pH values of casts ranged from 6.36 to 8.18. Fresh casts were characterized by higher EC, Mg^{2+}, Ca^{2+}, K^{+}, Na^{+} and organic matter than in old cast. The values were higher in earthworm casts of Khitarae (*Pheretima peguana*). The moisture contents were significantly higher in fresh casts (ranged 6.89 % to 33.93 %). The cast of Khikhu (*Pheretima* sp) bulk density values was highest (1.19 g cm^3). Exchangeable K^{+}, Ca^{2+}, and Mg^{2+} in earthworm casts were higher than bulk soil. Porosity was highest (69.52 %) in fresh casts of Khitarae (*P. peguana*). In conclusion, the physical-chemical properties of earthworm casts were different between the earthworm species. The distribution and biodiversity of earthworm may play and importance role in soil fertility.

Keywords earthworm casts, earthworm epecies, soil properties, aging

INTRODUCTION

Earthworm casts are known to contribute significantly to surface soil fertility in agroecosystems. Earthworm casts are mainly produced during the rainy season in tropical regions (Chaudhuri et al., 2009). Seasonal variations in cast production are attributed to fluctuations in factors including soil physico-chemical properties, land use patterns, feeding habits and availability of food resources. The cast of the earthworm, fortified with mucilaginous secretion, helps in aggregate formation and stability (Shipitalo and Protz, 1988; Marinissen and Dexter, 1990) which is the foundation for soil structure formation. Water stable biogenic structures i.e. organic matter in aggregates are found in the earthworm presence soil (Jouquet et. al., 2004; Bossuytet et al., 2005; Jouquet et. al., 2009). Three ecological categories of earthworms epigeics, anecics and endogeics. Each of these creates earthworm spheres with differing characteristics. The anecics and endogeics are known as soil ecosystem engineers and their impact on soils is great and may influence properties and processes

at the ecosystem level. The functional role of epigeics is primarily that of litter transformers, like other litter invertebrates (Lavelle, 1997).

Therefore, the present investigation was conducted to study physical-chemical properties of earthworm casts of different earthworm species. Earthworm casts properties were measured in order to explain the distribution of earthworm cast on soil ecosystem. This study focuses on the dynamic of physical and chemical properties of earthworm casts from different species of earthworm ranging from low to high casting activity.

MATERIALS AND METHODS

Sampling of Earthworm Casts

Cast samples were collected in three replicates of 50 g each, at the Research Developing and Learning Center on Earthworm for Agriculture and Environment, Khon Kean University, Thailand. Sampling was carried out during two weeks in December 2017. Earthworm casts were divided into two ages: (i.) Fresh cast (from earthworm surface casting activity on soil), and (ii.) Old cast (rounded shape macro-aggregates that were clearly identified not recent). Four species of earthworm were used in this study; (i.) Tiger worm (*Eisenia foetida*); (ii.) African Night Crawler (*Eudrilus eugeniae*); (iii.) Khitarae (*Pheretima peguana*) and ; (iv) Khikhu (*Pheretima* sp.).

Measurements

Cast samples were collected from the study sites by random sampling, particularly near the site of surface casting. Three random samples (25 cm × 25 cm × 30 cm) were collected (Anderson and Ingram,1993). Casts were taken to the laboratory, air-dried, ground with mortar and pestle, and passed through a fine (0.2 mm-mesh) sieve. The study monitored and compared the change of earthworm cast physical and chemical properties. Exchangeable cations and total exchange capacity were measured by the ammonium acetate method at pH 7.0 (Lavkulich, 1981). pH was determined in 1:2.5 (soil:water) suspensions. Organic matter was assessed by measuring total C content with an elemental analyzer by titrating $FeSO_4$ dropwise (Walkley and Black,1980). Soil core (100 cm^3) were collected from 2-7 cm depth. After drying in the oven at 105 ^{0}C during 24 h, gravimetric soil water content was calculated. The weight of soil core and the volume of particle density in soil were measured and used to determine the percent of moisture and porosity.

Statistical Analysis

Data collected were first subjected to classical statistical analysis to obtain descriptive statistics, including minimum, maximum, mean, standard deviation, skewness, and coefficient of variation. Spearman rank order correlation coefficients between cast abundance and all parameters were calculated with Statistical program software. Differences were considered significant, only when P values were lower than 0.05.

RESULTS AND DISCUSSION

The pH values of most casts ranged from 6.36 to 8.18. Fresh casts had higher pH and EC (mS/cm) contents than the old casts ($P<0.05$) (Table 1). The higher pH of cast soil may be due to the ammonia secreted in the worm's gut, which may act as a neutralizing factor (Wallwork, 1983) and the production of calcium carbonate in calciferous glands and its release into the intestine (Lee, 1985).

Organic matter mostly ranged from 2.15 to 11.50 %. Organic matter was significantly higher in earthworm cast type fresh casts (Table 1). It appeared that microbial activity was considerably influenced by organic matter availability in soil. The EC creates hot spots that promote high microbial biomass as they contain higher moisture content and available organic carbon than surrounding soil (Edwards and Bohlen, 1996). Organic matter ranged from 4.99% in old casts to

8.29 % in new casts (Table 2). The lower production of casts in the present study may be attributed partly to the lower abundance of surface casting species of earthworms (viz. *Drawida* sp. and *M. houlleti*) and to low organic matter production in the early stages of the agroforestry sites. Reduction in casting rates has been related both to the degree of plant biomass removal and re-establishment of cover crops (Hauser and Asawalam, 1998). Casts had higher exchangeable cations(mg/kg^{-1}) contents with significant ($P < 0.05$) correlation between worm fresh cast and old casts to the potassium ranging from 435.08 % and 178.85 %, magnesium (283 % and 216.69 %), calcium (2296.2 % and 1754.8%) and sodium (280.42% and 113.42%) (Table 2). In this case, particle size selection by earthworms did not occur and casts only had a higher pH and were enriched in carbon and exchangeable cations (here Ca^{2+}, Mg^{2+} and K^{+}). The amount of organic and mineral materials incorporated into casts varied considerably depending upon diet and whether earthworms were actively feeding or burrowing (Lee and Foster, 1991).

The moisture content was significantly higher in fresh casts and ranged from 6.89 % to 33.93 %. Bulk density values ranged from 0.61 to 1.19 g cm^3 and most of the old casts. Earthworm casts are usually found to have greater exchangeable K^{+}, Ca^{2+}, and Mg^{2+} than bulk soil (Edwards and Bohlen, 1996; Mariani et al., 2007). Particle density and porosity were significantly higher in fresh casts (Table 1).

Table 1 Physical and chemical properties of old casts and new casts in different species of earthworm

Parameter/Species	Khikhu		The Tiger worm		African Night Crawler		Khitarae		CV %
	Old	New	Old	New	Old	New	Old	New	
Chemical									
pH	7.37^{c}	7.05^{d}	6.36^{e}	7.39^{c}	7.13^{d}	7.42^{c}	7.81^{b}	8.18^{a}	1.54
EC (mS/cm)	0.09^{g}	0.24^{f}	1.94^{d}	2.64^{b}	0.97^{e}	2.39^{c}	0.09^{g}	3.16^{a}	3.29
K^{+} (mg/kg^{-1})	56.67^{d}	70.33^{d}	400.63^{b}	434.43^{b}	178.43^{c}	430.93^{b}	79.67^{d}	804.63^{a}	9.36
Mg^{2+} (mg/kg^{-1})	187.60^{e}	216.33^{d}	294.38^{b}	290.23^{bc}	280^{c}	310.80^{a}	104.33^{f}	317.60^{a}	2.91
Ca^{2+} (mg/kg^{-1})	1330.3^{f}	1573^{e}	2186^{d}	2434.3^{bc}	2305.7^{cd}	2625.7^{a}	1197^{f}	2551.7^{a}	4.33
Na^{+} (mg/kg^{-1})	62.67^{f}	117.67^{e}	168.00^{d}	384.00^{a}	160.00^{d}	252.00^{c}	63.00^{f}	368.00^{b}	3.00
Organic matter (%)	3.85^{e}	4.39^{e}	5.69^{d}	7.88^{c}	8.28^{c}	9.36^{b}	2.15^{f}	11.50^{a}	7.30
Physical									
Bulk density	1.19^{a}	1.03^{b}	0.83^{c}	0.69^{d}	0.96^{b}	0.61^{de}	0.61^{de}	0.54^{e}	7.65
Particle density	2.08^{bc}	2.23^{a}	2.08^{bc}	1.98^{cd}	1.92^{d}	2.17^{ab}	1.74^{e}	2.00^{cd}	3.26
Porosity	42.45^{F}	54.20^{de}	60.21^{cd}	65.06^{bc}	50.28^{e}	71.94^{a}	69.23^{ab}	69.80^{ab}	6.02
Moisture (%)	1.85^{f}	15.01^{d}	8.01^{e}	37.33^{b}	2.19^{f}	40.11^{b}	20.69^{c}	43.31^{a}	6.91

Similar letter within the same row indicates no significant difference at p = 0.05 between treatments

Properties Correlation between Species Earthworm Casts

The higher pH values of casts most of Khitarae (*Pheretima peguana*). Casts had higher electrical conductivity (mS/cm) contents than the old casts of the Tiger worm (2.29 mS/cm), African Night Crawler (1.68 mS/cm), Khitarae (1.62 mS/cm) and lower EC (mS/cm) of Khikhu (0.17 mS/cm). Earthworm species Khitarae had higher K^{+} in fresh casts ranging from 804.63 mg/kg^{-1} to 79.67 mg/kg^{-1} and lower in old casts (Table 1). Higher Ca^{2+}, $Mg^{2+}$and Na^{+} was found in the Tiger worm, African Night Crawler and Khitarae species in fresh casts. Lower chemical properties were found in the species Khikhu (*Pheretima* sp). Epigeic species live in, consume, comminute and partially digest surface litter, rarely ingesting soil particles.

The mode of litter processing by earthworms in natural systems results in greater nutrient leaching into the soil. Since epigeics feed purely on litter and generally have a short gut transit time they probably depend on a rapid response of gut microbes to aid in digestion. Epigeic earthworm guts preferentially stimulate some microorganisms, and reduce others leading to a relative dominance of microorganisms different to that found in undigested soils (Lavelle, 1983). Physical properties of casts on earthworm species Khikhu higher bulk density and particle density mean

1.11 (g cm^{-3}) and 2.16 (g cm^{-3}). Such differences in porosity between the earthworm species Khitarae was higher 69.52%, The Tiger worm 62.62 % , African Night Crawler 61.11 % and lower porosity in Khikhu 48.33 %. Moisture higher in Khitarae, The Tiger worm and African Night Crawler range from 37.33 to 43.31% in fresh casts and lower moisture in Khikhu (15.01%) content.

Table 2 Mean value of old casts and new casts and soil physical and chemical properties

Parameter	Old casts	New casts
Chemical		
pH	7.17^{A}	7.51^{B}
EC (mS/cm)	0.77^{B}	2.11^{A}
K^{+} (mg/kg^{-1})	178.85^{B}	435.08^{A}
Mg^{2+} (mg/kg^{-1})	216.69^{B}	283.74^{A}
Ca^{2+} (mg/kg^{-1})	1754.8^{B}	2296.2^{A}
Na^{+} (mg/kg^{-1})	113.42^{B}	280.42^{A}
Organic matter (%)	4.99^{B}	8.29^{A}
Physical		
Bulk density	0.87^{A}	0.73^{B}
Particle density	1.96^{B}	2.09^{A}
Porosity	55.55^{B}	65.25^{A}
Moisture (%)	6.89^{B}	33.94^{A}

Similar letter within the same row indicates no significant difference at p = 0.05 between treatments

CONCLUSION

Our study focuses on the dynamic of physical and chemical properties of earthworm casts in different species of earthworm and aging of earthworm. Our results show that different earthworm species are affected by those properties and the severity of these effects vary between casts for each kind of earthworm. These effects are linked to nutrient gradients in the soil. Earthworm casts are usually found to have greater exchangeable K^{+}, Ca^{2+}, Mg^{2+} and Na^{+} in fresh cast more than bulk soil. Porosity were significantly higher (69.52 %) in fresh casts of Khitarae (*Pheretima peguana*). The lower production of casts in the present study may be attributed partly to the lower abundance of surface casting species of earthworms and reduction in casting rates has been related both to the degree of plant biomass removal and systems.

Although the four studied earthworm species belong to two different ecological groups, no generalization can be made on the respective impact of anecic, epigeic and endogeic species. Microbiological properties should also be measured to better understand the cast functioning under such interactions between soil types and earthworm species. Indeed, physico-chemical and microbiological properties are closely interlinked and contribute together to nutrient cycling in casts.

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Review article

Nutrient Dynamic of Vermicompost Tea after Adding Molasses and Oxygen

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Abstract Nowadays, organic agriculture has become an important activity for control of soil pollution and degradation. The use of organic manures and bio fertilizers are important practices in the field of agriculture. Vermicompost tea is a liquid organic bio fertilizer. Vermicompost tea is composed of plant nutrient, plant hormone and microorganism. However, during storage of the vermicompost tea, its quality could change, hence improving the quality of vermicompost tea is important. The aim of the study was to investigate the changes of quality of vermicompost tea after molasses and oxygen addition. The vermicompost tea used in this study came from the *Eudrilus eugeniae* composting worms, fed with vegetable, soil, cow manure, and ashes of 4:3:2:1 ratio. Experiment design was factorial 4*2 in completely randomized design with three replications. Factor A was different rate of molasses (0%, 0.5%, 2.5% and 5.0%). Factor B was oxygen and non-oxygen. After 3 days, the results showed that there was an interaction of pH, EC, total nitrogen and total phosphate content but no interaction of total potassium content between 2 factors. Nutrient content (total nitrogen, total phosphorus and total potassium) and electrical conductivity (EC) were significantly increased at higher rates of molasses but pH was decreased ($P<0.01$). The addition of oxygen, pH, EC and total potassium content was increased while total nitrogen and total phosphorus were decreased. Therefore, the quality improvement of vermicompost-tea can be achieved by adding molasses.

Keywords Vermicompost tea quality, molasses, oxygen

INTRODUCTION

Organic Agriculture is agricultural production management system that sustains the ecosystems, health of soil and people. This system uses organic substance (e.g., compost. vermicompost, vermicompost tea) and avoids the used synthetic materials or plants, animals or microorganisms derived from genetic modification (National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2009). These synthetic chemicals are fertilizers, pesticides, hormones, antibiotics, etc. In addition, organic agriculture provides high yielding soil, rich in nutrients and non-toxic together with low production cost. Vermicompost tea is liquid biofertilizer from vemicomposting. It is also rich in the macro and micronutrients and growth regulators (e.g., indole acetic acid, gibberellins, and cytokinins) (Arancon et al., 2005) and can also be useful as a foliar spray (Edward et al., 2010). Scientists found that there was an abundance of microorganisms which promoted plant growth and yield. Humic acid in

Vermicompost tea can improve quality of soil (Atiyeh, 2001). However, during storage of the vermicompost tea, quality can be changed, hence improving the quality of vermicompost tea is interesting. The aim of study was to investigate the quality changes of vermicompost tea after molasses and oxygen addition.

METHODOLOGY

Vermicompost-tea

The study was conducted at the Center for Learning and Development of Earthworms for Agriculture and Environment Faculty of Agriculture Khon Kaen University. The vermicompost tea used in this study came from the Eudrilus eugeniae composting worms, fed with vegetable, soil, cow manure, and ashes of 4:3:2:1 ratio used with vermicompost tea for storage time of 6 months

Experiment Design

The pot experiment was conducted under greenhouse conditions. A factorial treatments in 4*2 completely randomized design was installed. Factor A was 0%, 0.5%. 2.5% and 5.0% rate of molasses. Factor B was adding oxygen and non-oxygen on 3 days.

Analysis of Chemical Properties

The study of some chemical properties was carried out in the laboratory at the Central Laboratory (Thailand) Co. Ltd. The pH was measured using a pH meter, 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.

Statistical Analysis

Analysis of variance (ANOVA) was done on the data using Statistix 10 program. Treatment means were compared by applying Least Significant Difference (LSD) and the significant difference was accepted at $P \leq 0.05$.

Table 1 Chemical characteristics of molasses

parameter	Results
H (1:2)	5.1
EC (1:10)	6.63 mS/cm
Total nitrogen	0.3361%
Total phosphorus (T-P_2O_5)	0.133%
Total potassium (T-K_2O)	1.563%

RESULTS AND DISCUSSION

The chemical results of vermicompost-tea after adding different rates of molasses (0%, 0.5%, 2.5% and 5.0%) and oxygen are shown in Table 2.

Table 2 Chemical properties of vermicompost-tea after adding molasses and oxygen

Treatment	pH	EC (mS/cm)	T-N (%)	T-P_2O_5 (%)	T-K_2O (%)
Vermi- tea	8.27 a	11.28 ef	0.0212 d	0.0006 e	0.284 f
Vermi-tea + 0.5%Molasses	7.33 b	10.58 f	0.0073 e	0.0026 b	0.286 f
Vermi-tea + 2.5%Molasses	5.53 d	12.62 cd	0.0243 c	0.0038 a	0.315 e
Vermi-tea + 5.0 %Molasses	5.67 d	13.72 ab	0.0772 a	0.0043 a	0.382 b
Vermi-tea + Oxygen	8.07 a	13.09 bc	0.0197 d	0.0012 de	0.346 cd
Vermi-tea + 0.5%Molasses + Oxygen	7.33 b	11.94 de	0.0197 d	0.0022 b	0.330 de
Vermi-tea + 2.5%Molasses + Oxygen	6.67 c	12.01 de	0.0221 cd	0.0016 cd	0.362 c
Vermi-tea + 5.0 %Molasses + Oxygen	6.43 c	14.43 a	0.0461 b	0.0044 a	0.428 a
Main Factor : A					
Vermi- tea	8.17 a	12.19 b	0.0204 c	0.0009 c	0.315 c
Vermi-tea + 0.5%Molasses	7.33 b	11.26 c	0.0135 d	0.0024 b	0.308 c
Vermi-tea + 2.5%Molasses	6.10 c	12.32 b	0.0232 b	0.0027 b	0.339 b
Vermi-tea + 5.0 %Molasses	6.05 c	14.07 a	0.0616 a	0.0044 a	0.405 a
Main Factor: B					
Non oxygen	6.70 b	12.05 b	0.0325 a	0.0028 a	0.317 b
Oxygen	7.13 a	12.87 a	0.0269 b	0.0024 b	0.367 a
AxB	**	**	**	**	ns
A	**	**	**	**	**
B	**	**	**	**	**
%CV	3.38	3.82	5.04	15.30	3.11

*ns = non significantly difference, ** Significant correlation at 0.01 level, * Significant correlation at 0.05 level*
Means within the row and column followed by the same letter were not significantly different at $p \leq 0.05$ by the Least Significant Difference (LSD)

Acidity and Alkalinity (pH)

There were significantly different values of pH after adding molasses and oxygen ($p \leq 0.01$) and it had interaction between ratio of molasses and oxygen ($p \leq 0.01$). The pH value decreased after adding molasses. It may be due to acidity of molasses but the pH value increased after adding oxygen, possible due to higher amounts of alkalinity.

Electrical Conductivity (EC)

There is significantly different EC after adding molasses and oxygen and it has interaction between ratio of molasses and oxygen ($p \leq 0.01$). The EC values increased after adding molasses and oxygen; this may be due to the amount of increasing microorganisms which was affected by the decomposition of organic matter that resulted in increased ions causing the EC values to rise.

Total of Nitrogen (TN)

There were significantly different values of TN after adding molasses, oxygen ($p \leq 0.01$) and it had interaction between the ratio of molasses and oxygen ($p \leq 0.01$). The TN values increased after adding molasses but decreased after adding oxygen. However, it was bulk matter that increased the TN values and depended on the amount of molasses.

Total of Phosphorus (T-P_2O_5)

The T-P_2O_5 values provided the same analysis results as the TN. There were significantly different values of T-P_2O_5 after adding molasses, oxygen ($p \leq 0.01$) and it also had interaction between the

ratio of molasses and oxygen ($p \leq 0.01$). The T-P_2O_5 values increased after adding molasses but decreased after adding oxygen. The reduction may be due to the immobilization. The amount of increasing microorganisms in the compost takes up phosphorus in greater quantities for growth.

Total of Potash (T-K_2O)

There were significantly different values of T-K_2O after adding molasses, oxygen ($p \leq 0.01$) and it has no interaction between ratio of molasses and oxygen ($p > 0.05$). The T-K_2O provides an increase as observed for EC T-N and T-P_2O_5 after adding molasses. The T-K_2O values increased after adding molasses and oxygen. The increase of EC after adding molasses and oxygen due to the amount of microorganism.

CONCLUSION

The study on the influence of molasses and oxygen on the quality of vermicompost tea proved that nutrient content (total nitrogen, total phosphorus and total potassium) and electric conductivity were significantly increased at higher rates of molasses but pH was decreased ($P<0.01$). On the addition of oxygen, pH, EC and total potassium content were increased while total nitrogen and total phosphorus were decreased. Therefore, the addition of molasses improved the quality of vermicompost tea.

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Research article

Effect of Management and Constraints on Grape Farming: A Case Study in Mirbachakot, Kalakan and Shakardara Districts of Kabul, Afghanistan

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Abstract The skillful management is one of the foremost important success factors for today's farms. When a farm is well managed, it can generate funds for its sustainability. Grape is one of the most diffuse fruits in the world and Afghanistan. Grape is covering an estimated 82,450 hectare which is equivalent 48% of the total fruit growing area with estimated 874.500 tons production and the average yield per year is 8.5 ton/h. Although fresh grape is one of the cash crops however, the quality and quantity are not satisfactory for producers and external markets. The situation has not changed with the years. Therefore, a survey was conducted in 2017 with 60 grape growers, supported by questionnaires in Mirbachakot, Kalakan and Shakardara districts of Kabul province. The purpose was to get an understanding of, 1) current socio-demographic characteristics of farmers, 1) management methods, 3) constraints factors, 4) and contribution of grape farming to household income. Findings indicate that grape farming was predominant 83.3% male activity and main source of annual income. Further, 60% of small-scale grape producers had less than one hectare of land under grape production. Likewise, 50% had more than 10 years and 33.3% between 1-5 years' experience in grape farming. Improper vine training, poor canopy management and weak postharvest vineyard management were the core factors for incidence of pest and disease which put negative effect on grape production. Moreover, high level of farmer's illiteracy and diseases had significant digit effect on growth, yield and quality of grapes. Hence the low quality and quantity of grape are influenced by poor management methods, such as non-availability experts, lack of technical guidance and high initial investment was the severest constraint's factor for development of grape farming in the study site. Thereby the study recommended and suggested that improved managerial skills of farmers and providing initial investment material for grape producers could contribute to address the problems.

Keywords effect, management, constraints, grape, Kabul

INTRODUCTION

Most production economist refers to the production factors as land, labour, and capital. While the decisions on how to use the production inputs and resources, and implementation of the plans are the responsibility of this fourth factor management. The quality of the decisions gives rise to the success of the operation and management skill is clearly critical to efficiency and profit (Peter L. Nuthal, 2010). Farms like other small businesses require sound management to survive and prosper. Land, labor, and capital do not automatically produce fruit or any other products, these resources must be organized into a proper combination, the proper amount and at the proper time for the desired production to occur.

The continual development of new agriculture technologies means that farm managers must stay informed of the latest advances (Ibrahim et al., 2008). Farmers are requiring upgrading of skills and capabilities in farm management and marketing to more efficiently run their farm business (FAO, 2007). Good management is a crucial factor for success of any business especially farms. When a farm is well managed it can generate funds to be sustainable. To be successful, farm managers need to spend more time make management decisions and developing management skills (Ronald et al., 1999). A manager, regardless of position, must use the ideas of scientific management carefully generated by Frederick Taylor during early 20th century. The best management is a real science, which shows that the basic principles of scientific management is applicable for all types of human activities from the simplest of our individual actions to the work of our large companies (Alistair McKinnon, 2003). This is due to production agriculture in Afghanistan and other countries is changing as following; more mechanization, increasing farm size, continued adoption of new production technologies, new marketing alternatives and price fluctuation, and increased business risk (Atul Patil, 2008). These factors create new management problems, but also present new opportunities for managers with the right skills.

Moreover, farm managers and economists have always been interested in the reasons why some farms have higher net incomes than others and the reasons of differences is identified in 1900 century that is managerial skills (USAID, 2005). Historically, farm management researchers and writers have commented the importance of managerial skill (Ronald et al., 1999; Yamuna S. Devarajan, 2009). This aspect of production efficiency and constraints associated with production are seldom highlighted and level of research funds devoted to the areas is quite minimal. This situation is needed to change as any manager is clearly the key to combining resources appropriately to achieve the farm goals. So, it would be worthwhile to study the problems associated with pre and postharvest operations by grape growers in Shakardara, Mirbachakot and Kalakan districts of Kabul province.

METHODOLOGY

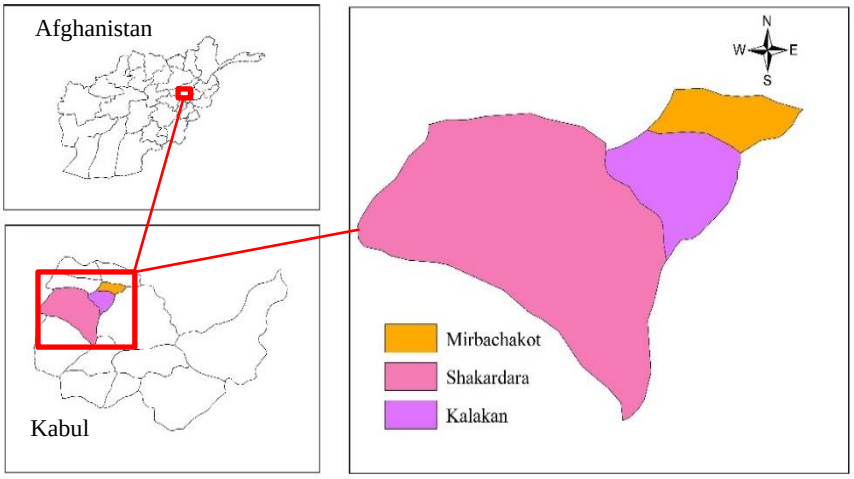

Fig. 1 Map of study sites in Kabul, Afghanistan

A survey of 60 grape growers was randomly selected and conducted in Shakardara, Mirbachakot and Kalakan districts of Kabul province, Afghanistan Fig 1. A face-to- face interview was used supported by structured and semi-structured questionnaire. The questionnaire covered several areas to obtain the objectives of the research. The main aspects covered in the questionnaire were; Questions on socio-demographic characteristics of farmers, management methods, farm size under grape and yield, identify main problems, constraints and the last part of the questionnaire covered contribution of grapevine farming to household income, as experienced by grapevine farming. The

data analyzed using average rank formula and descriptive tools such as the frequency and percentage in excel.

RESULTS AND DISCUSSION

According to Table 1, the majority of grape growers 66.0% were aged 35-64 and 33.3% were less than 35 in trellised grape farmers. While 58.3% of Bush grape farmers were less than 35 years and 41.6% were 35-64 years. Grape farming was a predominantly male activity (83.3% male, 16.6% female), followed by married individuals constituted 66.6%, large family size 5 members and above was characteristics observed from 66.6% of trellised system Fig. 2 compared to 33.3% of bush system Fig.3. The majority of the respondents 66.0% were illiterate, while 21.6% primary and 16.6% had secondary education background.

Table 1 Socio-demographic characteristics of grape farmers

Variable	Trellised grape farmers n=30	Bush grape farmers n=30	All N= 60
Age			
<35	10(33.3)	20(58.3)	30(50)
35-64	20(66.0)	10(41.6)	30(50)
Sex			
Male	25(83.3)	23(76.0)	48(80)
Female	5(16.60)	7(24.0)	12(20)
Marital status			
Married	20(66.6)	20(66.6)	40(66.6)
Single	10(33.3)	10(33.3)	20(33.3)
Education			
None	18(60.0)	19(63.3)	37 (61.6)
Primary	6(20.00)	7(23.3)	13(21.6)
Secondary	6(20.00)	4(13.3)	10(16.6)
Household size			
Less than 5	10(33.3)	20(66.6)	30(50)
5 and above	20(66.6)	10(33.3)	30(50)

Note Parentheses indicate the percentages

Fig. 2 Trellised system

Fig. 3 Bush system

In Australia, grape growers are highly skilled, constantly updating their knowledge of the cultivating, and are interested on adopting new technologies and practices. There is a comprehensive education program at all levels. Several universities are active in the field of practical skills of grape cultivators, and government agricultural agencies properly introduce education in new ways and technology arising from research centers (Rajeev Bhat, 2017). It evidenced that communicating laboratory research or knowledge generated from research centers to local farming communities is an important part of dealing with the sustainability challenges faced by the agriculture sector.

Comparing Traditional and Trellised Grape Farming

To attain your quality goals, you should learn both traditional and modern practices. According Fig. 4 in traditional vineyard system, improper vine training, poor canopy management and weak postharvest vineyard management were the core factors for incidence of pest and disease 45% which put negative effect on grape production. Conversely trellised system not only support the weight or the fruit, but it spreads the grape ensuring sunlight penetrates all parts of the vine. In addition to promoting good air circulation which is essential for keeping down the incidence of disease (reduced 20 %) and produce disease-free grapevines can have an impact on survival, growth yield, susceptibility to pests and diseases, and the quality of fruit. All of which affect profitability and insure the long-term sustainability and success of the vineyard. Proper planting and training of young grapevines are essential for the establishment of a productive vineyard. The objective is to achieve a uniform planting of strong, healthy, well-shaped vines.

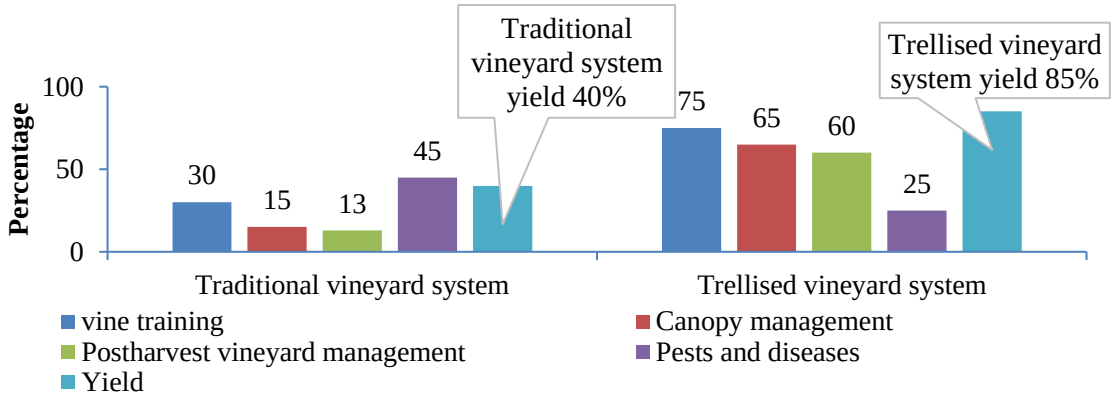

Fig. 1 Comparing traditional and trellised vineyard management system

Table 2 Engage years, farm size and grape yield

Variable	Frequency	Percent
Number of years engage in grape farming		
<5	10	16.6
5-10	20	33.3
>10	30	50.0
Farm size under grape production (hectare)		
<1	35	58.3
1-5	15	25.0
>5	10	16.6
Total yield last year ton/ha		
<10	30	50.0
10-15	20	33.3
>15	10	16.6

According to Table 2 the qualified majority of respondents 50.0 % were engaged in grape farming more than 10 years, 33.3 % between 5-10 years, while only 16.6 % engaged less than <5 years in grape farming. On the other hand, 58.3 % grape farmers had less than <1 hectare, 25 % between 1-5 hectare and 16.6 % more than >5 hectare of land under grape production. The average yield per hectare 12.5 tons which is lower comparing with neighboring countries such as India produce 30 – 50 tons per hectare, due to use of improved varieties, technologies, and moreover very good grapevine management practices.

Average Rank Formula

Descriptive statistics particularly tabulation was used to summarize the data. To determine the constraints and factors that influenced decline in agricultural production, average ranking for each of the ranked causes was used to determine the most influential factors using the formula;

Average rank $P_a = \frac{X_1P_1+X_2P_2+X_3P_3+\cdots+X_nP_n}{Total\ response\ count}$ (1)

Where X_i is the response count for each choice and P_i is the ranked position.

Table 3 Constraints of grape farming as experienced by farmers

Constraints	Rank				
	1st	2nd	3rd	4th	Average Rank
Low price of grape	30(50.0)	20	7	3	1.7
High cost of input	23(38.3)	20	12	5	1.9
Limited access to market	35(58.3)	15	7	3	1.6
Unavailability of cold storage facilities	40(66.6)	10	5	5	1.5
Pests and diseases	35(58.3)	10	6	9	1.7
Water shortage	38(63.3)	12	5	5	1.6
Limited access to quality seedlings	30(50.0)	10	8	12	2.0
Limited access to financial services	20(33.3)	11	18	11	2.1
High initial investment	45(75.0)	6	4	5	1.4
Less response of dealers and distributors in repay the amount in time	28(46.6)	9	12	11	2.1

Note Parentheses indicate the percentages

Based on Table 3 the results reveal that high initial investment average rank was 1.4 and the severest problem which was expressed by (75%) of grape producers followed by lack of storage facilities, limited access to market, and pest and disease average ranked were 1.5, 1.6, 1.7 respectively. This is linked to due to market is mainly domestic and grapes are sold as fresh as no value –adding activities. The market linkages for grapes are therefore weak and undermine the overall growth grape-subsector in the area. Important pests were (leafhopper and spider mites) while major diseases were powdery mildew and downy mildew. These diseases had significant digit effects on growth, yield and quality of grapes. Although data for grape losses due to pests and diseases are not available, discussion with farmers and based on my previous research paper clearly revealed that pests and diseases cause considerable damage to grapevine (Yusufi, 2017).

Table 4 Farmer's preference on grape characteristics for improvement

Characteristic of grape varieties	Score of farmers' preference			Average rank
	1st	2nd	3rd	
High yielding	70	35	15	1.2
Demand for domestic and foreign markets	86	22	12	1.3
Good quality of grape	80	25	15	1.4
Resistance to pests and diseases	85	15	20	1.4
High price	87	14	19	1.4
Need less fertilizer	80	17	23	1.5
Early maturity	75	30	15	1.5
Resistance to drought	60	35	25	1.7

According Table 4, the average rank reveal that varieties with 'high yielding 1.2, more demand for domestic and foreign market characteristics 1.3' were the most preferred by grape growers for they

assure an abundant harvest for family consumption, and extra income to support household expenditure. Followed by good quality, resistance pest and diseases, high price, early maturity, less fertilizer and resistance to drought. In the study site some farmers grew more than one grape variety in their grape farm, but lack of manual labor at peak of harvesting season was one of the problems of the farmers. So, planting a number of early maturing varieties would facilitate better scheduling of labor during harvesting season. Farmers could harvest first the short duration (early maturity) varieties, then medium and late duration varieties. Due to, grape growers usually do not have access refrigeration to stock in the storages at the peak of harvesting season. Therefore, the short duration varieties were very important for them. Uniformity color, taste, shape and medium size were also preferred as farmer's perception that these were indicators of good grape quality as a third preference.

Table 5 Contribution of grape farming to household income

Year	Labor cost*	Initial investment cost AFN**	General expenses	Total cost
2014	75,000 (65.2)	25,000 (21.7)	15,000 (13)	115,000
2015	85,000 (66.9)	27,000 (21.2)	13,000 (10.2)	125,000
2016	87,500 (70.0)	30,000 (24.0)	11,000 (8.8)	128,500
		Value of Grape Production		
	Yield	Price/ kg	Production value	
2014	14,000	20.0	280,000	
2015	10,000	23.0	230,000	
2016	13,500	25.0	337,500	
Average	12,500	22.6	282,333	
		Economics of Grape Production		
	Production value	Production cost	Coefficient	Net income
2014	280,000	115,000	2.4	165,000
2015	230,000	125,000	1.8	105,000
2016	337,000	128,500	2.6	209,000
Average	282,333	122,333	2.2	159,666

**Family labor is accounted and ** Afghani currency*

Based on Table 5 net income from farm produce was derived by production value minus production cost. The average annual net income per household from grape farming was 159.666 AFN, which is equivalent to 70% of the total income. While livestock and livestock products and other agricultural activities contributed only 30 % to household income. Moreover, the average coefficient for the analyzed period from 2014 to 2016 was 2.2; similarly, the coefficient in 2016 was slightly higher 2.6, which was the result of high-value production and high selling price of grape 25 AFN/kg. This reveals there is high potential of household welfare and reducing poverty levels through grape farming, especially when grape productivity is improved.

CONCLUSION

This study indicates that management is a critical factor for success of any business especially agriculture. Land, labor and capital cannot automatically produce fruits. Resources must be organized in the right combination for the desired production. Findings revealed that grape farming is predominantly 83% male activity and the main source of annual income (70%) for small scale farmers in Afghanistan. In trellised vineyard system the incidents of diseases drastically reduced 20% and grape production considerably increased 40%, due to vineyards are properly managed in the light of advice of agriculture experts. Despite this advantage, adoption of trellised system remains low in the research site. In this connection it also found that high initial investment in grape farming 75%, unavailability of cold storage facilities 66.6%, limited access to market that fully derive benefit of grape production 58.3%, scarcity of water 63.3%, pest and diseases 58.3%

were the core constraints factors identified for adoption of trellised system. The poor quality and quantity of grape is affected by weak management practices such as non-availability of experts, lack of access to technical guidance. If these issues are not considered, the long-term viability of grape production will be at risk. Despite the challenges, the result indicated that grape farming not only bring maximum profit to household income but also maintaining sustainability. Thereby, the study recommended that a concrete action should be taken for providing initial investment material and effective extension programme to improve viticulture knowledge of grape producers.

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Research article

The Effectiveness of Liver Fluke Prevention Behaviors Program among Ordinary People in Tao-Ngoi District, Sakon Nakhon Province, Thailand

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Abstract Liver fluke disease (henceforth LFD) in North-East region community remains the significant public health problem in Thailand. It is necessary to carry out disease measures to establish a good prevention practice for ordinary people to reduce the incidence of LFD and cholangiocarcinoma. This quasi-experimental research aimed to study the effectiveness of the Liver Fluke Prevention Behaviors Program (henceforth LFPBP). The study samples included 108 ordinary people from Tao-Ngoi district, Sakon Nakhon province. The samples were randomly selected into the experimental and the control group. There were 54 people in each group equally. The experimental group received the LFPBP designed by the researcher. The questionnaire was used to collect data. Percentage, mean, standard deviation, independent t-test and paired t-test were used to analyze the data. The findings revealed that the experimental group had higher perceived susceptibility of LFD, perceived severity of the LFD, benefits of liver fluke prevention behaviours, cues to action of liver fluke prevention behaviours and self-efficacy on practising liver fluke prevention behaviours than before participating in the program. Also, it showed that the experimental group has statistical significance (.05) than those in the control group. On the other hand, after participating in the program, the subjects in the experimental group reduced the perceived barrier of the liver fluke prevention behaviours than the baseline and then those in the control group at a .05 statistical significance level. In conclusion, the Liver Fluke Prevention Behaviors Program is effective. The local organization in the North-East region, who face with LFD and the cholangiocarcinoma can implement the program in their provinces, in order to promote liver fluke prevention behaviours to the ordinary people.

Keywords health belief model, liver fluke disease (LFD), prevention behaviour, health program modification

INTRODUCTION

The World Health Organization has classified Liver Fluke Disease (*Opisthorchis viverrini*) as a carcinogen causing the highest rate of cholangiocarcinoma in the world and has been an essential problem of Ministry of Public Health for more than 100 years. Cholangiocarcinoma is found predominantly in the north-eastern part of the country making Thailand still the country with the highest incidence of cholangiocarcinoma in the world. Cholangiocarcinoma is one of the leading causes of death in Thailand, 14,000 persons per year, and more than half of those numbers are the population from northeastern Thailand (Department of Disease Control, Ministry of Public Health, 2016). The information from previous disease surveillance indicated that patients suffered from

LFD were accounted for 0.40 of morbidity rate per one hundred thousand populations. Five provinces in northeastern Thailand have a high rate of live fluke incidence. The prevalence rate occurred per 100,000 people of LFD infection were from Sakon Nakhon (15.38), Khon Kaen (4.60) Mukdahan (0.03), Sa Kaeo (0.18), Nakhon Phanom (0.14), see also statistical results from Department of Disease Control, Ministry of Public Health in 2017. Recent evidence suggests that prevalence of LFD in the north-eastern part of Thailand is very high due to the long tradition of consuming fresh-water fish or improperly cooked fish (Rangsin et al., 2009).

It has previously been observed that LFD is still a significant problem which must be urgently solved. Several attempts have been made to address the problem since 1987, the LFD still exists. Probably, it can be said that the operation in previous days was passive instead of proactive to target groups in communities (Ministry of Public Health, Khon Kaen University and National Health Security Office, 2013). In this regards, initiation of the strategy for controlling eating habits of raw fresh-water and improperly cooked fish should be emphasized. For example, education to the people of a high prevalence of liver fluke infection and the long-term consequences of the disease are welcome. It should also bring about the perception of risks in having the disease, severity of the disease, benefits for practices, and barrier for practices. This will, in turn, influence behavior changing of individuals. Since belief in individuals' capability and persuasion to practices can foster people to have sustainable behaviour in preventing LFD and it is consistent with the Health Belief Model (Becker & Maiman, 1974). Therefore, this paper attempts to apply Health Belief Model (HBM) to modify people' s behaviour in preventing LFD, and it can lead to problem-solving and a guideline for developing a scheme to prevent LFD sustainably. This paper begins by stating the objectives and methodology. It will then go on to results and discussion and conclusion.

OBJECTIVES

This study, therefore, set out to assess the effect of LFPBP with the application of Health Belief Model to modify people's behaviour in preventing LFD in Tao-Ngoi District, Sakon Nakhon Province, Thailand.

METHODOLOGY

Research Design

This study is a quasi-experimental research design. There were two groups of the sample; an experimental group and a comparison group (pre-test and post-test). The population in the research is ordinary people aged between 20 to 60 years who have their names in house registration and live in Tao-Ngoi district, Sakon Nakhon province. The sample size is determined by calculation to make a comparison of the difference in means of two groups of the independent population (Jirakun, 2004). References are made to the study result of an application of the health belief model with the integration of participatory learning process for behavioural modification to prevent LFD (Chanthakhuembong, Songkasri & Rattanasang, 2014). There are 54 persons in each sample group from 2 villages of Tao-Ngoi district, Sakon Nakhon province. The criteria selected of the sample are (1) being a large size village, (2) a village share similar aspects of social, economic, and context, and (3) good collaboration of community leaders. Simple random sampling is used to find out a village in the experimental group and a village in the comparison group. By using a random sampling method, I can select the sample who join the program throughout the research voluntarily.

Research Instruments

There are two parts of instruments; instrument used in an experiment and instrument used for data collection according to the following details:

Part 1: The instrument used in an experiment is the LFPBP with the application of the health belief model that the researcher is developed. Village Health Volunteers (VHVs) are assigned to manage the learning process for people through the integration of home visit activity; 2 times for every two weeks. The 1st activity is "Fear with live fluke", and the 2nd activity is "You can visit them." Emphasis is placed on giving news, knowledge sharing with people, presentation of the model, follow-up and evaluation with the use of flip charts and people's manual on LFD prevention.

Part 2: Questionnaire was designed to measure the participants' attitudes towards the effect of LFPBP and comprised of eight parts. Questions in the first part concern general information of the sample, while the questions in part two and three asked participants to rate perceived susceptibility of LFD and severity of the LFD. The third and fourth part of the questionnaire asked participants to rate the perceived benefits of liver fluke prevention behaviours and the perceived barrier of the liver fluke prevention behaviours. The rest of the questionnaire (part 6-8), participants were asked to respond cues to action of liver fluke prevention behaviours, self-efficacy on practising liver fluke prevention behaviours, and liver fluke prevention behaviours. Inter-rater reliability was also employed by five experts. The reliability of the questionnaires was .889 which considered acceptable.

Ethical Approval

Ethical approval was obtained from the Human Research Ethics Committee, Borommarajonani College of Nursing, Nonthaburi Province, Thailand. (COA No. 5/2557 (2014) approved dated 2014/May/30).

Data Analysis

Descriptive statistics; frequency; percentage; means, and standard deviation, is used for data analysis of the sample and inferential statistics; Paired t-test and Independent t-test, is used to compare means.

RESULTS AND DISCUSSION

The data analysis indicated that the sample was divided into 54 persons for an experimental group, and 54 persons for a comparison group. All of them were between 46-60 years of age; female; married; with primary school education level; and they were farmers. Most of them had a history of stool examination for finding LFD.

According to the experimental group's post-test results, we can see that the mean scores by the components of the Health Belief Model; perceived susceptibility, perceived severity, perceived benefits, cues to action, and self-efficacy was higher than the pre-test with a statistical significance ($p<.001$). It also indicated that perceived barrier was lower than the pre-test with a statistical significance ($p<.001$). Meanwhile, prevention behaviours were higher than the pre-test with a statistical significance ($p<.001$). Concerning the comparison group, a factor difference between the pre-test and post-test was self-efficacy (see Table 1). The results obtained from the analysis of components of the Health Belief Model and liver fluke prevention behaviours of the two groups of participants showed no difference. Interestingly, factors in the Health Belief Model and liver fluke prevention behaviours of the experimental group was observed to be better than the comparison group with a statistical significance ($p<.001$) (see also Table 2).

The most striking result to emerge from the data is that liver fluke prevention program with the application of the Health Belief Model was effective. In the post-test, the results of the respondents in the experimental group related to the components of the Health Belief Model and liver fluke prevention behaviours is significant at the $p<.001$ level higher levels of the comparison group.

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in the experimental group related to the components of the Health Belief Model and liver fluke prevention behaviours is significant at the p<.001 level higher levels of the comparison group. A possible explanation for this might be that the LFPBP developed using village health volunteers (VHVs) is useful since the VHVs are considered as a helpful person in the process. Another possible explanation for this is that the VHVs can manage the learning process through the integration of home visit activity (twice). They were responsible for providing information and news, sharing an opinion, doing a model presentation, sharing experience, doing a follow-up modified behaviour through flip charts. In doing so, the developed LFPBP can meet the context of people and people's manual. These results are likely to be related to enabling the experimental group to have better factors according to the components of the Health Belief Model, resulting in better liver fluke prevention behaviours accordingly.

Table 1 Comparison of means of variables in the experimental and comparison groups before and after the operation by LFPBP

Variables	Experimental Group (n=54)						Comparison Group (n=54)					
	Before		After		t	P value	Before		After		t	P value
	Mean	S.D.	Mean	S.D.			Mean	S.D.	Mean	S.D.		
perceived susceptibility	61.82	3.94	67.58	4.90	10.763	<.001	61.73	5.59	61.39	5.26	0.534	.597
perceived severity	23.29	2.85	25.25	3.38	5.980	<.001	22.92	2.52	23.07	2.73	0.558	.578
Perceived benefits	28.52	2.88	30.38	3.13	5.347	<.001	27.92	2.99	28.28	2.85	1.119	.265
perceived barrier	25.00	4.54	23.57	4.75	2.640	<.001	25.43	4.20	25.14	4.80	0.607	.545
cues to action	29.89	3.51	32.24	3.65	5.606	<.001	29.85	3.09	29.82	3.52	0.067	.947
self-efficacy	34.22	5.13	41.13	4.90	12.217	<.001	34.33	5.80	31.63	4.66	3.734	<.001
prevention behaviors	36.32	6.77	44.99	4.42	12.776	<.001	35.25	6.82	36.08	6.14	1.333	.185

Table 2 Comparison of means of variables before and after the operation under LFPBP between the experimental and comparison groups

Variables	Before the experimentation (n=108)						After the experimentation (n=108)					
	Experimental		Control		t	P value	Experimental		Control		t	P value
	Mean	S.D.	Mean	S.D.			Mean	S.D.	Mean	S.D.		
perceived susceptibility	61.82	3.94	61.73	5.59	0.147	.833	67.58	4.90	61.39	5.26	9.443	<.001
perceived severity	23.29	2.85	22.92	2.52	0.792	.429	25.25	3.38	23.07	2.73	5.754	<.001
Perceived benefits	28.52	2.88	27.92	2.99	1.561	.120	30.38	3.13	28.28	2.85	5.418	<.001
perceived barrier	25.00	4.54	25.43	4.20	0.752	.453	23.57	4.75	25.14	4.80	2.556	.011
cues to action	29.89	3.51	29.85	3.09	0.098	.922	32.24	3.65	29.82	3.52	5.225	<.001
self-efficacy	34.22	5.13	34.33	5.80	0.165	.869	41.13	4.90	31.63	4.66	15.377	<.001
prevention behaviors	36.32	6.77	35.25	6.82	1.226	.221	44.99	4.42	36.08	6.14	12.900	<.001

This study is aligned with the study of Health Belief Model from Becker and Maiman (1974). They stated that preventive health behaviour was not expressed until a person believed that disease was so severe and could destroy or do harm to health. Then, that person would decide to have better behaviour to prevent disease. In the meantime, how a person would choose to practice depended on the readiness of body and mind as well as a belief that would be useful or barrier for the practice. In terms of methods, it must be something that they believe they would give them the most benefit and had the least barrier including persuasion for practice. Bandura (1986) suggested that the way individuals believed in their capability, which meant the way that individuals decide their capability to manage and take action to reach their set goals, and it would drive them to express the desired behaviour. The current study found that there were changes in intrapersonal

factors according to the six components of Health Belief Model with different methods through individuals who are close to people and be able to share the same context can drive people to behave and modify their desired behaviour to prevent LFD accordingly.

CONCLUSION

This study has shown that behavioural modification in preventing LFD by developing LFPBP with the application of the Health Belief Model enables people to modify their desired behaviour in preventing liver fluke. The results of this study indicate that related public health agencies in areas where LFD is a problem should take such program into practice by integrating with the routine work of agencies and applying to fit with the context of people and society for sustainability accordingly.

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Research article

Comparison of Organic Farmer-Trainers in Japan and the Philippines

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Abstract Farmer-trainer is a generic term used to address farmers who provide and conduct trainings not only to farmers, but also to other actors such as agricultural extension agents, students, teachers, hobbyists, and businessmen in a community. They play very important roles in the dissemination and adoption of technologies. Through these farmer-trainers, younger generations will be encouraged and motivated to engage in organic farming, and issues related to decreasing number and aging population of existing farmers in Japan and the Philippines can be partially solved. Prior to conducting research about the effectiveness of organic farmer-trainers in Japan and the Philippines, this paper aims to qualitatively explore, interpret, and understand perceptions, experiences, and motivations to compare organic farmer-trainers (OFTs) and institutions of both countries. Using Life History Approach (LHA) and Grounded Theory Approach (GTA), this qualitative study analyzed collected data from interviews and observations of purposively selected four OFT and two institutions. Observations and interviews revealed that OFTs have varied reasons such as sustainability, health, and environmental concerns, and motivations to conduct their respective trainings. These reasons and motivations affect the farmer-trainer's training method and quality, and impact to their respective trainees. In general, Filipino OFTs should consider and adopt the philosophy and uniqueness of how Japanese OFTs conduct trainings and impact the community.

Keywords farmer-trainer, agricultural training, organic agriculture, motivation, qualitative

INTRODUCTION

Japan with 126.89 M population and the Philippines with 102.96 M are respectively on the 6th and 7th place of the top 10 populated countries in Asia. The continent accounts for 60% of the world population (Asia Population, 2017). This population put pressure to the farmers to produce more food as the demand on food and food production also increases. With the huge number of mouths to feed, problems and challenges on food safety and food sufficiency in terms of the decreasing numbers of new farmers arise.

In Japan, one of the greatest factors limiting agricultural sustainability is the shortage of farmers due to lack of new farmers and aging of existing farmers, with an average age of 67 years old (Muramoto, et al., 2010). The food security of the Philippines, on the other hand, is also at risk, as millions of farmers and fishermen are also aging with an average age of 57 years old (Saliot, 2013). Younger generations are not keen on taking over the farm and do not see farming as lucrative career.

To answer these challenges, organic agriculture (OA) appears to have a good potential. Moreover, to encourage younger generations to engage in farming and to uplift the morale of farmers, appropriate and effective dissemination of technologies must be considered. The study of Murshed-E-Jahan and Pemsl (2011) on trainings for Bangladeshi small farmers concluded that providing trainings to build the capacity of farmers is more valuable than the provision of financial support. Moreover, farmer-trainers or trainings involving farmers were also significant in mobilizing and training fellow farmers, hosting demonstration plots, and bulking and distributing planting materials in Kenya (Lukuy et al., 2012) and playing a complementary role to formal extension services in facilitating the spread of agricultural technologies and improving farmers' capacities (Kiptot and Franzel, 2015).

In the Philippines, outstanding farmers are recognized as *Magsasaka Siyentista* (MS) or Farmer-Scientist by the Department of Agriculture (DA). According to Qamar (2012), MS plays vital roles in showcasing and promoting indigenous and science and technology-based agriculture by providing direct farmer-to-farmer extension services based on their own farming experiences. In Japan, "veteran farmers" (*rōnō*) have been acknowledged as the significant instrument in bringing out the success of the policy that seeks ways to develop methods suitable to agriculture since the 1870s, and knowledgeable of traditional farming and conduct farmer-to-farmer activities (Minami, 1986).

Farmers have important roles as scientists in the creation of agricultural technology and educators to disseminate such innovations. Farmers have been increasingly recognized as innovators and experimenters, and their indigenous knowledge have also been accepted as valid and useful in agriculture (Chambers et al., 1989).

OBJECTIVES

Prior to conducting research about the effectiveness of organic farmer-trainers (OFT) in Japan and the Philippines, this paper aims to qualitatively explore, interpret and understand perceptions, experiences and motivations of selected OFTs and institutions to compare the trainers in Japan and the Philippines.

METHODOLOGY

Fig. 1 Map of the Philippines (a) and Japan (b) showing the location of selected farms and institutions
Source: Google Maps

This research is a qualitative study based on interviews and observations of four OFTs (two respondents per country) and two trainers from institutions which were selected using purposive sampling. Life History Approach (LHA) and Grounded Theory Approach (GTA) are utilized to reveal new information, uncover dimensions (e.g. beliefs, thoughts, and motivations), and provide insights into complex relations, which can be critical in order to understand their similarities and differences. A series of field surveys were conducted in May, August and November 2017 in Saitama and Tochigi, Japan, and in March and July to August 2018 in Laguna, Philippines. Figure

1 shows the map, location, and distances from the respective capitals to OFTs' farms and institutions.

Life History Approach (LHA) and Grounded Theory Approach (GTA) were utilized to analyze the lives of farmers in relation to their motivation and reasons why they conduct trainings; and provide the guidelines to identify categories, make links between categories, and establish relationships between them, respectively. Indicators (e.g. motivation, training strategy, contents, and innovation modified or invented) were explored and utilized.

RESULTS AND DISCUSSION

Farmer-trainers in Japan

Since the Japanese government acknowledged the importance of veteran farmer (*rōnō*) (Minami, 1986), there is a need to comprehend how and why they have continued to conduct trainings. Table 1 summarizes the profile, duration, strategy, and method of trainings based on LHA and GTA. Established in 1971-1981, they had an average of 43 years OA training experience. Both OFTs had formal agricultural education and came from farming families. Moreover, both serves as key speakers prior to conducting proper trainings. As training methods, laboratory method (LM; where participants will be actively involved by experiencing the technology or innovation through hands-on activity) and inquiry-based method (IBM; OFTs will only share knowledge on specific topics or technology to trainees if they were asked) are identified. On the other hand, researchers and staff serve as resource speakers prior to the LM for the institution.

Table 1 Profile, duration, strategy, and methods of trainings conducted by selected OFTs and institution in Japan

Farm /Institution Name	J Institution	S Farm (OFT)	K Farm(OFT)
Resource Speaker	Researcher/ Staff	Owner	Owner
Established since	1973	1971	1981
Method of Training	Laboratory Method	Laboratory Method Inquiry-Based Method	Laboratory Method Inquiry-Based Method
Training Packages	Lecture, Tour, Farm Stay	Lecture, Tour, Farm Stay	Lecture, Tour, Farm Stay
Duration	1 day- 9mos [1 day=8hrs]	½ day-12mos [½ day=4 hr]	2-3 years [½ day=4 hr]
Training Fee (1day)	¥1,000 ($8.8 with 2 meals)	¥2,200 ($19.36)	N/A
Training Strategy	Value appreciation then persuasion	OA appreciation and model showcase then persuasion	OA model showcase then persuasion
Training Contents	History, philosophy, vision, and motto	Food and energy of local production-local consumption	Introduction on OA and its benefits
	Enrichment of "Food life" through OA	OA philosophy and motivation	Farm history and motivation
	Servant leadership	OA as a cyclical system	Zero-waste farming
	Community-building	Regional collaboration	Plastic tunnel houses
	OA practices	OA practices	Farm integration
Reasons why OA	Safe and sustainable	OA as lifestyle	Safe food and production
		Sustainability in cyclical system	Trust and good farmer-consumer relationship

Source: Field Survey, 2017 and 2018
Note: Exchange rate: ¥1=USD0.0088

Table 1 also shows that OFTs and J institution have interrelated innovation that they disseminated interconnected reasons why they conducted OA trainings, and linked motivations to do trainings. Interestingly, all training strategies led to persuasion but differed from the initial focus

(e.g. value appreciation, OA appreciation, and model showcase). Moreover, they focus on OA technologies specifically to attain sustainability. Food safety and sustainability are their common denominators as reasons to conduct OA trainings. LHA application on the life experiences of OFTs leads to the clear understanding of their motivations, philosophy, and reasons to conduct trainings.

LHA and GTA in J Institution

The J Institution focused on sustainable agriculture which utilizes methods of integrated OF to help uplift the poor peoples' living condition. Trainings on servant leadership (emphasizing on leader who serves and works at the level of the people, and inspires, motivate and empower them), and how to organize and develop their community (emphasizing on ways to persuade the whole community to participate fully in decision making and contribution abilities) were also included. One training batch commonly involves 30 selected individuals. The institution believes that working, teaching, and learning together for nine months will provide trainees mutual growth and experiences.

The concept of "learning by doing" is also employed to encourage the application of the knowledge they gained during lectures and field trips. Moreover, the idea of "food life" is the center of their training. Trainees also enjoyed the experience of sharing meals prepared from their community farm where every member puts efforts to grow and produce crops and livestock.

This study found that the selected institution conducts trainings to provide servant leaders the capacity to uplift living conditions of poor people through sustainable integrated OA guided by the idea of "food life" towards the community empowerment.

LHA and GTA in S Farm

This OFT shared his motivation and OA philosophy, farm development process and practices, and how OA transformed his community through the years. Training observation revealed that FT was highly determined to encourage the community and other stakeholders by unconditionally sharing his OA knowledge and experiences. He also offered farm stays to any individual including the youth who wish to learn and/or engage in sustainable and integrated OA. He is also involved in *Teikei* system, a mutually beneficial relationship between producers and farmers. Aside from these, OFT proactively supports different OA promotion activities not only in his community but also in the whole country. He also emphasized that community adoption is the key to create an impact.

His determination, philosophy, experiences and motivation are the reasons why he conducts trainings and support different OA activities.

LHA and GTA in K Farm

Participation, observation, and interview revealed that the main objective and mission of this farm are to educate new farmers and assist them in putting up their own organic farm, respectively. OFT commonly gives a short lecture about the farm history and diseases, and nutritional contents of their organic crops. LHA revealed that they have engaged in OA because it is safe for humans and the environment, and they are also involved in *Teikei* system. He has been motivated because "Many people are interested to do OA, and they just need someone to assist them," which he personally encountered.

Farmer-trainers in the Philippines

Aside from the institutions in Laguna, C Farm and A Farm are the two major organic farms that conducts trainings, owned by the two farmer-scientists. Table 2 summarizes the profile, duration, strategy and method of trainings based on LHA and GTA. In institutions, researcher and extension agent (EA) serve as speakers, while owner and/or training staff serve as speakers in the private farms. Agricultural background, method of trainings, training duration and packages also varied.

Related innovations and training contents mainly focused on OA technologies to attain sustainability. It was also observed that training strategies led to persuasion but differed from the attention such as appreciation, model showcase, and provision of options. Food safety was the common denominator of trainers for their reasons to conduct OA trainings.

Table 1 Profile, duration, strategy, and methods of trainings conducted by selected OFTs and institution in the Philippines

Farm/ Institution Name	P Institution	C Farm (OFT)	A Farm (OFT)
Resource Speaker	Researcher/ EA	Owner, Training Staff	Owner, Training Staff
Established since	2008	2005	1987 (OA since 2007)
Method of Training	Laboratory Method	Inquiry-Based Method	Inquiry-Based Method
Training Packages	Lecture, Tour, Hands-on	Tour, Lecture	Tour, Lecture
Duration	10 sessions (8hr/session)	1 day - 6 months	1 day - 6 months
Training Fee (1 day)	Free	Php 1,275 ($24.23)	Government-funded
Training Strategy	OA appreciation then persuasion	OA model showcase then persuasion	provision of options then persuasion
Training Contents	Definition, history, importance of OA	Definition, advantages of OA, farm history	Definition, advantages of OA, farm history
	Natural farm inputs	Zero-waste farming	Zero-waste farming
	Seed Production	Vermicomposting	Fruit propagation
		Farm integration	Farm integration
Reason why OA	Safe and sustainable	Safe and sustainable	Safe food and production,
		No feeding of toxics to own family	Trust and good farmer-consumer relationship

Source: Field Survey, 2017 and 2018
Note: Exchange rate: Php1=USD0.019

LHA and GTA in P Institution

LHA revealed that P institution "starts training by appreciation then persuasion," conveying that farmer needs to appreciate first what they are doing for them to understand the importance of each technical or theoretical lecture in the training. After understanding the importance, persuasion is done using video presentations and true-to-life story sharing. Technical discussions of innovation will follow and focus on production of natural farm inputs such as bio pesticide, botanical concoctions as fertilizers, and how the farmers can produce their own seeds. The trainer from the institution also added that "Farmers are proud of themselves as they were given a chance to uplift their morale and boost their confidence. Every time they share their experiences, they feel important." These were some of the observations she encountered during the interaction with the farmers. These were also the reasons why she continues to conduct trainings on OA.

LHA and GTA in C Farm

Initially, C farm harvests were only for family consumption to feed their children fresh, nutritious, toxic- and chemicals-free food. With no farming background, OFT had difficulty in starting OA. They even needed to go abroad to attend trainings and to adopt different technologies. Since most Filipino farmers do not have the capacity or means to study abroad and attend trainings, OFT decided to share their learnings and technologies to farmers and interested individuals. Moreover, their own experiences and struggles motivated them to share what they know through trainings.

LHA and GTA in A Farm

A Farm also catered to farmer-participants in their farm. Their philosophy and motivations pushed them to conduct training and share what they discovered to other farmers. They also have the passion and hope that there will be more people who can benefit and enjoy the advantages of OA,

while ensuring safe food for the consumer and safe management production for the farmer and environment. This OFT believe that OA creates trust and good farmer-consumer relationships.

Comparison Between OFT in Japan and the Philippines

LHA and GTA revealed that OFTs in Japan and the Philippines have varied training methods, packages, duration, and contents. Japanese OFTs have formal education as agricultural background, while Filipino OFTs only have trainings and experiences of experimentation in their farm. Different training strategies were identified but all led to persuasion in adopting OA practices. All OFTs in both countries are motivated and recognized the importance of OA in food and environmental safety, and sustainability. Japanese OFTs are hands-on trainers as they personally conduct every training that utilizes both laboratory method and inquiry-based learning method to ensure that their trainees really understood and can apply what they learned. On the other hand, the Filipino OFTs need support of their respective staff in conducting trainings and are focused on inquiry-based method. Therefore, their technology or innovations, reasons of practicing OA, and philosophy and motivations are interrelated.

CONCLUSION

Based on observations and interviews, this study concludes that OFTs in Japan and the Philippines have varied training methods, packages, duration, strategy, and contents. In contrast, their technology or innovations, reasons, and philosophy and motivations of practicing and conducting trainings in OA, are interrelated and basically grounded in disseminating the advantages of OA in safe food and production, environment conservation, and attainment of sustainability to further persuade adaptors.

In general, it can also be concluded that being hands-on farmer-trainers in Japan that utilizes both laboratory method and inquiry-based learning method, guarantees a better understanding and application of the subject matter to another farmers. Filipino OFT should consider and adopt the philosophy and uniqueness on how Japanese OFT conduct the trainings and impact the community.

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Research article

The Feasibility Study of the Greenhouse with a Temperature and Humidity Controller Utilization in Sunflower (*Helianthus annus* L.) Seedling

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Abstract Global temperatures have raised because of phenomena such as Greenhouse effect and Global warming. Theses phenomena affect primary producers; plants, on earth. As health issues become significant in Thai society, variety types of healthy food are available in Thai markets, Sunflower sprouts are sold among them. The controlled room or greenhouse became needier in plantation and seedling because air temperatures and humidity can be adjusted and controlled to suit plants inside the greenhouse, the temperatures in the greenhouse could be reduced from 2 to 10 Celsius and relative humidity could be arranged from 70 to 99%RH. This work focused on utilizing the greenhouse installed with the developed temperature and humidity controller in sunflower seedling for income earning in a community. A new temperature and humidity controller including sensors was designed and fabricated to control conditions inside the greenhouse based on Arduino technology with a low fabrication cost and easy to program as well as maintenance. The greenhouse investigation was performed by using three different sunflower seedling nutrient solutions which were affordable and locally available solutions; a commercial nutrient solution, solutions prepared from cattle and earthworm manure bio-extracts, and three different seedling materials; cotton balls, coconut coir and loam. The greenhouse was set 4 Celsius lower than ambient temperatures and temperature and different relative humidity values compared with the ambient air were set to be between 25 and 35 %RH, the greenhouse performance in this work was indicated by sunflower sprout germination percentage and germination index. From the experimental results, the maximum sunflower sprout germination percentage at 91.11% and the maximum germination index at 13.98 were obtained when the sunflower seeds were grown in the coconut coir with the solution prepared from earthworm manure bio-extracts, the higher germination percentage than that of a literature. The greenhouse with the developed in-house temperature and humidity controller has proved its performance in seedling sunflower sprouts and this feasibility study has shown that it had potentiality to be used in a household seedling application.

Keywords greenhouse, sunflower, seedling, controller and heat and mass transfer

INTRODUCTION

According to the current world's environment situation, the rising of the world's temperature leading to many phenomena (Kelemen et al., 2009). Greenhouse effect and Global warming are some of the examples that affect the plant, the primary producer and the main source of food for all living things. Thus, a greenhouse with a temperature and humidity controller is interesting for farmers in plantation and seedling plants due to its ability to control temperature and humidity for each plant growing condition. Healthy diets have become significant, especially vegetable which

contains essential nutrition and good for health. One of vegetables that has become more prominent is a sunflower sprout. All parts of the sunflower have many economic values and many beneficial properties, so it has become prominent. The sunflower sprouts are consumed by a group of health lover consumers due to their rich of essential nutrition that good for health. Bhuwapat et al. (2016) informed that sunflower sprouts have great scent, crunchy and sweet, and edible both fresh and cook such as salad, spicy salad, papaya salad, stir fried with oyster sauce, soup, and noodle instead of bean sprout (Department of Agricultural Extension 2016).

Ugate et al. (2015) presented a study to compare seedling materials and seed soaking periods that affected increasing of the sprouts in 2 experiments. In the first experiment, the seedling of sunflower seeds was performed in 13 different materials for 7 days. The experimental results showed that black husk provided the highest germination rate and the best height and weight products per 100 seeds. In the second experiment, they soaked sunflower seeds in water in two different temperatures; 27 °C and 50 °C, for 4, 8, 12 and 16 hours, then, they grew seedlings in black husk for 7 days. The experiment showed that the soaked seeds in 50 °C water for 16 hours provided the best products. Kiatsakul (2016) presented a study of material and seedling methodology of sunflower for commercial purposes. He had soaked sunflower seeds in water for 16 hours, then, he incubated the seeds for 24 hours. The 5-day seedling was performed in four mixing-seedling materials; compost and coconut coir (1:1), seedling material and coconut coir (1:1) and (2:1), as well as soil and compost (1:1). In the second experiment, he had soaked sunflower seeds in the water for 24 hours and he did seedling both floated seeds and sunk seeds. The experimental results showed that the composition of seedling material and coconut coir (2:1) and the floated seeds provided 83.33% of sunflower germination and produced the heaviest sprouts. Threesurn and Junmatong (2017) introduced a study of soaking a seed in Salicylic acid (Salicylic, SA) that affected germination, growth and ability to be antioxidant of sunflower sprouts. The results showed that soaking seeds in SA had no effect on sunflower seed germination. Soaking seeds in the SA solution in the 500-micromole concentration could increase the growth rate of sunflower. Sunflower sprouts which were grown from soaking in the SA solution had a better ability to inhibit oxidation than those of the control unit.

Numhormchan and Sareepattananon (2014) designed and developed the temperature and humidity control system for the hydroponics greenhouse using a water-cooling system with Programmable Logic Control (PLC) as a controller. The PLC controller received analog signal from temperature and humidity sensors inside the greenhouse in front of the controlling unit which was designed to work manually and automatically. The results showed that the automatic controlled system could turn on and turn off the system perfectly within the assigned time. The system could order the water-cooling system to work according to the set time and temperature criteria. Inside the greenhouse, the average temperature was 30.45°C and the average humidity level was 80.54%. The water spray worked averagely 10 minutes per day, and the water evaporate cooling system worked averagely at 6.37 hours per day. Cheng and Wang develop (2016) presented a distributed and multi-span measurement and control system for a greenhouse. Their system was based on the Controller Area Network (CAN bus) for communication technology and embedded technology. They measured temperature, moisture, illumination. They also presented their circuit software and hardware. They claimed that their control system enabled the greenhouse to work as their design and goal.

This research focused on developing a greenhouse with a temperature and humidity control system by using Arduino technology which had a low fabrication cost and low maintenance. The controlling software was also designed based on Arduino technology to control a water pump and a fan in an evaporative cooling system. The cooling system was used to reduce heat inside the greenhouse to bring air temperature inside the greenhouse down. The control system could switch on and off another fan on top of the greenhouse which took water vapor inside the greenhouse out to reduce relative humidity of the greenhouse. In this study sunflower sprouts were chosen as a subject in seedling. All seedling equipment, seedling materials and nutrient solutions could be found and could be produced locally. All nine experiments were performed to investigate the greenhouse performance germination percentages and indexes. These parameters were used to indicate the greenhouse performance in applying for the sunflower seedling. The information from

this work could be used to promote sunflower seedling inside the greenhouse with the affordable temperature and humidity controller plantation system in a greenhouse like Evaporative Cooling was developed and widely used for agricultural purposes.

OBJECTIVE

This research focused on developing a greenhouse with a temperature and humidity controller by using Arduino technology which had low investment and maintenance cost. In this study sunflower sprouts were chosen as a subject in seedling. All seedling equipment, seedling materials and nutrient solutions could be found and could be produced locally. All nine experiments were performed to investigate the greenhouse performance. Germination percentages and indexes were used to indicate the greenhouse performance in applying for the sunflower seedling. The information from this work could be used to promote sunflower seedling inside the greenhouse with the affordable temperature and humidity controller.

METHODOLOGY

The greenhouse which was studied and developed in this work was 1.8 meters in width, 2.1 meters in length, 3.1 meters in height and covered with opaque plastic sheets. The temperature and relative humidity of air inside the greenhouse were controlled by an Arduino based system operated by in-house commands to control the Arduino board. The set different air temperature between inside and outside the greenhouse were 3 – 5 °C, and the set relative humidity levels were 80-98% RH to keep the temperature inside the greenhouse stable and suitable for the plantation. If the temperature and humidity were not in the set ranges, a relay would order a fan and/or a water pump to start working immediately, the temperature and humidity level data were obtained from sensors inside the greenhouse. When the temperature and humidity levels returned to the set ranges, the fan and the water pump stopped working. The sunflower seeds were planted inside the greenhouse to observe the growth of them as the greenhouse performance indexes. The relative humidity and temperature of air; both inside and outside the greenhouse, were observed and collected. Among 9 experiments, each experiment consisted of 3 replications. Three nutrient solutions were as following;

1. Commercial nutrient solution (15% by volume of Nitrogen, 15% by volume of Phosphorus and 15% by volume of Potassium): 10 ml of the solution mixed with 20 L of water as the company suggestion on a label,
2. Cattle manure bio-extract: 1 L of the solution mixed with 5 L of water having pH in the 6.5 – 7.5 range, and
3. Earthworm manure bio-extract: 250 ml of the solution mixed with 15 L of water.

Three seedling materials were as following;

1. Cotton,
2. Coconut coir, and
3. Planting soil from local market.

All sunflower seeds were purchased from the local market. The seed had been soaked for 16 hours, incubated for 24 hours and seeded in 29 cm x 17 cm seedling containers for 7 days. Each maintainer contained 50 seeds to be observed for their growth. During the 7-day seedling period, the temperature and relative humidity values of air inside and outside the greenhouse were collected. The sprouts at 7 days old were collected and counted for their amounts. Collected data during the harvest period were used to calculate germination percentage (G % in a unit of %) and germination index (dimensionless) as following equations;

$$\text{Germination percentage} = \frac{\text{The number of normal sprouts}}{\text{The total number of seeds}} \times 100 \quad (1)$$

$$\text{Germination index} = \sum \frac{\text{The number of normal sprouts}}{\text{The number of seedling days}} \quad (2)$$

RESULTS AND DISCUSSION

The greenhouse, which was installed with the temperature and humidity control system (Fig. 1a), was shown in Fig. 1b. Two sets of the sensors were placed in the middle and near the back wall of the greenhouse. We checked temperature distributions inside the greenhouse (Pramuanjaroenkij et al., 2018) and found that the closer area to the greenhouse wall, the higher temperatures and the closer area to the cooling pads, the lower temperatures. The temperature and humidity control system was controlled by the in-house Arduino codes was written and synchronized with and Arduino board of the controller. In the codes, the temperature was set to turn on the water pump when the temperature was higher than 30 °C to maintain the different temperatures between the inside and outside greenhouse to be in the range of 3 – 5 °C. The humidity was set to turn on the ventilating fan when the relative humidity was higher than 75 %RH. The operating results of the greenhouse was shown in Table 1. From the results, we found that the temperatures and relative humidity were in the designed ranges, 3 – 5 °C and 80 – 98 %RH, respectively. Then, the greenhouse equipped with the control system was investigated for its performance in the sunflower seedling process.

Table 1 Air temperature and relative humidity inside and outside the greenhouse

Experiment number	Temperature (°C)			Relative humidity (%RH)		
	Inside	Outside	Difference	Inside	Outside	Difference
1	27.25	31.18	3.93	93.18	71.10	22.09
2	26.39	30.50	4.11	86.84	59.33	27.50
3	26.81	30.89	4.07	88.11	66.38	21.73

(a) **(b)** **(c)**

Fig. 1 The greenhouse with the temperature and humidity controller

We put seedling sets outside the greenhouse to evaluate the germination percentages and indexes of sunflower sprouts. The sprouts outside the greenhouse were damaged and destroyed by pests; hence we could not compare the percentages and indexes of sunflower sprouts harvested from outside and inside the greenhouse. The greenhouse performance was shown in Table 2 as germination percentages and indexes. From the results, the average germination percentages were higher that 80%. From the Kiatsakul (2016) research, the germination percentages of his sunflower sprouts planted in the coconut coir were lower than the average germination percentages of this research. This lower percentage may be caused by black husk in the literature mixture could hold water less than coconut coir in this research as mentioned in the literature (Kuldilok and Loawsakul, 2000). The germination percentages obtained from the current work were also higher than those obtained from another literature, Ukate et al. (2015). Apart from that, the nutrient

solutions, temperatures and relative humidity values were found as factors that affected the growth of the sprouts too. Figs. 2 and 3 provided the experimental results; the germination percentages and indexes, obtained from the sunflower seeding process. We compared the germination percentages and indexes among three seedling materials respectively.

Table 2 Average germination percentage and germination of sunflower sprout

Nutrient solution	Coconut coir		Cotton		Planting soil from local market	
	G %	GI	G %	GI	G %	GI
Commercial nutrient solution	91.11	13.44	86.00	12.62	89.78	12.67
Cattle manure solution	90.67	13.45	88.00	13.52	90.89	12.84
Earthworm manure solution	90.67	13.98	83.56	13.21	89.78	12.72

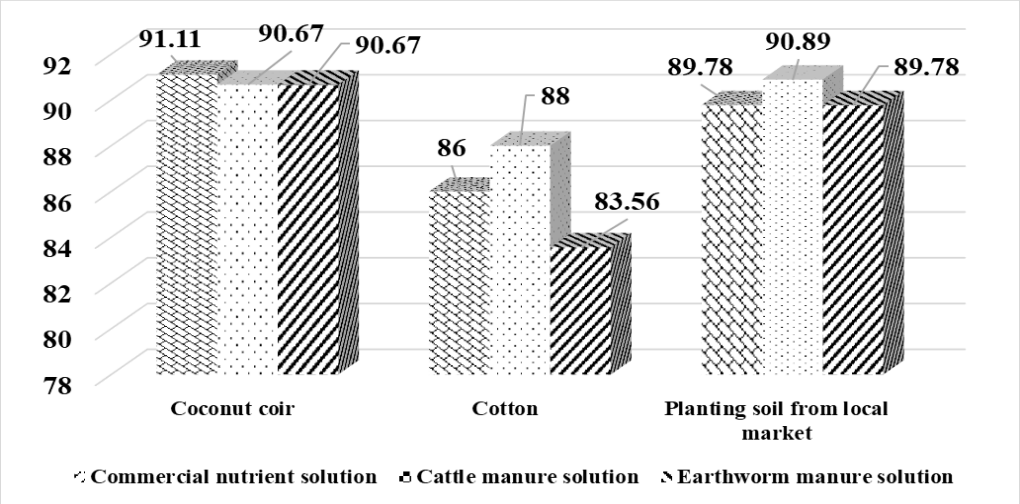

Fig. 2 Germination percentages of sunflower seedlings

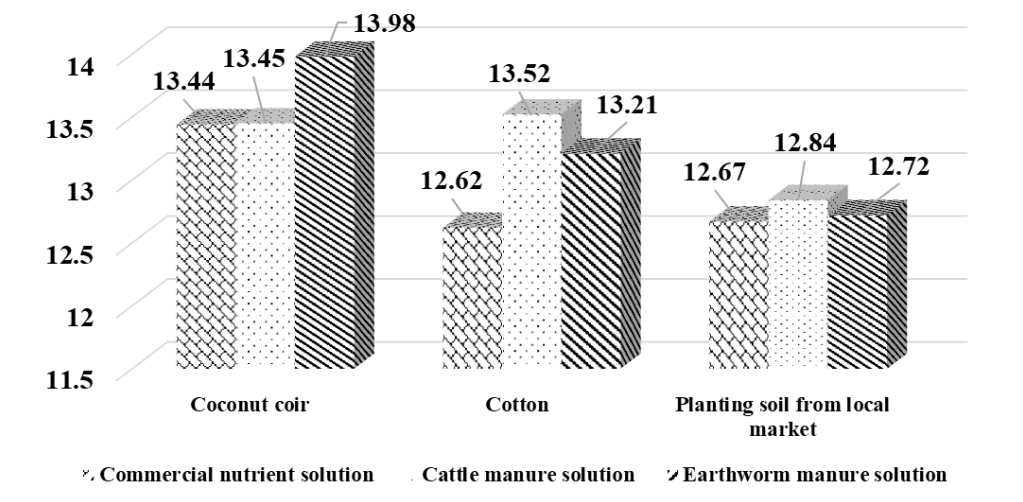

Fig. 3 Germination index of sunflower seedlings

CONCLUSION

The research focused on presenting the temperature and humidity control system for the plantation greenhouse. The greenhouse was utilized in sunflower (*Helianthus annus* L.) seedling. The

greenhouse is 1.8 meters long, 2.1 meters wide, 3.1 meters high and covered with opaque plastic sheets. The in-house Arduino codes of the in-house controller were written to control the temperature and relative humidity of air inside the greenhouse. The average temperature and relative humidity differences were recorded as 4.07 ℃ and 21.73% RH, respectively, the aimed conditions were achieved as the plantation conditions. The performance of the greenhouse was indicated by the germination percentages and indexes of the sunflower sprouts. The germination percentages and index results obtained from this work were higher than those of the literatures (Kiatsakul, 2016 and Kuldilok and Loawsakul, 2000). All nine experiments with three replications were performed. The minimum germination percentage was at 83.56% and the minimum germination index was at 12.62. While the maximum percentage was at 91.11% and the maximum index was at 13.98. The developed temperature and humidity control system coupled with the greenhouse was proved its performance and showed its potential in the sunflower seedling for the commercial purpose. The investment cost of the greenhouse and control system was 5,800 Baht (193.33 USD), as the affordable cost at 1,534 Baht per square meter (51 USD per square meter). From all results, the coconut coir as the seedling material provided the best germination percentages. Farmers could use cattle and earthworm manure solutions instead of the chemical nutrient solution in the sunflower seedling because both solutions provided better germination percentages than that of the chemical one.

ACKNOWLEDGEMENTS

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Research article

The Optimum Speed Investigation of the CASE Harvester Cleaning Fan for KK3 Sugarcane

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Abstract During sugarcane harvesting process on fields, there were sugarcane losses occurred in the process such as blown-out loss from a primary extractor fan used to clean leaves out of the sugarcane, loss from conveyers and from high cutting by a base cutter. Different species of sugarcane (*Saccharum officinarum* L.) contained different trunk and leaf sizes, different cleaning fan speeds should be considered. If the losses are reduced, the better process can be obtained, and farmers get more income from more products and less loss. This work focused on finding the proper operating speeds of the primary extractor fan equipped in the sugarcane harvester; A8000/8800 model CASE IH trademark, to harvest the Khon Kaen 3 (KK 3) sugarcane (*S. officinarum* L.) in the minimum contamination and by the maximum flawed sugarcane sticks less than 2%. The harvester manufacturer has recommended the fan speed at 800 rpm as the suggested speed. The experimental investigations in five different operating speeds; 700, 800, 900, 1000 and 1100 rpm, of the fan were performed at the sugarcane field in Saybouly District, Kenghat village, Lao PDR. Ten different sampling points were specified to check contamination; sand, leaves and flawed sugarcane sticks, along 400-meter-long plots with 1.65-meter plot offset. Each sampling point was in a 10-meter-square area. The reported values were average values obtained from all points in three repeating examinations. We found that the minimum contamination was 7.26% and the flawed sugarcane was 1.95% when the fan speed at 700 rpm. The maximum contamination was at the highest speed. Therefore, the fan speed at 700 rpm was used as the new operating speed for the harvester in the KK 3 sugarcane harvesting process to reduce the losses.

Keywords sugarcane, sugarcane harvester, primary extractor fan

INTRODUCTION

Nowadays, the sugarcane and sugar industries have been experiencing a shortage of labor in agriculture and the cost of sugarcane harvesting is clearly increased. Thai society is entering the ageing society and the government policy has promoted increasing the minimum wage. Consequently, young workers are more interested in working in factories and service sectors than in agricultural sectors. It is anticipated that the labor shortage is going to occur in Thai and other sugar industries.

A Chopper sugarcane harvester is one of popular sugarcane harvesters and it has been used to harvest sugarcane to replace human workers and to reduce the harvesting cost. Thai public and private groups have imported sugarcane harvesters from overseas and have researched to develop sugarcane harvesters in Thailand. However, sugarcane harvesters have still been imported from abroad. One of disadvantages found from using the harvesters is contamination during the

harvesting process that affects the sugar production directly. The contamination can cause sugarcane fractures which fall out the cutter and the harvester cannot pick up from harvested fields.

Sugarcane losses during the sugarcane harvesting have been reported by Ridge et al. (1993) as following; 1) the loss from two cleaning fans blowing small sugarcane sticks away; the large one equipped on the top of the sugarcane collecting basket and the small one equipped at the end of the conveyor, 2) the loss from the conveyor because gaps on the conveyor were bigger than the sticks, 3) the loss from human errors such as workers have low skills causing high sugarcane cutting and unsuitable sugarcane-row preparation and 4) the loss during transportations such as sugarcane transportation from fields on trucks and during transportation between the fields and factories on the trucks without any covers.

The sugarcane harvesters in Thailand, especially in the sugarcane industry, can be divided into two categories; the Whole Stick Sugarcane Harvester and the Chopper Sugarcane Harvester. The Whole Stick Sugarcane Harvester (Opanukul et al. 2012), which is attached to a large tractor as in Fig. 1(a), can cut sugarcane into whole trunks and stack the trunks in piles next to sugarcane rows, then a sugarcane loader grips the trunks onto transporting trucks to transport the sugarcane to the sugar factories. Performances of these harvesters are in 50 to 80 tons per day. The Chopper Sugarcane Harvester (Opanukul et al. 2012), as shown in Fig. 1(b), can cut the sugarcane by the base cutter into trunks, convey the trunks on the conveyor set to the chopper set, chop the trunks into small sticks and transport the sticks by the elevator set on transporting trucks to the factories. Performances of the latter harvesters are in 100 to 300 tons per day.

(a) **(b)**

Fig. 1 (a) The Whole Stick and (b) the Chopper Sugarcane Harvesters (Opanukul et al. 2012)

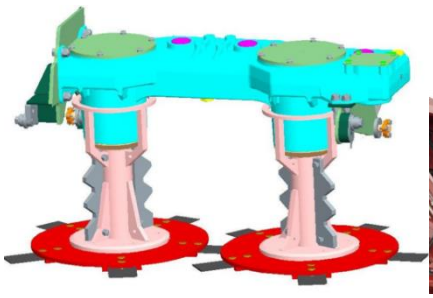

Fig. 2 Base cutter blade (Ma et al., 2014)

Fig. 3 Primary extractor fan (Ma et al., 2014)

Ma et al. (2014) introduced research and development of sugarcane harvest technology. There were 2 popular ways in sugarcane harvesting; the harvesting with a pre-burning process before a cutting process and the fresh harvesting without any pre-burning processes. Since the burning process produce greenhouse gases, this work also tried to raise social awareness on the greenhouse gas effects and impacts on the environment. This work presented mechanics and geometry information such as the speed of the Base cutter blade (Fig. 2), the cutting angle and inclination of the bottom-cutter blade and the shape of the blade influencing the cutting process and quality. They showed that there were two interesting techniques could be applied to improve harvesting yields; to

adjust the rotation speed of the primary extractor fan (Fig. 3) and to control the height of the cutter blade to cut sugarcane at the lowest part of the sugarcane. They also noted that the research and development of the harvester components, as well as, improving the cutting and conveying mechanisms, could reduce losses and contamination in the sugarcane harvesting.

Manhaes et al. (2014) presented visible losses in harvesting with the sugarcane cutter; Case IH Baguette Model A4000. This research was conducted with the RB7515 sugarcane without any pre-burning processes in the daytime. Sugarcane row lengths, soil moisture contents, soil types, sugarcane ages and harvesting yields per hectare were collected in the research and to evaluate the visible losses from the cutter. The research information was randomly collected from 350-m field length while 8 samples were taken in every 50 m in width and length of 10x2 m is 20 square meter. This research reported that sugarcane was cut and broken into small pieces by the knife set of the cutters and these sugarcane pieces were sucked out by the large cleaning fan along with sugarcane leaves causing losses. The visual losses were reported as the average loss was at 1.85 tons per hectare or 3.4% of the total samples while the average percentages of the loss suggested by Benedini et al. (2011) were from 2.5 to 4.5%. The results from this work showed that preparation of the sugarcane fields which were longer than 350 m with 1.5-m row spacing enhanced the good production yields from using the harvester because no harvester turn was required, and the harvester wheels did not press on the sugarcane base.

The loss of sugarcane harvested from the sugarcane cutter resulted from the cutting speed and the speed of the cleaning fan was reported by Martins et al. (2017). This work evaluated the losses and contaminants in sugarcane harvesting of the cutter; the CASE IH 8800 sugarcane cutter, from three cutter speeds; 3, 5 and 7 km/h, and two rotation speeds of the fan set; 700 (R1) and 1,000 (R2) rpm. The Copersugar Technology Center 15 (CTC 15) sugarcane was chosen to harvest without any pre-burning processes in straight fields with 1.5-m row spacing and the average harvesting yield was 92.5 tons per hectare. Results of the work showed that the contamination percentages obtained from the large cleaning fan at R2 was in the range of 4 to 6% while the percentages obtained from the fan at R1 was more than 7%. The sugarcane fracture percentages blown from the large cleaning fan was less than 2.5%. This work concluded that the higher the cleaning fan speeds showed the lower the contamination while the harvester speeds did not affect the contamination.

OBJECTIVES

This research was carried out to investigate losses from the sugarcane fractures left on the fields and from the contamination sucked from the large cleaning fan of the harvester. The latter loss occurred from the fan was analyzed to determine the optimum fan speed in the sugarcane harvesting, as well as, to provide information for sugarcane farmers who have their own sugarcane harvesters. This research aimed to find the suitable speed of the big cleaning fan equipped in the harvester; CASE IH sugarcane cutting machine model A8000/8800. The suitable speed could provide the lowest loss in the Khon Kaen 3 (KK3) harvesting from 5 different speeds; 700, 800, 900, 1000 and 1100 rpm.

METHODOLOGY

1. Analyzing KK3 sugarcane age information from a database of Mitr Lao Sugar Co., Ltd., to find ages of sugarcanes which were harvested.
2. Selecting the proper experimental field which provided 10 tons per 0.16 hectare or ha (Fig. 4).
3. Selecting the harvester suggested by Mitr Phol group and on duty in the selected field from Step 2.
4. Adjusting the speed of the big cleaning fan equipped in the harvester to 5 investigated speeds; 700, 800, 900, 1,000 and 1,100 rpm.
5. Collecting data at each speed of the big cleaning fan; a distance between collecting points, weights and types of residue rejected from the fan and weights of usable sugarcane sticks

(yield). Types of the residue, which was rejected from the fan, consisted of sugarcane scraps and waste. An area of the collecting point was 5x2 square meters, a canvas sheet (Fig. 5) was selected and laid to collect the samples.

6. Analyzing the sugarcane loss by calculating following equations applied by Mitr Lao Sugar Co., Ltd. (2018). This work focused on the loss from the primary (large) cleaning fan blowing sugarcane scraps away.

The sugarcane scrap loss in kilogram per 0.16 hectare (0.16 ha equals to 1 Rai in Thai unit);

$$Sugarcane\ scrap\ loss = \frac{Average\ sugarcane\ weight\ (kg)\ x\ sugar\ cane\ length\ per\ hectare\ (m)}{Sugar\ cane\ sampling\ length\ (m)} \quad (1)$$

The percentage of the sugarcane scraps blown out by the primary cleaning fan;

$$Blown-out\ percentage = \frac{Loss\ of\ sugarcane\ (kg\ /\ 0.16\ ha)}{1{,}000}\ x\ \frac{100}{Productivity\ (ton\ /\ 0.16\ ha)} \quad (2)$$

The percentage of waste blown out by the primary cleaning fan;

$$Waste\ blown-out\ percentage = \frac{Impurities\ (kg\ /\ 0.16\ ha)}{1{,}000}\ x\ \frac{100}{Productivity\ (ton\ /\ 0.16\ ha)} \quad (3)$$

Fig. 4 One of sugarcane fields

Fig. 5 Sugarcane sampling

RESULTS AND DISCUSSION

From the database of Mitr Lao Sugar Co., Ltd., the sugarcanes aged from 10 to 14 months were harvested because they provided an average yield of 10.282 tons per 0.16 hectare. The proper experimental field was at 111 Unit 10, Kenghet Village, Xaybouly District, Savannakhet Province, Lao PDR. The sugarcane field was prepared to have 1.65-m row spacing. the Chopper harvester; CASE IH sugarcane cutting machine model A8000/8800 with 350 hp, was selected as the experimental harvester. The harvester speeds could vary from 5 to 6 km/h, the harvester was set to have the average speed at 5.5 km/h. From the harvester information, the minimum speed of the fan was 700 rpm. In this work, 5 different speeds were investigated and found that the higher the speeds provided the heavier the residue as shown in Table 1. The residue consisted of waste (sand and leaves) and broken sugarcane sticks.

The distance between collecting points was 10 m. Weights and types of the residue rejected from the fan were shown on Table 1, leaves were heavier than sand in every fan speed. The average weights of the usable sugarcane sticks which could be calculated as the yield was at 10.282 tons per 0.16 hectare. The calculated results were shown in Figs. 6 and 7. The minimum and maximum

small-sugarcane-stick losses in kilogram per 0.16 hectare were 200.37 kilogram at 700 rpm of the cleaning fan and 372.97 kilograms per 0.16 hectare at 1,100 rpm of the cleaning fan, respectively. The minimum and maximum percentages of the small sugarcane scraps blown out by the primary cleaning fan were 1.95% and 3.62%, respectively. The minimum and maximum percentages of waste blown out by the primary cleaning fan were 7.26% and 11.21%, respectively.

Since the harvester manufacturer recommended users to set the fan speed; the suggested fan speed, at 800 rpm. We observed from Fig. 7 that the higher the fan speeds the more the residue weights. The KK3 sugarcane has its own characters, therefore, we should find the proper fan speed to clean the KK3 sugarcane sticks before they are sent to next processes. Therefore, we found the proper fan speed to clean the KK3 sticks at 700 rpm because, at this speed, the harvester provided the best percentage of the blown-out scraps compared with the total weight at 21.16%, the least amount of the scrap. Moreover, the higher the fan speeds, the harvester consumed more fuel.

Table 1 Collected data from 5 different speeds and their statistical information; Average (Avg.) and Standard Deviation (SD) values

Fan Speed (rpm)	Avg. Sand Weight (kg/0.16ha) (1)	SD Sand Weight (2)	Avg. Leaf Weight (kg/0.16ha) (3)	SD Leaf Weight (4)	Avg. Sugarcane Scrap Weight (kg/0.16ha) (5)	SD Sugarcane Scrap Weight (6)	Avg. Total Weight (kg/0.16ha) (7)	Scrap per Total Weight (%) (5) / (7)
700	233.29	0.11	513.02	0.09	200.31	0.10	946.61	21.16
800	271.60	0.08	578.61	0.13	228.92	0.55	1,079.13	21.21
900	303.61	0.44	626.14	0.98	253.17	0.10	1,182.92	21.40
1,000	331.26	0.42	671.24	0.68	276.94	0.45	1,279.43	21.65
1,100	356.48	0.37	796.37	1.03	372.97	0.57	1,525.81	24.44

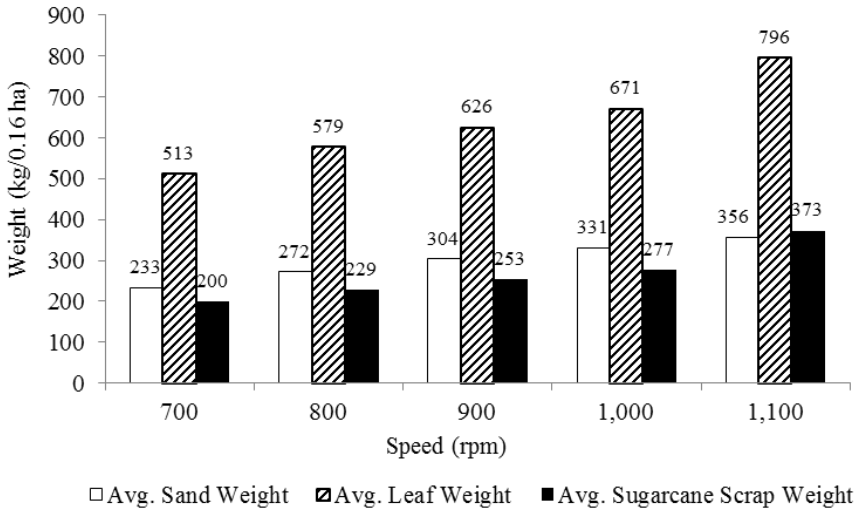

Fig. 6 Average weights of the waste and scrap

CONCLUSIONS

The sugarcane scraps blown out from the primary (big) cleaning fan of the sugarcane harvester can be considered as one of the main losses in the sugarcane and sugar industries. This research focused on the sugarcane scrap loss from the Chopper harvester; CASE IH sugarcane cutting machine model A8000/8800 with 350 hp. The experimental field was in Lao PDR and the KK3 sugarcanes were planted, the fields which provided an average of 10 tons per 0.16 hectare was

chosen. Five different speeds of the primary cleaning fan were tested; 700, 800, 900, 1,000 and 1,100 rpm, the blown-out residue was collected 10 positions along the field lengths. Then, the residue was separated into sand, leaves and sugar scraps, weight of each part was collected and calculated in the literature equations. When we considered the scrap weights divided with the whole residue weights as the percentages of the scrap compared with the total weights, we found that the scrap percentages obtained from the fan speeds at 700, 800, 900 and 1,000 rpm were about 21. If we considered fuel consumption values among these four percentages, the fan speed at 700 rpm consumed the least fuel with the minimum scrap percentage. The current research information suggested that the primary fan of the CASE IH sugarcane cutting machine model A8000/8800 should be set speed at 700 rpm to clean the unwanted parts out from the KK3 sugarcane sticks harvested from the fields.

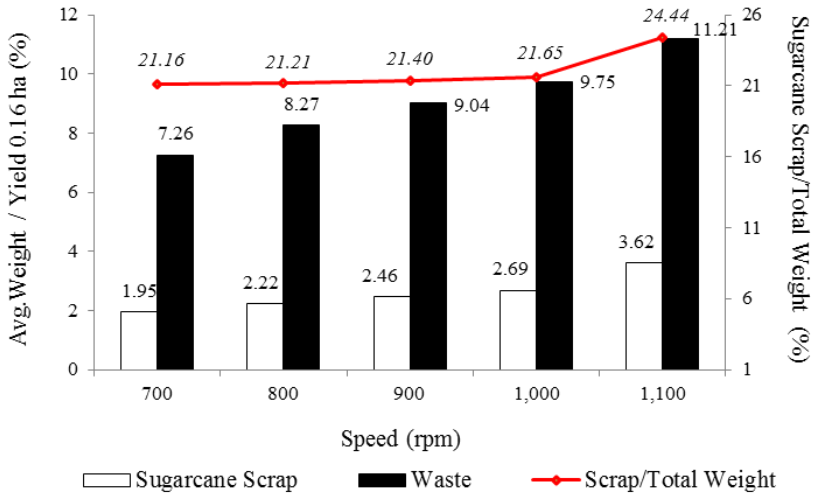

Fig. 7 Percentages of the scrap and waste weights compared with the yield weights (the left axis) and percentages of the scrap compared with the total weights (the right axis)

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Research article

Effect of Fertilization on Soil Microorganisms in Kampong Cham Province, Cambodia

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Abstract Fertilizers are one of the most important nutrient inputs into soil for supplying nutrients that were remove by plant growth. Application of organic and inorganic fertilizers has given an effect to soil properties directly or indirectly. Recently, organic fertilizers application such as compost, cow manure, and green manure were introduced to local farmers in Kampong Cham Province, Cambodia. However, improper agricultural practices incorporating with raw materials or immature compost have a direct impact on plant health and crop productivity with resulting in contamination of soils with pathogenic microbes. Therefore, the objective of this study was to investigate the survival of pathogenic microbes with organic and inorganic fertilization in Kampong Cham Province, Cambodia. Twenty samples of soil where collected from farmlands where organic and inorganic fertilizers were applied in Samraong and Baray Communes. Also, 5 samples of compost and cow manure were collected in the same areas. From these samples of soil, compost and cow manure, the biological properties such as pathogenic bacteria *E. coli* and fungi were analyzed. The experiment results indicated that there was a certain contamination of *E. coli* in these samples of soil, compost and cow manure. Also, the degrees of contamination were divided into 4 categories as very low, low, medium and high, respectively. In addition, the results of pathogenic bacteria *E. coli* in samples of soil were summarized in hazard map. However, the relationship between microbes such as pathogenic bacteria *E. coli* or fungi and fertilization was not observed statistically while organic and inorganic fertilizers has been applied to the soil. It was considered that the sources of *E. coli* are not only from organic fertilizer in this research area, but also transported from upstream, as there are many range lands for breeding cows in the upstream of both Samraong and Baray Communes. From these results, farmers able to control on the spread of pathogenic bacteria *E. coli* contamination to other areas with the summarized of *E. coli* hazard map.

Keywords fertilization, pathogenic bacteria, *E. coli*, contamination, hazard map

INTRODUCTION

Soil is an excellent culture media for growth and develop of various microorganisms (Balasubramanian, 2017), intensive agriculture has resulted in negative effects on soil environment over the past decades. Sustainable crop cultivation needs the use of appropriate fertilizers that rich in nutrients, free from pathogenicity and contributes to increase in soil fertility. Hartemik (2006) defined soil fertility as the capacity of soil that supply nutrients in adequate amounts and in proper balance for sustainable biological productivity, maintain environmental quality and promote plant and animal health. Hence, fertilizers are one of the most important nutrient input into soil for supplying nutrients that were remove by plant growth. Organic and inorganic fertilizers that supplies to plants, provided the necessary nutrient for plant growth and maximum in yields (Alimi et al., 2007). Application of organic and inorganic fertilizers has given an effect to soil properties

directly or indirectly. Recently, organic fertilizers application was introduced to local farmers in Kampong Cham Province, Cambodia, as it contributes to increase in nutrient contents and improve on soil physical, chemical and biological properties (Pinamonti, 1998, Brown et al., 2004 and ERECON, 2009). However, improper agricultural practices incorporating with raw materials or immature compost resulting in contamination of soil with pathogenic microbes. Therefore, the attention has been given to safety use of raw materials or compost that supplied nutrient to crop and soil, and the survival of pathogenic microbes should be eliminated under different types of fertilization in some provinces of Cambodia.

OBJECTIVE

The objective of this study was to investigate the survival of pathogenic microbes with organic and inorganic fertilization in Kampong Cham Province, Cambodia.

METHODOLOGY

Study Site

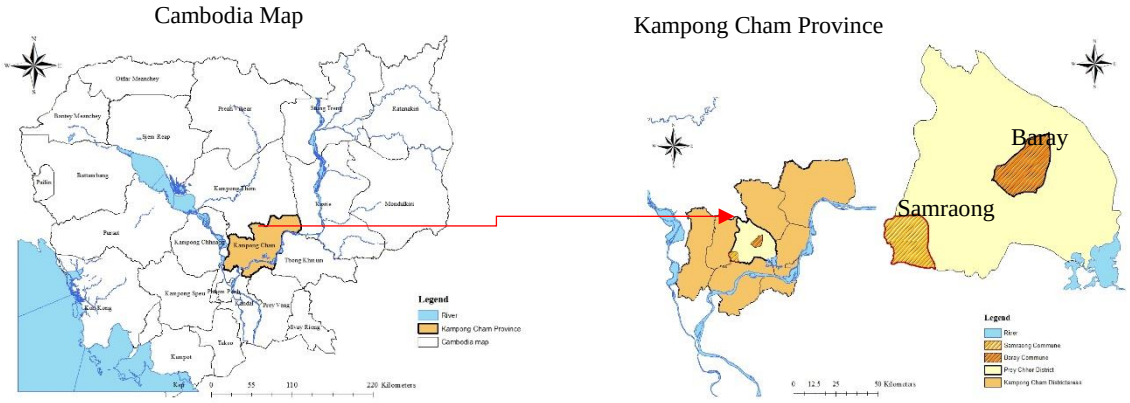

Fig. 1 Map of the study areas

Samraong and Baray Communes, Prey Chhor District, Kampong Cham Province, Cambodia (Fig. 1) were chosen to be the study site. Samraong Commune consists of 11 villages and 1,714 households. Also, Baray Commune consists of 13 villages and 2,446 households. Ninety percent of the population are dependent on agriculture with the produce of rice and some amount of vegetables (CDB, 2010). Recently, agriculture practices in these villages have changed from traditional to market oriented with integrated used of organic and inorganic fertilizers. However, the experience of organic fertilizers application in Samraong Commune has been applied for 3 years and 10 years in Baray Communes (ERECON, 2017).

Data Collection and Analysis

Secondary data collection: relevant documents were collected from the research institutions, journals and reports of the project implement and the experts who had carried out studies in study areas in order to better understand the issues involved.

Primary data collection: interviewed farmers with the design questionnaires in Samraong and Baray Communes and 20 famers household were selected by using simple random method. The information of questionnaires survey based on general information, economical and agricultural condition of farmers in the study areas.

Field data collection: Twenty samples of soils were collected from Samraong and Baray Communes. Also, 5 samples of compost and cow manure were collected from the same farmlands.

Pathogenicity Test for *E. coli* in the Field

Instant-check was used to investigate the survival of pathogenic microbe directly in the field. The instant-check 25 ESCM from EIKEN Chemical for analyzing the presence of *E. coli* in soil samples (Fig. 2). Two replicated of each soil samples were tested. The plates were put in outside temperature from 30-35 ºC for 48 hours. Presence of pink and blue colonies showed the present of *E. coli* in the samples. The colonies were counted and categorized into different degree of contamination according to the number of colonies detected.

Laboratory Test

Samples of soil, compost and cow manure which from the field were analyzed on its chemical, physical and biological properties. For the biological properties pathogenic bacteria *E. coli* and fungi were analyzed by using distill dilution and plate counts method, the medium for growing the *E. coli* is XM-G Agar and Difco™ Cook Rose Bengal Agar for fungi.

Interpolation Map of *E. coli* Contamination by Inverse Distance Weight

Interpolation is use for predicts values for cells in a raster from a limited number of sample data points and can be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentration and noise levels. The Inverse distance weight (IDW) interpolation use for estimates unknown values with specifying search distance closet points. To do this we first start with known values and estimate the unknown points through interpolation. By creating this interpolation map the ArcGIS software was used as a tool to record the data of *E. coli* from the laboratory and created the IDW interpolate of *E. coli* hazard map.

RESULTS AND DISCUSSION

Information of Community Database

Table 1 Community database

	Samraong Commune	Baray Commune
1. Population	8,123	10,637
2. Total number of families	1,714	2,446
3. Villages	11	13
4. Cultivated area/household	Less than 1 ha	Less than 1 ha
5. Main crops	Rice and vegetables	Rice and vegetables
6. Soil type	Brown hydromorphics, regurs, and cultural hydromorphics	Brown hydromorphics, regurs, and cultural hydromorphics
7. Number of families using chemical fertilizer	1,587	1,479
8. Project implemented	Project on Promoting Sustainable Agriculture in Kampong Cham Province, Cambodia supported by JICA (2011-2016)	Project on promotion of organic farming through composting and liquid fertilizer making in Wat Chas and Roung Kor Villages, Baray Commune supported by MAFF, Japan (2006-2009)

The community database in Table 1 showed that there were 8,123 and 10,637 population in Samraong and Baray Communes respectively. The total number of families are 1,714 in Samraong and 2,446 in Baray Communes. Farmers in Samraong and Baray Communes has owned cultivation land less than 1 ha. Rice and vegetables are cultivated for both sale and self-consumption. However, there were different projects implement on promoting the sustainable use of organic fertilizer in Samraong and Baray Communes. In Samraong Commune the project started from 2011-2016 and Baray Commune the project started from 2006-2009. After the project implemented till now farmers have experience on used of organic fertilizer around 3 years in Samraong and 10 years in Baray Communes.

Pathogenicity of *E. coli*

The results of instant-check in filed in Fig. 2 showed that there was presence of pathogenic bacteria *E. coli* in the soils. The present of *E. coli* can be categorized into different degree of contamination according to number of *E. coli* detected (Kaneko, 1999). Therefore, the *E. coli* contamination were divided in to 4 categories very low, low, medium and high, respectively.

Fig. 2 Instant check of *E. coli* contamination

Laboratory Test of *E. coli*

Table 2 Degree of contamination of *E. coli*

No.	Communes	OFD (%)*	Instant Check of *E. coli* in the field	Determine	Degree of pollution	*E. coli* $\times 10^4$ (cfu/g)*	Fungi $\times 10^4$
1	Samraong	26.1	>30	++++	High	37.47	48.48
2	Samraong	62.3	0-10	+	Very low	33.23	50.59
3	Samraong	33.5	>30	++++	High	36.08	52.73
4	Samraong	27.4	>30	++++	High	34.17	54.95
5	Samraong	18.3	>30	++++	High	45.23	48.23
6	Samraong	0.1	21-30	+++	Medium	35.55	57.92
7	Samraong	1.2	11-20	++	Low	1.45	59.11
8	Samraong	0.9	0-10	+	Very low	9.92	54.47
9	Samraong	0.0	20-30	+++	Medium	38.69	4.97
10	Samraong	0.0	11-20	++	Low	56.45	55.86
11	Baray	11.3	21-30	+++	Medium	4.19	47.74
12	Baray	17.8	>30	++++	High	1.39	47.77
13	Baray	7.1	0-10	+	Very low	12.84	46.20
14	Baray	58.7	0-10	+	Very low	6.99	38.93
15	Baray	75.0	20-30	+++	Medium	10.25	45.99
16	Baray	0.0	>30	++++	High	35.53	44.41
17	Baray	0.0	>30	++++	High	42.58	42.38
18	Baray	0.0	21-30	+++	Medium	69.42	48.59
19	Baray	0.0	21-30	+++	Medium	25.42	36.85
20	Baray	0.0	21-30	+++	Medium	24.98	41.87

**E. coli colonies in soil samples which counted in laboratory, OFD (%) is the Organic Fertilizer Dependences*

According to laboratory test of *E. coli* in the samples of soil, compost, and cow manure in Table 2 and Table 3 showed that there were certain degrees of *E. coli* presented in those samples. The present of *E. coli* in the samples of soil from the laboratory analyzed were respond to the degree contamination of instant-check from the field. However, fungi were also presented in the samples of soil which showed in Table 2. Addition to samples of compost and cow manure in the laboratory were also showed the present of E. coli contamination in these organic fertilizers. So, it can be discussed that while immature raw material or composted and cow manure improperly applied to the field, the pathogenic microbes will be easily transferred to the soils. This result agrees with the results of Stuart (2006) which states that largely exposure of crops to untreated livestock waste or plant residues with improperly composted manure are likely sources of *E. coli* in farmlands.

Table 3 Number of E. coli in soil samples and organic fertilizers

No.	Communes	OFD (%)	*E. coli* $\times 10^4$ (cfu/g)*	Types of Organic fertilizer	*E. coli* $\times 10^4$ (cfu/g) **
1	Samraong	26.1	37.47	Compost 1	9.99
2	Samraong	62.3	33.23	Compost 2	20.91
3	Samraong	33.5	36.08	Compost 3	40.81
4	Samraong	27.4	34.17	Compost 4	56.98
5	Samraong	18.3	45.23	Compost 5	30.92
11	Baray	11.3	4.19	Cow manure 1	50.68
12	Baray	17.8	1.39	Cow manure 2	34.35
13	Baray	7.1	12.84	Cow manure 3	46.95
14	Baray	58.7	6.99	Cow manure 4	41.90
15	Baray	75.0	10.25	Cow manure 5	9.98

**Number of E. coli in soil samples, ** number of E. coli in samples of cow manure and compost*

Correlation Coefficient Anaylsis

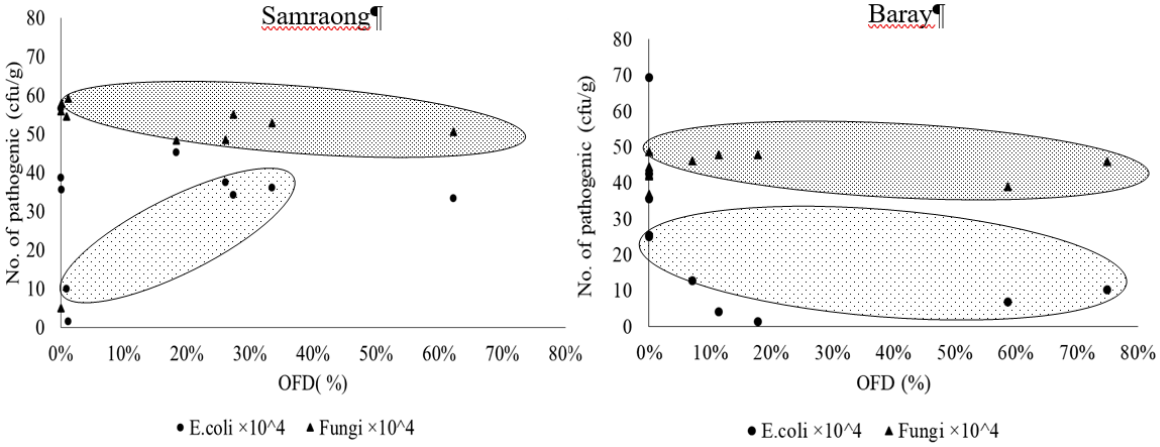

Fig. 3 Correlation coefficient between OFD %, *E. coli* and fungi in Samraong and Baray Communes

Based on the results in (Fig. 3) showed that the relationship between *E. coli* and fungi with the percentage of organic fertilizers application were not observed statistically. Since, the results were not clearly observed, it can be discussed that the present of *E. coli* in soil supplied not only from the fertilization. However, samples of compost and cow manure in (Table 3) showed certain contamination of *E. coli* in these organic fertilizers. The present of *E. coli* in compost and cow manure given a clear result that those materials were immature and not ready to apply into the field.

So, precautions should be taken before application of those organic materials. The survival of *E. coli* dependents on the numerous factors such as temperature, pH, water availability and it can survive extended periods in water and soil. In addition, pathogenicity is said to be transfer from compost and cow manure to the soil and surface of crops, once on the surface of crop pathogens can persist for up to 150 days and *E. coli* can survive for more than six months in the soil. However, present of fungi in soil were also observed in the study areas, but the species of good and bad fungi were not provided. Furthermore, fungi are function as decomposing detritus and recycling nutrient back to soil and some fungi in soil form a positive relation with plant root to absorb nutrient and water and bring back to plant to use (Einallah, H et al., 2014).

Interpolation Map of *E. coli* Contamination by Inverse Distance Weight

Interpolate map of *E. coli* contamination in (Fig. 4) showed from known value point and unknown value point areas in Samraong and Baray Communes. This interpolation map showed the spread of E. coli contamination around the study areas. Based on the information in (Fig. 4) the dark area in the map shows higher possibility of contamination by pathogenic microbes compared to lighter areas and the location point of sampling does not fall in high contamination zone. It can be said that certain modes of carrier might have been responsible for it. As the results, farmers able to find out how pathogenic bacteria spread on their farmland and the water body nearby. By creating this map farmers will be able to act no control and avoid contamination spreading to other areas.

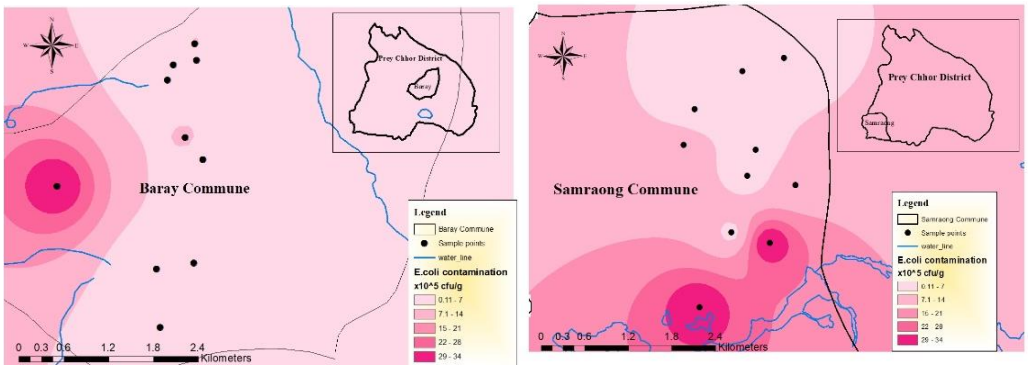

Fig. 4 Interpolate map of *E. coli* contamination in Samraong and Baray Communes

CONCLUSION

It's suggested that for successful soil fertility management, integrated used of organic and inorganic fertilizers are recommended. However, the input of organic fertilizer such as compost and cow manures should be consider with maturity or well decomposed of those material, the *E. coli* should be eliminated before applying to the field. Since, the relationship of *E. coli* and fungi with the application of organic and inorganic fertilizers were not observed. But with the present of *E. coli* contamination in samples of soil, compost and cow manure. In order to eliminate the presence of pathogenicity of *E. coli*, the attention should be given to the treatment of organic fertilizers materials, the process of decomposing, and storage before applied to the field. This will be consider for the future research on how to eliminate the *E. coli* from organic fertilizers material in the study areas. In addition to *E. coli* interpolation map, it will be used as bio-hazard map for local farmers for producing safety agro-production and controlling the spread to other areas nearby.

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Research article

Changes in the State of Organic Matter Present in Sediment by Different Methods of Electrokinetic Treatment

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Abstract During sedimentation, organic matter is absorbed on metal ions or clay minerals (soil particles), affording metal complexes that are difficult to use as organic materials. Hence, it is critical to separate the organic matter from metal or clay mineral complexes, possibly leading to the effective use of sediment and agriculture soils. Previously, a solar cell-combined sediment microbial fuel cell, constituting one of electrokinetic treatments, was applied into the sediment. As a result, metal complexes in the sediment were found to be dissociated, leading to changes in the state of organic matter present in the sediment. In this study, a new perspective into the changes in the state of organic matter by different methods of electrokinetic treatment was reported. In laboratory experiments, the sediment was subjected to different methods of electrokinetic treatment. Positive current was conducted for the transfer of electrons from the sediment to water, i.e., electron recovery. On other hand, negative current was conducted for the transfer of electrons into the sediment, i.e., electron supply. Thermogravimetric analysis (TG-DTA) and Fourier infrared (FTIR) spectral analysis of each sediment were carried out at the end of experiments. TG-DTA results revealed that the mass loss on ignition increases compared to the control sediment due to electron recovery, indicative of the release of organic matter. However, a difference was not observed with electron supply. FTIR results suggested that changes in the state of organic matter are the same for electron recovery and electron supply, i.e., release of O-H hydroxyl and C=O carboxylic acid groups were confirmed. Notably, by supplying electrons after electron recovery, the losses of O-H hydroxyl and C=C aromatic groups from the sediment were confirmed. Clearly, different states of organic matter were obtained by changing the method of electrokinetic treatment.

Keywords sediment, electrokinetic treatment, organic matter state, TG-DTA, FTIR

INTRODUCTION

Abnormal weather leads to the flow of large amounts of wastewater into wastewater treatment plants. As conventional wastewater treatment plants cannot treat such large amounts of increased wastewater, a significant amount is discharged into local water bodies. During sedimentation, organic matter present in the wastewater is absorbed on metal ions or clay minerals (soil particles) to form metal complexes, accumulating in the water bodies. Previously, several studies have reported that the excess accumulation of organic matter in water bodies leads to the deterioration of the aquatic environment (Martin, 2009; Wright et al. 2012).

The sediment is highly reduced because of the excess decomposition of organic matter. The oxidation reduction potential is extremely low (approximately -200 mV vs SHE for littoral sediments); hence, it is possible to recover electricity from the sediment. Numerous studies have reported the generation of electricity from the sediment by using sediment microbial fuel cells

"SMFCs" (Hong et al., 2008; Touch et al., 2014). Furthermore, the sediment can be a useful natural resource due to the presence of organic compounds. Unfortunately, as a metal complex, organic matter is considered to be barely decomposed organic matter, making it difficult to use as an organic material. Therefore, it is critical to separate organic matter from metal or clay mineral complexes to possibly improve the potential use of sediment.

From the viewpoint of using organic compounds, several methods have been proposed for changing organic compounds into useful products. For instance, Zhang et al. (2016) have carried out alkaline treatment involving the addition of steel slag into waste-activated sludge and reported better performance for the hydrolysis and acidification of sludge. The authors have revealed that alkaline treatment leads to the increased production of volatile fatty acids and high enzyme activities. Li et al. (2013) have demonstrated that alkaline post-treatment leads to the increased production of volatile fatty acids and polysaccharides in the sludge. Song and Jiang (2011) have reported that heating the sediment prior to use as a fuel in SMFCs affords a high power density of SMFCs. Furthermore, the application of SMFCs into the sediment has been reported to alter the organic matter state in the sediment (Hong et al., 2010).

In our previous studies, electrokinetic treatment has been reported to decrease the sediment pH, which can dissociate metal complexes. This dissociation in turn can lead to the release of ferric ions in the sediment pore water (Touch et al., 2015) and change the ignition characteristics of the sediment (Touch et al., 2017a). In addition, the application of a solar cell-combined SMFC (SC-SMFC) into the sediment can dissociate metal complexes present in the sediment (Touch et al., 2018). Interestingly, the state of the dissociated organic matter was different according to different application methods of SC-SMFC. As such, this study aims to examine the details of changes in the state of organic matter in response to different methods of electrokinetic treatment.

OBJECTIVE

The objective was to examine changes in the state of organic matter based on thermogravimetric analysis (TG-DTA) and Fourier infrared (FTIR) spectral analysis after making positive current flow (transfer electrons from the sediment to water) and negative current flow (transfer electrons into the sediment) in sediment.

MATERIALS AND METHODS

Experimental Device and Materials

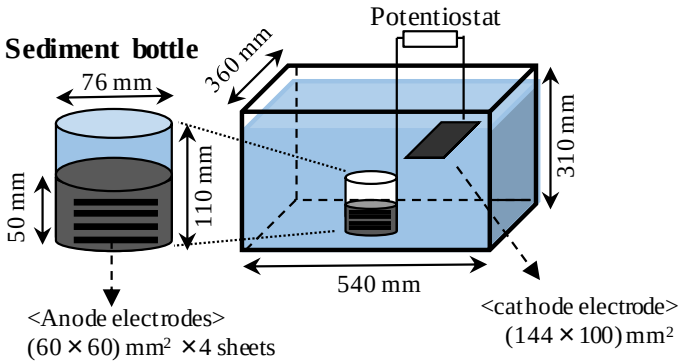

Fig. 1 Experimental device used in this study

Figure 1 shows the experimental device, comprising a cylindrical bottle with an inner diameter of 76 mm and a height of 110 mm. The wet sediment was placed till a height of 50 mm from the bottle bottom, and tap water was loaded on the sediment. The sediment was collected from the seafloor of the Fukuyama inner harbor (Fukuyama, Hiroshima, Japan). Approximately 30 cm of the

deposited sediment on the seafloor was collected and transported to the laboratory. The sediment was passed through a 2 mm-mesh sieve, which was placed in a room at 25°C ± 2°C before being used in the experiments. The pH, redox potential (ORP), and water content of the sediment were 6.92, −416 mV vs. Ag/AgCl (−218 mV vs. SHE), and 530%, respectively. The pH and ORP were measured using a digital pH/ORP meter (Horiba, D-50). Mass loss on ignition (LOI) at 600°C for 4 h was approximately 288 mg/g.

In the sediment layer, four sheets of carbon cloth (News Company, PL200-E), i.e., anode, were installed at intervals of 10 mm from the bottle bottom. This installation ensured the homogenous electron flow in the sediment layer. One sheet of the anode electrode exhibited a surface area of 3600 mm2. After installing the anode, the sediment bottle was placed in a container (360 mm in width, 540 mm in length, and 310 mm in height) that was filled by tap water. The pH, ORP, electrical conductivity (EC), and dissolved oxygen (DO) concentration of tap water were 7.78, 302 mV, 13.63 mS/m, and 8.49 mg/L, respectively. The EC and DO concentrations were measured using an EC meter (Horiba, D-74) and a DO meter (WTW, FDO925), respectively.

In the container, carbon cloth with a surface area of 14400 mm2 (100 mm in width and 144 mm in length), i.e., cathode, was horizontally submerged in the container close to the water surface. Notably, the carbon cloth was heated at 500°C for 1 h to improve its performance before being used as the electrode material following Nagatsu et al. (2014).

Operations and Analyses

The experiments were conducted under various operations (Fig. 2). Four days after placing the sediment bottle in the container, the anode and cathode were connected to a potentiostat (Hokuto Denko, HSV-110) for making electrical current flow (Fig. 1). A Ni-wire (Nilaco, NI311477) was used for the connections.

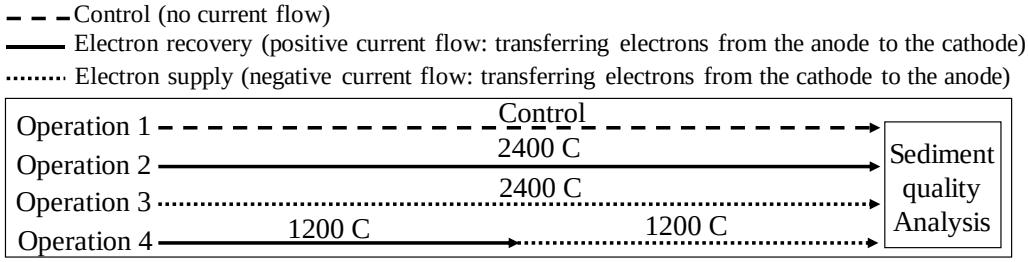

Fig. 2 Operation conditions for changing the state of organic matter

Three methods of electrokinetic treatment were conducted (Fig. 2). First (Operation 2), a positive current (electron recovery) was made for transferring electrons (electrical charge of 2400 C) from the anode (sediment) to the cathode (water). Second (Operation 3), a negative current (electron supply) was made for transferring electrons (electrical charge of 2400 C) from the cathode to the anode. Third (Operation 4), an electrical charge of 1200 C was supplied into the sediment after recovering an electrical charge of 1200 C from the sediment. In each operation, electrical current was fixed at 1 mA by the potentiostat. This current was chosen on the basis of our previous study (Touch et al., 2015). Operation 1 refers to the sediment without the current flow (control sediment).

At the end of the experiment, the sediment was collected from the bottle, followed by drying in the oven at 50ºC for 5 days. To examine the state of organic matter present in each sediment, TG-DTA and FTIR analyses were conducted using a Shimadzu-DTG 60H analyzer and a Shimadzu IRAffinity-1S (DRS-8000), respectively. It should be noted that the dried sediment was passed through a 75μm-mesh sieve prior to use in analyses. In TG-DTA, a 30 mg sample of the dried sediment passed through a 75μm-mesh sieve was heated to 800°C at a scan rate of 5°C/min and under a steady nitrogen flow of 40 mL/min.

RESULTS AND DISCUSSION

Variations in the Mass Loss on Ignition (LOI) of the Sediment

Previously, Cuypers et al. (2002) have demonstrated that the state of organic matter could be evaluated on the basis of the ignition behavior of the sediment. Notably, labile and rather simple organic matter (e.g., fatty acids, peptides, and carbohydrates) predominantly burned at 290–310°C. On the other hand, humified organic matter (e.g., humic and fulvic acids) predominantly burned at 370–390°C and 530–540°C. The burning temperature increased with the increased humification of the organic matter.

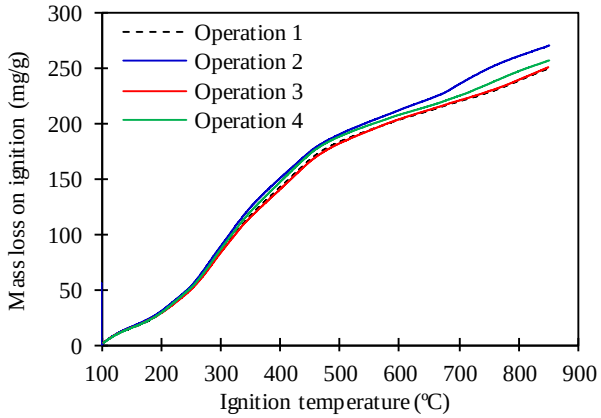

Fig. 3 Mass loss on ignition of the sediment at the end of each operation

Figure 3 shows the LOI of the sediment at the end of each operation. By the comparison to the control sediment (Operation 1), electron recovery (Operation 2) caused a large increase in the LOI at a temperature greater than 300°C. Conversely, a difference was not found in the case of electron supply (Operation 3). As there was no re-supply of organic matter into the sediment, the dissociation of metal complexes was thought to contribute to the increased LOI. This was in good agreement with our previous report (Touch et al., 2018).

Interestingly, the electron supply after electron recovery (Operation 4) caused an increase in the LOI; however, the increase was less than those observed in Operation 2 at 500–850°C. Touch et al. (2017b) have reported that approximately 99% of organic matter is burned at 500°C based on the losses in the content of carbon in the sediment. Hence, from the results obtained in Operation 4, the electron recovery causes to the dissociation of metal complexes, leading to the release of metal and organic compounds. The electron supply after the electron recovery immobilized the released metal compounds, while it did not affect the released organic compounds. The immobilization of metal compounds may be partly related to the increase in hydroxyl ions owing to the electron supply (details can be found in the report by Yuan and Weng, 2003). The combination of electron recovery and electron supply can lead to the effective separation of the organic matter from metal complexes.

Variations in the State of Organic Matter Present in the Sediment

Figure 4 shows the spectral difference between the treated and the control sediment. The difference equaled to the spectra of the control sediment minus the spectra of the tread sediment. Hence, negative absorbance reveals the release of a substance in the sediment, while positive absorbance reveals the loss of a substance from the sediment.

In Operations 2 and 3, negative absorbance was confirmed at 3300–3700 cm−1 and 1600 cm−1 (Fig. 4). These operations predominantly exhibited the same change of spectra, i.e., release of O-H hydroxyl (3300–3700 cm−1) and C=O carboxylic acid (around 1600 cm−1) groups. Both electron

recovery and electron supply predominantly exhibited the same effects on the change in the state of organic matter in the sediment

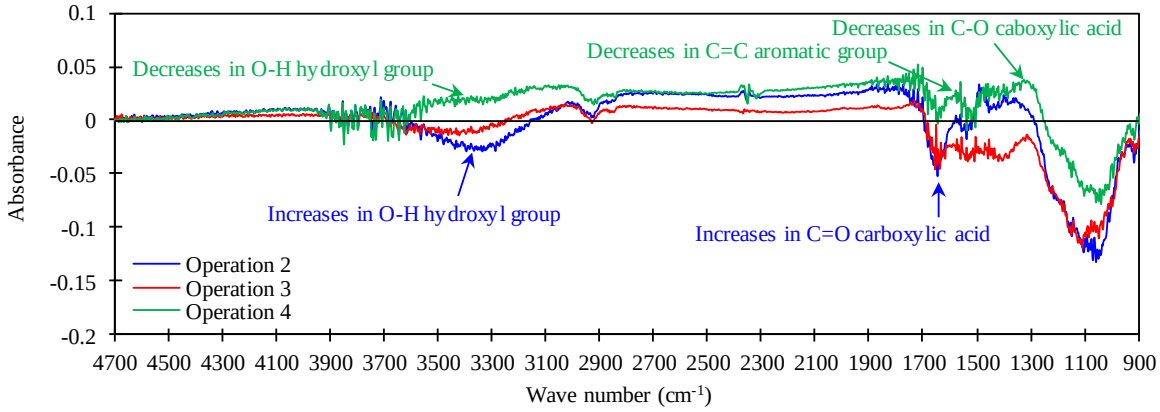

Fig. 4 Spectral difference between the treated and the control sediment

Conversely, losses of the O-H hydroxyl group and C=C aromatic group from the sediment were confirmed in Operation 4. In addition, the loss of C-O carboxylic acid group (around 1400 cm-1) was observed, indicating that the state of organic matter is effectively changed in Operation 4. This further establishes that the combination of electron recovery and electron supply can effectively separate organic matter from metal complexes. The decrease in the O-H hydroxyl group in Operation 4 may be partly related to the immobilization of metal compounds owing to the electron supply, which is consistent with the suggestion from Fig. 3.

CONCLUSION

In this study, laboratory experiments were conducted to examine changes in the state of organic matter owing to the application of different methods of electrokinetic treatment, i.e., electron recovery, electron supply, and a combination of electron recovery and electron supply. Both electron recovery and electron supply can dissociate metal complexes present in the sediment, leading to the increase in the LOI of the sediment. However, electron recovery was more effective for the dissociation of metal complexes. Based on the FTIR results, this dissociation released the O-H hydroxyl group and organic compounds. By conducting electron supply after electron recovery, the loss of the O-H hydroxyl group and the decrease in LOI greater than 500°C were confirmed, indicative of the immobilization of metal compounds owing to the electron supply. Furthermore, changes in the state of various organic matter were confirmed. Hence, different states of organic matter can be obtained by changing the method of making the flow of electrical current in the sediment. The combination of electron recovery and electron supply can effectively separate organic matter from metal complexes.

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Research article

Impact of No-tillage on Rice Yield and Some Soil Properties in Tropical Flooded Transplanting Lowland Rice Cultivation

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Abstract Flooded transplanting rice with full tillage is a traditional rice production technique in Thailand. However, the intensity of soil tillage increased operation costs and affected soil fertility especially on soil organic carbon (SOC). No-till is widely used as a system to improve soil properties and reduce operation costs. However, the effectiveness of no-till to flooded transplanting rice needs further investigation. The aim of this study was to determine the effectiveness of rice yield response and the change of soil properties under flooded transplanting rice conditions after using a no-tillage system. A field experiment was conducted over three years on Typic Plinthaquults (Phen series) with 4 treatments including conventional tillage (CT), conventional tillage with green manure incorporation (CTG), no-till (NT) and no-till with green manure application (NTG). NT and NTG treatments showed a significant increase in SOC, soil total nitrogen, Bray II P and exchangeable K compared with CT. Under flooded transplanting rice, no-till had a negative effect on rice yield in the first 2 years. However, the NT yield significantly increased in the third crop and was comparable to the CT yield. Adequate application of green manure to no-till could improve yield reduction at early year of no-till adoption. The results in this paper reveal that no-till is more effective to use in a flooded transplanting rice system which improves soil properties and rice yield.

Keywords no-tillage, rice, soil organic carbon, soil properties, yield

INTRODUCTION

Rice is the principal food of more than half of the global population. The global estimated production area is 161 million ha with a production of 716 million metric tons of paddy rice in 2016, nearly all (87%) produced in Asia (IRRI, 2017). More than 90% of the global rice production is harvested from lowland paddy fields (Tuong and Bouman, 2003). In Thailand, where the world's largest rice exporter had a total area of 11.7 Mha of rice production, most of farmers use a paddy rice cropping system (Office of Agricultural Economics, 2015). Flooded transplanting rice is a traditional practice in Thailand rice production, especially in a rainfed area, and similarly in other rice production countries in South and Southeast Asia (Liese et al., 2014).

In general, the rice establishment in Asia with a lowland ecosystem and flooded transplanting rice involves hand transplanting followed by full tillage that consists of primary and secondary tillage and soil puddling. Soil tillage and puddling are mainly completed for weed control, easy transplanting and decreased water percolation which results in retained standing water in rice fields

(Rodrigues and Lal, 1985; Singh and Kaur, 2012). However, these techniques do increase the water requirement during land preparation, labor and energy consumption. The rice fields are continuously flooded during the period of crop growth until final drainage occurs around 7–10 days before harvest (Tuong and Bouman, 2003). Continuous flooding is a benefit for weed control, to make water management easier and to ensure that an adequate amount of water maintained during crop growth in an unstable rainfed area. However, regular tillage accelerates mineralization of soil organic matter (SOM) by increasing the contact of crop residues with soil, and thus consequently declining the SOM and deteriorating the soil quality (Wall, 2007). In general, soil quality is largely defined by the status of SOM; there are many confirmed reports of a decline in SOM in conventional tillage soil compared to no-tillage soil (Madari et al., 2005; Ogle et al., 2005). A decline in SOM leads to reduced soil fertility because SOM is an important source of plant nutrients. Sahrawat (2004) reported that 50–75% of nitrogen in paddy rice crops comes from organic matter.

SOM also greatly influences the biological, physical and chemical properties of soil. Johansen et al. (2012) concluded that a decline in SOM results in reduced soil particle aggregation, soil aeration, soil water holding capacity and an increase in the soil bulk density. Besides a decline in soil fertility, an increase in the production cost is another concern in rice production. The production cost of transplanting rice increased by 50–200% in developing countries in Asia from 1990 to 2010 (Liese et al., 2014; Papademetriou et al., 2000). In Thailand, the growth rate of rice production costs steadily increased by about 19% since 2001 until it increased to 54% in 2008 while increased from 73 US$ per Mt in 2001 to 201 US$ per Mt in 2008 (Poramacom, 2014). This increase in the cost of rice production was due to an increase in the input prices including fuel, fertilizers, wages of labor and land preparation cost. Traditional land preparation including full tillage and soil puddling accounted for 10–15% of the total production cost (Poramacom, 2014).

No-tillage in the context of conservation agriculture is widely adopted; data reported in 2010 indicated that the adoption area of no-tillage is over 115 Mha. More than 96% of the total no-tillage area is in North and South America and Australia, while less than 3% is found in Asia (Derpsch et al., 2010). The advantages of conservation tillage over conventional tillage includes reduced cultivation costs, increased SOM, an improvement to the physical and chemical properties of soil and an improvement to soil microbial ecology (Hobbs et al., 2008; Mathew et al., 2012). For rice production, many reports have shown the improvement to soil and economic benefits of no-tillage in a rice-wheat system, but less information has been presented on tropical flooded transplanting rice ecosystem. Moreover, the effectiveness of no-tillage on crop and soil properties evolves over time. Yield reduction after no-tillage adoption found in several cases due to an imbalance between mineralization and immobilization of SOM (Pittelkow et al., 2015; Soratto et al., 2014). Therefore, the duration of transitional period should be determined for design fertilizer recommendation before no-tillage adoption. The present study has the following objectives: 1) to determine the effectiveness of no-tillage on flooded transplanting rice in a tropical environment; and 2) to determine rice yield response and the change in soil properties under no-tillage conditions.

METHODOLOGY

Experimental Description

Experiments were conducted during three growing seasons (2010–2012) in the Sakon Nakhon province of Thailand, in a tropical savannah climate (17_08°N, 104_04°E). According to weather data collected from the Kasetsart University Chalermphrakiat Sakonnakhon Province Campus weather station from 2010 to 2012, the annual precipitation was between 1,350 and 2,014 mm, and most of the rainfall was between May and October (Fig. 1). The soil was a Typic Plinthaquults **(**Phen series**),** being loamy-skeletal in texture. At the beginning, soil contained 3.60 g kg^{-1} of soil organic carbon (SOC), 430 mg kg^{-1} total nitrogen, 0.92 mg kg^{-1} Bray II P and 47.97 mg kg^{-1} exchangeable K.

The field experiments were arranged in randomized complete block design with 4 replications consisting of 4 treatments: (1) conventional tillage (CT), included disc ploughing followed by secondary tillage and puddling; (2) conventional tillage with green manure incorporation (CTG), green manure was applied before primary tillage; (3) no tillage (NT) and (4) no tillage with green manure application (NTG). Green manure (*Crotalaria juncea*) was grown ex-situ outside of the experimental plot. After Crotalaria flowering, the above ground biomass was harvested and applied to the plot by treatment at a rate of 3,750 kg ha^{-1} (dry weight). Rice cultivar Chai Nat 1 was transplanted in spacings of 20 × 20 cm with 3 seedlings per hill in a 35 m^2 plot. 30 days after emergence, the seedlings were used. Nitrogen at a rate of 30 kg ha^{-1}, phosphorus at a rate of 30 kg P_2O_5 ha^{-1} and potassium at a rate of 15 kg K_2O ha^{-1} were applied 7 days after transplant and top dressed at a rate of 60 kg N ha^{-1} at the booting stage.

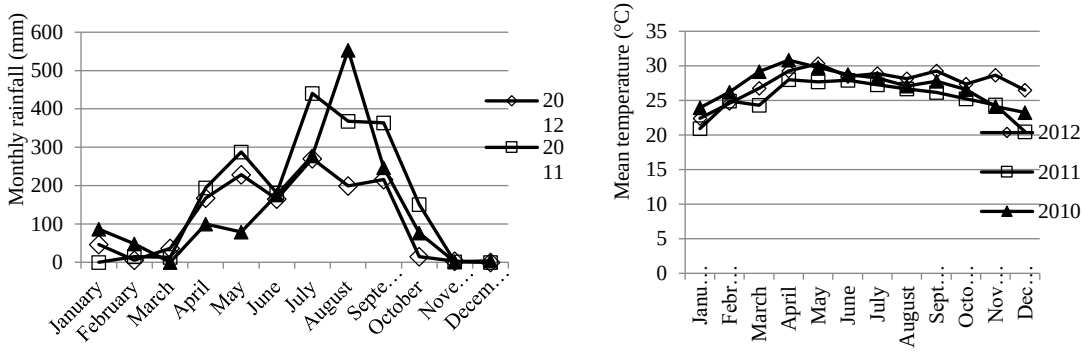

Fig. 1 Monthly rainfall and mean temperature during experiments in 2010, 2011 and 2012

In green manure treatment (CTG and NTG), the N fertilizer addition rate was calculated by subtracting the N received from the organic materials while each plot had the same amount of N at the rate of 90 kg N ha^{-1}. In the first crop, the Crotalaria green manure contained 2.0 % N and 46.7% C. In the second crop, Crotalaria contained 1.98% N and 51.0% C, while the third crop, the Crotalaria contained 1.83% N and 47.5% C. The rice residue was left on the soil surface after harvest of each crop. The water level in the experimental field was maintained at a depth of 10–15 cm throughout maturity. The first crop started in July 2010, the second crop started in July 2011 and the third crop started in March 2012.

Sampling and Analyses

Soil samples were taken after the rice harvest in each crop for analysis of the nutrients including SOC, total N (micro Kjeldahl), available P by Bray II extraction and ammonium acetate (NH_4OAc) extraction for exchangeable K. Whole rice shoots from 5 hills were collected at harvest on 115 Day After Transplanting (DAT) to determine N uptake using the micro Kjedahl method followed by a flow injection analyzer (FIA); to determine the amount of P colorimetry was used (Murphy and Riley, 1962) and for the amount of K, flame emission spectroscopy was used. Grain yield and the dry weight of shoots were determined from a 2 m^2 area. Statistical analysis was completed using one way analysis of variance (ANOVA) and the significant difference among means was determined by using least significant difference (LSD) at $\alpha = 0.05$. All of data were analyzed using program STATISTIX (version 8).

RESULTS

The Change in Soil Properties

In the first crop, SOM in all treatments increased to 6.20–6.86 g kg^{-1} from the initial soil, but there was no significant difference between the treatments (Table 1). Green manure application in the CTG and NTG treatments increased SOC to 0.37 and 0.13 g kg^{-1} relative to CT, respectively, but

the level was less than CT in NT without green manure addition (Table 2). In the second year, SOC increased to 11.8–25.8 % over the first year with highest level observed using the NTG treatment (8.33 g kg^{-1}) and the lowest level observed using the CT treatment (7.26 g kg^{-1}), while SOC in the NT treatment increased to the same level as CT and CTG (Table 1). Table 2 shows an accelerated SOC accumulation in NTG compare to CT. No-tillage without green manure addition also increased SOC to 0.39 g kg^{-1} relative to CT. No-tillage with green manure gave the highest SOC level (10.44 g kg^{-1}) in the third crop, but this level was not significantly different to NT, while the lowest level was found with CT (Table 1). An increased SOC was found in the no-tillage treatments (NT and NTG) with 13.0% and 23.1% greater than CT, respectively (Table 2). Soil total nitrogen (STN) after harvest in the first year was highest with the NT treatment (861.3 mg kg^{-1}) equivalent to 18.5% relative to CT (Table 2). The lowest level of STN was found with the CT treatment (721.3 mg kg^{-1}), but this was not significantly different to the CTG and NTG treatments (Table 1). Using no-tillage with a green manure application, STN was significantly greater than CT in the second crop, equivalent to an increase of 158.6 mg kg-1 compared to CT (Table 2). Despite this, there was no significant difference in the STN values among the CT, CTG and NT treatments (Table 1). In the third crop, the highest level of STN was found in the CTG treatment equivalent to an increase of 152.7 mg kg^{-1} compared to CT (Table 2). However, STN, using the NTG treatment, declined to same level as using the NT treatment (655.7 mg kg^{-1}), but the STN value remained significantly higher than that found with the CT treatment (Table 1).

Table 1 Effect of tillage method and green manure application on soil organic carbon, total N, available P and exchangeable K after harvested in 2010, 2011 and 2012

Tr.	SOC (g kg^{-1})			Total N (mg kg^{-1})			Bray II P (mg kg^{-1})			Exch. K (mg kg^{-1})		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
CT	6.49	7.26c	8.48c	721.3b	563.2b	578.6c	1.33	2.58	3.62b	157.5	122.5b	97.5b
CTG	6.86	7.80b	9.35b	756.6b	622.8b	731.3a	1.38	2.60	3.96b	155.5	137.5a	127.5a
NT	6.20	7.65bc	9.58ab	861.3a	610.3b	621.3bc	1.27	3.01	5.62a	162.5	140.0a	115.0a
NTG	6.62	8.33a	10.44a	766.7b	721.8a	655.7b	1.30	2.53	4.44b	162.5	152.5a	122.5a
F-test	ns	*	*	*	**	*	ns	ns	**	ns	**	**
CV (%)	12.91	9.82	11.9	11.93	13.5	16.91	7.13	19.24	22.6	17.02	18.11	18.73

Means labeled with the same letter in each column are not different as determined by LSD (P < 0.05)

The tillage and green manure method were not affected by available P in the first two years after the experiment (Table 1). Soil analysis showed Bray II P was in the range of 1.27–1.38 mg kg^{-1} in 2010 and 2.53–3.01 mg kg^{-1} in 2011. However, a significant increase in available P was found in 2012 with the NT treatment, which was higher than CT by 2.00 mg kg^{-1} (Table 2). There was no significant difference in available P among the CT, CTG and NTG treatments, which were between 3.62 and 4.44 mg kg^{-1}.

Soil results showed a three-fold increase in exchangeable K in 2010 compared to the initial soil, but there was no significant difference among treatments that ranged from 155.5–162.5 mg kg^{-1}. Tillage methods and green manure incorporation affected the exchangeable K in soil in 2011. High levels of K were found with CTG, NT and NTG resulting in values between 137.5 and 152.5 mg kg^{-1} (15.0–30.0 mg kg^{-1} greater than the CT treatment). The same response pattern of soil exchangeable K was also found in 2012, with the higher level of K found in CTG, NT and NTG treatments than that of the CT treatment. Among CTG, NT and NTG, there was no significant difference in the exchangeable K that ranged from 115.0-127.5 mg kg^{-1} equivalent to an increase of 17.5-30.0 mg kg^{-1} compared to CT (Table 2).

Table 2 Soil organic carbon, total N, Bray II P and Exchangeable K in soil after harvest relative to CT

Tr.	SOC (g kg^{-1})			Total N (mg kg^{-1})			Bray II P (mg kg^{-1})			Exch. K (mg kg^{-1})		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
CTG	0.37	0.54	0.87	35.3	59.6	152.7	0.05	0.02	0.34	-2.00	15.0	30.0
NT	-0.29	0.39	1.10	140.0	47.1	42.7	-0.06	0.43	2.00	5.00	17.5	17.5
NTG	0.13	1.07	1.96	45.4	158.6	77.1	-0.03	-0.05	0.82	5.00	30.0	25.0

Yield and Nutrient Uptake

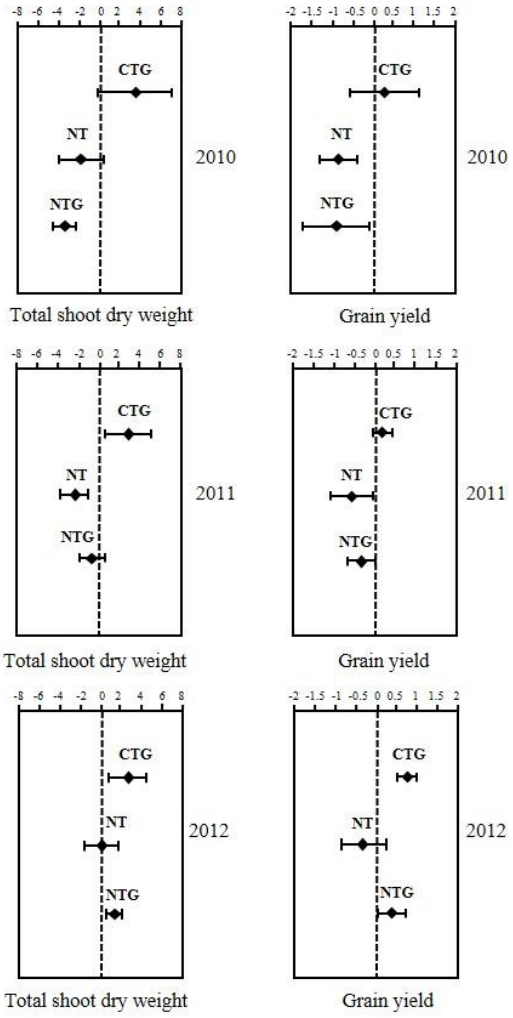

Fig. 2 Total shoot dry matter and grain yield of different tillage method relative to conventional tillage. Error bars represent LSD (P<0.05)

The tillage system had a significant effect on grain yield especially early in the experimental year. In 2010, NT resulted in lower total shoot dry weight and grain yield than CT, even though green manure was applied (NTG). The highest grain yield was obtained with CTG but was not significantly different to the CT treatment (Table 3). The highest shoot dry weight was also found in CTG and the lowest one was found in NTG. However, there was no significant difference between the CT and NT treatments in the first year. In 2011, the highest grain yield was obtained with CTG (3.52 Mg ha^{-1}), but the yield was not different to the CT method (3.34 Mg ha^{-1}). However, NTG did increase the grain yield and shoot dry weight to the same level as CT. The grain

yield was 3.01 Mg ha^{-1} and the shoot dry weight was 10.27 Mg ha^{-1} with NTG, while CT produced 3.34 and 10.83 Mg ha^{-1} for grain yield and shoot dry matter, respectively. The no-tillage treatments (NT and NTG) increased the grain yield and shoot dry weight to the same level as the conventional tillage treatments (CT and CTG) in 2012. The highest grain yield and shoot dry weight were found with CTG (4.29 and 12.70 Mg ha^{-1}, respectively), but the yield and shoot dry weight were not significantly different with NTG (3.94 and 11.41 Mg ha^{-1}, respectively). Moreover, NT also increased the grain yield and shoot dry weight to the same level as CT (Table 3). With the use of conventional tillage to provide a benchmark level of yield, the no-till reduced the yield in the first year by 22.2% and 23.5% for NT and NTG, respectively (Fig. 2). In the second crop, NTG can increase the yield to same level with CT. Both NT and NTG produced similar yields to conventional tillage yield in the third crop (Fig. 2).

The uptake of nutrients was affected by the tillage methods. In 2010, there was a lower N uptake with NT and NTG than CT and CTG by 24.1–29.6% (Table 4). With CTG, the shoot P uptake increased by over 48.7% when compared with CT, NT and NTG. However, there was no significant difference in the K uptake among treatments with values ranging from 94.9– 112.2 kg ha^{-1}. In 2011, NT and NTG increased N uptake to the same level as CT, whereas the highest level of N uptake was found with CTG. For P and K uptake, CTG had a greater level than CT, NT and NTG. In 2012, CTG had the highest N uptake, but this was not significantly different to NTG. There were no significant differences in P uptake among treatments, with values ranging from 4.2–6.2 kg ha^{-1}. The highest K uptake was found with the NT treatment, but this was not different to that from the NTG treatment with values ranging from 70.3–72.6 kg ha^{-1} (Table 4).

Table 3 Effect of tillage method and green manure application on aboveground dry weight, grain yield and shoot N uptake in 2010, 2011 and 2012

Tr.	Grain Yield (Mg ha^{-1})			Total shoot dry weight (Mg ha^{-1})		
	2010	2011	2012	2010	2011	2012
CT	3.91a	3.34ab	3.62ab	15.46b	10.83b	10.17b
CTG	4.18a	3.52a	4.29a	18.84a	13.55a	12.70 a
NT	3.04b	2.78c	3.26b	13.86bc	8.45c	10.18b
NTG	2.99b	3.01bc	3.94ab	12.24c	10.27b	11.41ab
F-test	*	*	*	**	**	*
C.V.(%)	14.62	8.73	11.53	11.21	9.6	8.93

Means labeled with the same letter in each column are not different as determined by LSD (P < 0.05)

Table 4 Effect of tillage method and green manure application on shoot nutrients uptake in 2010, 2011 and 2012

Tr.	Shoot N uptake (kg ha^{-1})			Shoot P uptake (kg ha^{-1})			Shoot K uptake (kg ha^{-1})		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
CT	84.6a	72.2b	72.0b	7.3b	7.7b	4.7	104.4	84.7b	61.4b
CTG	82.4a	96.2a	82.7a	14.6a	9.4a	4.2	112.2	101.3a	63.6b
NT	59.6b	60.8b	73.6b	7.5b	7.0b	5.6	94.9	81.2 b	72.6a
NTG	62.5b	73.1b	78.2ab	6.3b	7.1b	6.2	95.1	77.5 b	70.3a
F-test	**	**	*	**	*	ns	ns	**	*
C.V. (%)	9.4	13.9	5.0	32.6	12.2	21.7	17.3	12.5	9.1

Means labeled with the same letter in each column are not different as determined by LSD (P < 0.05)

DISCUSSION

According the results given in this paper, we have found that SOC increased to 9.58 g kg^{-1} with NT treatment to the same level as the CTG treatment in the third year; equivalent to an increase of 12.97% over that which was found with the CT treatment. Moreover, an increase in SOC of 23.11% over the CT treatment was found with the NTG treatment in same year. This indicates that the no-till treatments improve SOC in flooded transplanting rice production. Likewise, several previous studies have reported an increase in SOC or SOM in no-till systems (Al-Kaisi et al., 2004).

Bhattachayya et al. (2008) reported that SOC in a rice-wheat zero-tillage system was higher than that found with conventional tillage. In general, SOC plays an important role in maintaining soil structure and providing soil nutrients, which affects crop production. Accumulation of organic carbon was generally found in long term no-till treatments more than in conventional tillage treatments (Kushwaha et al., 2001). An increase in SOC under no-tillage was due to remaining plant residue on the soil surface which reduced the contact of residues with the soil (Singh and Kaur, 2012). Plant residues on the soil surface tend to decompose slower than soil incorporated residue. In the present study, SOC in the plot with no-tillage and without green manure addition (NT) was not significantly different compared to CT in the first 2 years, while significantly higher amounts of SOC was found with NT compared to CT in the third-year crop. However, green manure addition in NTG treatment can accelerate the rate of SOC accumulation to a higher level than CT within 2 years. Lal et al. (1999) concluded that the SOC dynamic is related to land use and management practices.

Adoption of conservation tillage resulted in a 56 % increase in SOC over a 10-year period compared to conventional tillage, while SOC slightly increased within five years, then a large increase occurred in the next five to ten years (Lal et al., 1998). Duiker et al. (1999) reported that the SOC accumulation rate was lower in plough-till compared to no-till. The tillage system also affects the content of nutrients in soil. The current study found that no-till increased the total N, Bray II soil P and exchangeable K after the second crop compared to CT. In general, a no-till system favors organic material accumulation on the soil surface that usually advocates recycling of nutrients and enhances soil fertility. Nevertheless, the SOM mineralization rate in no-till is lower than that of CT, which reduced the availability of nutrients to crops as during the period from system carry out to equilibrium (Soratto et al., 2014).

Application of the no-till system to flooded transplanting rice seems to have an equilibrium between immobilization and mineralization within three crop years that can be explained by rice grain yield and nutrients uptake. In this study, no-till produced rice grain yield equivalent to CT within three consecutive years. However, a declined grain yield, below the control in the NT and NTG treatments, was found in the first crop after adopting the no-till system. In the second crop, the grain yield and above ground dry weight from the NTG treatment was similar to that of CT but lower than that of CTG. In the third crop, the grain yield with the NTG treatment increased to the same level as the CTG and CT treatments. The results indicated that the grain yield, related to soil properties, changed by using no-tillage.

Several previous reports showed that no-till reduced crop productivity, especially in the first few years after adoption (Sa et al., 2014; Soratto et al., 2014). Haque et al. (2016) reported that minimum tillage and unpuddled transplanting rice gave yields of the same level as conventional puddling within three years after adoption. The reduction in yield in the first few years after implementation of no-till caused by soil, takes time to benefit the soil properties, such as an increased in SOC, availability of nutrients from SOM, mineralized and re-established desirable soil structure taking time to develop (Haque et al., 2016; Pittelkow et al., 2015; Soratto et al., 2014). Not only grain yield but the uptake of nutrients by rice shoots can also explain the relationship between the change in soil properties and the response of rice in a no-till system.

No-till treatment showed lower N, P and K uptake than CT in the first crop, while in the third crop no-till with green manure addition showed increased N, P and K uptake, to the same level as CT and CTG. The results of this research relating to the change in soil properties, rice grain yield responses and the uptake of nutrients, revealed a three-year transition period from conventional

tillage to a no-till system in a flooded transplanting rice system. However, this transition period of yield reduction can reduce or prevent soil management strategies such as nitrogen fertilization and organic matter addition (Lundy et al., 2015; Singh and Kaur, 2012; Sorattao et al., 2014).

CONCLUSION

A no-till system has quite a high effect on soil properties and rice yield under flooded transplanting conditions. The yield of rice declined with a no-till system in the first two years after adoption. However, the yield increased on the same level as CT treatment after the third year of no-till adoption. No-tillage had a positive impact on soil properties in flooded rice conditions. Under flooded transplanting rice conditions, no-till treatments were more beneficial than conventional tillage in terms of SOC, total N, available P and exchangeable K. Green manure applications to no-till systems can improve yield reduction at an early stage of no-till adoption and is beneficial to the improvement of soil properties in the long-term, also decreasing the operation costs.

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Research article

Evaluation of Salt Tolerance for Improved Rice Lines in terms of Agronomic Parameters

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Abstract Soil salinity has become a serious threat to crop productivity worldwide. Salt tolerance for rice varieties vary with different stages against salinity. This study was to evaluate the effect of three different levels [0.2, 6.0, and 8.0 dS m^{-1}] of salinity on the growth and yield of improved rice lines at different growth stages. This study was conducted as two-factor factorial in a randomized complete block design with three replications at Yezin Agricultural University in 2017 and 2018. After screening at seedling and vegetative stages, the selected rice lines were grown at three different salinity levels [3.3, 6.0, and 7.6 dS m^{-1}] in the field. Among the one hundred improved rice lines, thirteen lines were tolerant to 8.0 dS m^{-1} during three weeks of application at seedling stage. Studies at vegetative stage showed that these thirteen lines were tolerant to 6.0 dS m^{-1} during six weeks of application. However, seven rice lines were moderately tolerant to 8.0 dS m^{-1} during six weeks of application in term of leaf mortality. In the field experiment, all seven rice lines were tolerant to 6.0 dS m^{-1} at all growth stages, whereas death occurred at 7.6 dS m^{-1}. All agronomic parameters such as tiller numbers, panicle numbers and grain numbers per panicle were grown up to maturity under 6.0 dS m^{-1} at field condition. All these parameters were found to be major cause of yield reduction under saline conditions.

Keywords salinity; screening rice lines

INTRODUCTION

Rice (*Oryza sativa*), the staple food of half of the population of the world, is an important target for water use reduction because of its greater input water requirement than other crops. On the other hand, rice crop that resists to climate change is prevalent among farmer's requirements.

Soil salinization has become a serious problem all over the world and around 20% of the world's cultivated land are affected (Sumner, 2000). In Myanmar, soil salinization was found in coastal and inland regions. Coastal salinity was affected by seawater intrusion/ infiltration during flood resulting salt accumulation in the topsoil in the summer season. It was commonly happened in Ayeyarwady, Yangon, Yakhaing and Taninthari regions. Inland salinity is commonly seen in dry zone areas of the central Myanmar such as Mandalay, Magway and Sagaing regions. Swe and Ando (2017) observed that salinity is becoming a prominent abiotic problem declining rice production in central dry zone which little attention was paid in the past. They reviewed that with irrigation for several years continuously, alkali/saline soils have been developed in certain areas. The excessive applications of irrigation water have raised the ground water level sufficiently to increase concentration of salts through evaporation. It is related principally to the presence of sodium carbonate and sodium bicarbonate in these areas. Inland salinity or irrigation salinity is due

to over-watering, seepage from irrigation channel, impaired natural drainage and high water table. From the low land rice in these salt affected areas, high rate of evaporation and evapotranspiration of rice crop increase the capillary transport of water and solutes from the groundwater to the root zone. When there is a condition of no or negligible leaching of these salts, the soils will be affected with salinity within a few years. In addition, due to the poor drainage facilities in the irrigation areas not only the agricultural lands have suffered but also agricultural production has suffered from the twin hazard of water logging (hypoxia) and salinity.

Rice productivity is quite low due to the salinization, limitation of water resources, and low soil fertility in inland salinity areas of Myanmar (Oo et al. 2017). To improve crop productivity in these areas, it is needed to investigate the plant responses to conditions with the ultimate goal of improving crop performance in these areas where salinity has a problem. According to further improvement of rice breeding program in national level, it offers doing research and providing rice varieties for farmer needs are recently lined out. The water requirement and salt tolerance for rice genotypes vary with different stages of its establishment processes, and to determine the best tolerance on rice varieties at different stages in our country is one of the advantageous and encouraging rice productions to climate adaptability.

OBJECTIVES

This study was to evaluate the most salt tolerance rice lines at different growth stages among the improved genotypes and to determine the best improved rice lines based on influences of salinity stress on the growth and yield of rice in the central dry zone of Myanmar.

MATERIALS AND METHODS

Evaluation of Improved Rice Lines at Seedling Stage

A population of 100 improved rice genotypes (provided from the Department of Plant Breeding, Physiology and Ecology, Yezin Agricultural University) with Pokkali (tolerant check) and IR29 (susceptible check) were tested at the Department of Soil and Water Science, Yezin Agricultural University, Myanmar.

The first experiment was conducted in a net house with 31/21°C day/night temperatures and a minimum relative humidity of 75% during the day in 2017. Pre-germinated seeds of 100 rice lines were sown at two seeds per hole and a sheet with 100 holes and a nylon net bottom. The sheets were floated on a plastic tray filled with distilled water for 4 days and then in nutrient solution (Yoshida et al. 1976) for 4 days. All seedlings were then well-established, and the culture medium was salinized with EC 6 dS m^{-1} by adding NaCl. After 4 days, salinity was increased to electrical conductivity (EC) 8.0 dS m^{-1} by adding NaCl. The experimental design was set up with both non-saline and salinized nutrient solutions in a randomized complete block (RCB) design with three replications. The pH was maintained daily at 5.5.

Table 1 Modified SES of visual salt injury at seedling and vegetative stages (Gregorio et al., 1997)

Score	Observation	Tolerance
1	Normal growth, no leaf symptoms	Highly tolerant
3	Nearly normal growth, but leaf tips of few leaves whitish and rolled	Tolerant
5	Growth severely retarded, most leave rolled	Moderately tolerant
7	Complete cessation of growth, most leaves dry, some plant dying	Susceptible
9	Almost all plant dead or dying	Highly susceptible

Salinity tolerance was rated using a modified standard evaluation system (SES) in rating the

visual symptoms of salt toxicity (Gregorio et al., 1997) as shown in Table 1. This scoring discriminates the susceptible from the tolerant and the moderately tolerant genotypes. Scoring was started at 10 days after salinization and final scoring at 16 days after salinization.

Evaluation of Selected Improved Rice Lines at Vegetative Stage

This experiment was conducted as two-factor factorial in a randomized complete block design with three replications at vegetative stage in 2018. The selected seven rice lines, after screening at seedling stage, with Pokkali (tolerant check) and IR29 (susceptible check) were grown at three different levels (0.2, 6.0, and 8.0 dS m^{-1}) in the net house.

According to Gregorio et al. (1997) who modified the method for the screening of rice genotypes at vegetative stage, the wall of plastic pot was drilled with 3-4 mm diameter holes 2 cm apart with the topmost circle of holes at least 3 cm below the rim of plastic pot. Cotton cloth was used and fit well inside the plastic pot. The pots were filled with fertilized soil. These pots were placed in the plastic tray filled with ordinary tap water which served as water bath. Four to five pre-germinated seeds of test entries are placed on soil surface of each pot. Two weeks after seeding, seedlings were thinned to one per pot and the water level was raised to about 1 cm above soil. When the seedlings were 25 days old, all water in the water bath was siphon out. And then, salinized water was filled up to the desired EC level by dissolving NaCl in water. Maintain water level daily and protect the plants from any pests and diseases were performed.

Scoring was started at two weeks after salinization by using a modified standard evaluation system in rating the visual symptoms of salt toxicity (Gregorio et al., 1997) as presented in Table 1. Test entries was scored from then onwards based on visual symptoms. Plant height (cm) and the number of tillers per hill were recorded at 6 weeks after salinization.

Evaluation of Selected Improved Rice Lines at Vegetative Stage in the Field Condition

In order to determine the best improved rice lines based on influences of salinity stress on the growth and yield of rice, the experiment was conducted in the salinity area at Htein Kan Gyi village in Myittha Township, Mandalay Division where is situated in the dry zone area of Myanmar during the rainy season of 2018. The experiment was laid out in a randomized complete block design (RCBD) with four replications. The selected seven rice lines, after screening in the net house at vegetative stages, with Pokkali (tolerant check) and IR29 (susceptible check) were grown with a spacing of 20 cm x 20 cm under three different salinity levels (3.3, 6.0 and 7.6 dS m^{-1}) which were set up according to the salinity survey measurement in the study area. Scoring was started at two weeks after transplanting by using a modified standard evaluation system in rating the visual symptoms of salt toxicity (Gregorio et al., 1997) as shown in Table 1. Test entries was scored from then onwards based on visual symptoms. Plant height (cm) and the number of tillers per hill were recorded at 42 days after transplanting (DAT) (i.e at vegetative stage) and the number of panicles per hill and yield were measured at harvesting.

Data Analysis

The data collected were analyzed statistically using Analysis of Variance (ANOVA) Techniques, and rice lines means were compared by least significant different (LSD) method at 5% probability level. All statistical analyses were done using Statistix 8.0 software and Excel program (2010).

RESULTS AND DISCUSSION

Evaluation of Improved Rice Lines at Seedling Stage

All one hundred improved rice lines at seedling stage were grown strongly and showed uniform green colour in the non-salinized condition (0.2 dS m^{-1}). In salinized condition (8.0 dS m^{-1}), the rice

lines differed significantly for salt tolerance at seedling stage among the rice lines ranging from score 1 (highly tolerant) and score 9 (highly susceptible) (data not show).

The one hundred improved rice lines were classified into five groups from highly tolerant (score 1) to highly sensitive (score 9) as 0 (highly tolerant), 13 (tolerant), 12 (moderate tolerant), 28 (sensitive) and 51 (highly sensitive) at 16 days after salinization. Among the one hundred improved rice lines, thirteen lines were tolerant to 8.0 dS m^{-1} during three weeks of application at seedling stage. The effects of salinity stress on plants are complex and it is difficult to interpret the results if experiments are not designed carefully and if appropriate measurements are not made (Negrao et al., 2017). Hence, the selected seven rice lines from thirteen tolerant lines were evaluated at vegetation stage in the net house and field condition.

Evaluation of Selected Improved Rice Lines at Vegetative Stage

The visual evaluation scores, SES showed a variation in response to salt stress among the rice lines. SES increased with the increase in stress level, indicating greater susceptibility at higher stress level (Table 2). All seven improved rice lines at vegetative stage were grown strongly and showed uniform green colour in the non-salinized condition (0.2 dS m^{-1}). In salinized condition (6.0 and 8.0 dS m^{-1}), the rice lines differed significantly for salt tolerance at vegetative stage among the rice lines ranging from score 1 (highly tolerant) and score 9 (highly susceptible) (Table 2). The seven rice lines showed a higher degree of tolerant and moderately tolerant under two different salinity levels (6.0 and 8.0 dS m^{-1}, respectively).

Table 2 Salinity reactions of improved rice lines in terms of Standard Evaluation Score (SES) under three different salinity levels at vegetative stage in the net house

Improved rice lines	Reaction to salinity at 6 weeks after salinization		
	0.2 dS m^{-1}	6.0 dS m^{-1}	8.0 dS m^{-1}
YAU-1211-14-1-1	Highly tolerant	Tolerant	Moderately tolerant
YAU-1201-90-2-4	Highly tolerant	Tolerant	Moderately tolerant
YAU-1211-118-1-1	Highly tolerant	Tolerant	Moderately tolerant
YAU-1211-195-1-1	Highly tolerant	Tolerant	Moderately tolerant
YAU-1201-26-1-1	Highly tolerant	Tolerant	Moderately tolerant
YAU-1201-26-1-3	Highly tolerant	Tolerant	Moderately tolerant
YAU-1211-82-1-1	Highly tolerant	Tolerant	Moderately tolerant
Pokkali	Highly tolerant	Tolerant	Tolerant
IR29	Highly tolerant	Highly susceptible	Highly susceptible

Table 3 Salinity reactions of selected improved rice lines in terms of plant height and number of tillers per hill under three different salinity levels at vegetative stage

Improved rice lines	Plant height (cm)			Number of tillers per hill		
	0.2 dS m^{-1}	6.0 dS m^{-1}	8.0 dS m^{-1}	0.2 dS m^{-1}	6.0 dS m^{-1}	8.0 dS m^{-1}
YAU-1211-14-1-1	39.0 bcd	32.7	26.3	4.7	4.0	3.0
YAU-1201-90-2-4	37.3 de	32.3	25.7	4.3	4.0	3.3
YAU-1211-118-1-1	42.0 ab	32.7	23.7	4.3	3.7	3.3
YAU-1211-195-1-1	39.7 bcd	33.3	24.0	4.0	3.7	3.3
YAU-1201-26-1-1	44.7 a	32.0	26.7	5.0	4.3	4.0
YAU-1201-26-1-3	38.0 cde	35.7	22.7	4.0	3.3	3.3
YAU-1211-82-1-1	40.7 bc	34.0	27.3	4.3	3.7	4.0
Pokkali	35.3 ef	36.3	25.0	4.3	3.3	3.3
IR29	33.0 f	31.7	24.0	3.7	3.7	3.3
F-test	**	ns	ns	ns	ns	ns
C.V %	4.6	5.5	9.2	15.2	18.6	19.4

Values in the same column followed by the same letter are not significantly different at the 5% level by the LSD test, (**) significantly different at P≤0.01, ns − not significant

Salinity reactions of selected improved rice lines in terms of plant height and number of tillers

per hill under three different salinity levels at vegetative stage are showed in Table 3. The plant heights were significantly different among the rice lines in the non-salinized condition (0.2 dS m^{-1}). In contrast, these parameters were not significantly different among the rice lines in both salinized conditions. Similarly, the number of tillers per hill was not significantly different among the rice lines in all salinized conditions.

Evaluation of selected improved rice lines at vegetative stage in the field condition

According to the visual evaluation scores, the selected rice lines were tolerant to 3.3 and 6.0 dS m^{-1} salinity levels, whereas all rice lines were susceptible at 7.6 dS m^{-1} (Table 4). In high salinity level (7.6 dS m^{-1}), visual damage was serious; chlorosis and leaf rolling were observed on all plants of selected rice genotypes in the field condition.

Table 4 Salinity reactions of improved rice lines in terms of Standard Evaluation Score (SES) under three different salinity levels at vegetative stage in field experiment

Improved rice lines	Reaction to salinity		
	3.3 dS m^{-1}	6.0 dS m^{-1}	7.6 dS m^{-1}
YAU-1211-14-1-1	Tolerant	Tolerant	Susceptible
YAU-1201-90-2-4	Tolerant	Tolerant	Susceptible
YAU-1211-118-1-1	Tolerant	Tolerant	Susceptible
YAU-1211-195-1-1	Tolerant	Tolerant	Susceptible
YAU-1201-26-1-1	Tolerant	Tolerant	Susceptible
YAU-1201-26-1-3	Tolerant	Tolerant	Susceptible
YAU-1211-82-1-1	Tolerant	Tolerant	Susceptible
Pokkali	Tolerant	Tolerant	Susceptible
IR29	Moderate Tolerant	Susceptible	Susceptible

Table 5 Salinity reactions of improved rice lines in terms of plant height and number of tillers per hill under three different salinity stress levels at vegetative stage (42 DAT) in field experiment

Improved rice lines	Plant height (cm)			Number of tillers per hill		
	3.3 dS m^{-1}	6.0 dS m^{-1}	7.6 dS m^{-1}	3.3 dS m^{-1}	6.0 dS m^{-1}	7.6 dS m^{-1}
YAU-1211-14-1-1	50.0 cd	38.8 e	27.6	12.6 abc	7.8 de	3.4
YAU-1201-90-2-4	59.8 ab	39.0 e	28.9	14.7 a	6.3 e	3.1
YAU-1211-118-1-1	54.6 bcd	50.3 bc	24.6	10.8 bc	9.4 bcd	3.8
YAU-1211-195-1-1	56.0 bc	45.8 bcde	26.7	15.1 a	9.5 bcd	4.1
YAU-1201-26-1-1	54.7 bcd	46.7 bcd	29.5	12.9 abc	12.6 a	4.8
YAU-1201-26-1-3	57.5 bc	42.9 de	25.4	13.3 ab	8.5 cd	4.9
YAU-1211-82-1-1	58.8 bc	53.8 b	29.2	10.9 bc	10.4 b	4.3
Pokkali	67.9 a	67.7 a	29.4	10.8 bc	9.1 bcd	4.0
IR29	46.3 c	43.0 c	25.4	10.0 c	9.7 bc	2.6
F-test	**	**	ns	**	**	ns
C.V %	10.8	10.7	12.8	17.4	12.5	35.7

Values in the same column followed by the same letter are not significantly different at the 5% level by the LSD test, (**) significantly different at P≤0.01, ns − not significant

Comparing between seven improved rice lines, the result showed that effects of salinity on all measured traits were significantly different (Table 5 and 6). The selected improved rice lines were highly significant different in both 3.3 and 6.0 dS m^{-1} salinity levels in terms of plant height and number of tillers per hill at vegetative stage. At this growth stage, YAU-1201-26-1-1 line significantly produced maximum number of tillers per hill 6.0 dS m^{-1}. In the field experiment, salinity stress reduced the growth of the selected improved rice lines in 7.6 dS m^{-1} when compare with 3.3 and 6.0 dS m^{-1} salinity levels. In this study, Pokkali (tolerant check) was not tolerant to 7.6 dS m^{-1} in the field condition and it produced a smaller number of tillers per hill, when compare to

other improved rice lines. The selected improved rice lines were highly significant different in both 3.3 and 6.0 dS m^{-1} salinity levels in terms of number of panicles per hill and grain yield at harvesting (Table 6). YAU-1201-195-1-1 gave the highest values of grain yield among the rice lines in 6.0 dS m^{-1}. Mass and Grattan (1999) indicated that the rice yield decreased with increasing in soil salinity.

Table 6 Salinity reactions of improved rice lines in terms of number of panicles per hill and yield under three different salinity levels at harvesting in field experiment

Improved rice lines	Number of panicles per hill			Yield (g m^{-2})		
	3.3 dS m^{-1}	6.0 dS m^{-1}	7.6 dS m^{-1}	3.3 dS m^{-1}	6.0 dS m^{-1}	7.6 dS m^{-1}
YAU-1211-14-1-1	14.8 b	13.0 cde	n.a	671 bc	438 b	n.a
YAU-1201-90-2-4	13.8 bc	12.5 de	n.a	488 d	437 b	n.a
YAU-1211-118-1-1	17.7 a	16.3 ab	n.a	829 a	505 ab	n.a
YAU-1211-195-1-1	13.0 bc	15.5 abc	n.a	701 abc	573 a	n.a
YAU-1201-26-1-1	13.5 bc	17.3 a	n.a	644 bc	447 ab	n.a
YAU-1201-26-1-3	12.3 c	14.5 bcd	n.a	573 cd	292 c	n.a
YAU-1211-82-1-1	13.3 bc	16.5 ab	n.a	734 ab	529 ab	n.a
Pokkali	12.7 bc	12.8 de	n.a	499 d	473 ab	n.a
IR29	12.4 c	11.3 e	n.a	458 d	444 c	n.a
F-test	*	*		**	**	
C.V %	8.9	12.1		14.2	19.6	

Values in the same column followed by the same letter are not significantly different at the 5% level by the LSD test, (**) significantly different at P≤0.01, (*) significantly different at P≤0.05, na – not available

CONCLUSION

In conclusion, differences of 100 improved rice lines were observed for relative salt tolerance in terms of agronomic parameters such as tiller numbers, panicle numbers and grain yield. From this study, seven tolerant rice lines had good performance in the areas where salinity has a problem. This study will be useful for developing salinity tolerant varieties. Therefore, this performance would be valuable information for plant breeding program.

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Research article

Current Conditions and Constraints in Management of Organic Manure in Mid-hills of Eastern Nepal

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Abstract Soil fertility in mid-hills of Nepal has been largely maintained with application of locally made organic manure namely farmyard manure. It is often believed that organic manures in mid-hills of Nepal are of inferior quality, lacking in essential nutrients such as nitrogen, phosphorus and micronutrients due to inadequacy of technical knowledge and management strategies. This study focuses on knowing the present conditions and constraints in productions, application of organic fertilizers for agricultural sustainability in mid-hills of Nepal. This study was conducted on the basis of questionnaire survey, interviews, group discussions and field visits in 13 Village Development Community (VDC) of Dhankuta District. Manure samples were tested for their maturity, nutrient content and pathogenicity. The results showed that all the famers in the study area used organic fertilizer in their farm; most of them also used chemical fertilizers, but use of potassium fertilizer was less. Loss of nutrients and heat through runoff or leaching was a major problem as most of the farmers used heap method for composting in open, with improper methods used. Use of starter during composting was negligible. The amounts of organic manure produced increased with the number of livestock owned by the farmer. In general, frequency of application of organic manure corresponded to number of crops cultivated in the year irrespective to maturity of manure. Self-heating test and C/N ratio of manure samples showed that farmers used immature manure resulting in lower mineral content and presence of pathogenic bacteria.

Keywords organic manure, conditions and constraints, maturity, stability, nutrient contents

INTRODUCTION

Agricultural lands rich in soil organic matter are vital in increasing in soil productivity and resilience functions. These functions include increase in soil nutrients, increasing water holding capacity, providing habitat to organism in the soil, reduction in soil erosion and sedimentation. Nepal, being an agricultural country, a significant numbers of farmers in mid-hills uses organic manure in the form of farmyard manure for maintaining and enhancing soil fertility. Maskey et al., (2002) find out that more than 85% of farmers apply farmyard manure or compost in their fields. Farmers have been using indigenous knowledge and techniques for making organic fertilizers using organic matter in the form of forest litter, crop residues etc. collected from neighboring forest and pastures and manures from animals reared by the farmers. In the past, organic fertilizers contributed to the maintenance of a balanced input output of soil nutrients. But, in recent years, with change in cropping pattern, where more cash crops are produced and increase use of chemical fertilizers has resulted in nutrient loss of soil. Gami et al., (2001) and Upadhyay et al., (2005) observed a decline in the soil organic carbon stocks due to changes in land use, intensive cultivation, and poor management of manure. A review by Dahal & Bajracharya (2011) also revealed that in recent years, majority of farmers have switched to conventional usage of chemical fertilizers and intensified cropping systems as much as 3 or 4 crops per year, though a significant of

farmers still rely upon compost or FYM. Use of chemical fertilizers is not sustainable in mid-hills of Nepal where most of the farmers are small scale farmers with low purchasing power as chemical fertilizer are costly with poor accessibility. Moreover, overdependence of inorganic fertilizer causes land degradation and poor soil quality.

Unlike the conventional agricultural practices that often lead to impoverishment of soil quality and reduced productivity of lands, sustainable soil management practices such as using farmyard manure and compost should be adopted by farmers for sustainable development of agriculture in mid-hills of Nepal. But, with current scenario of low quality of organic fertilizers, it is necessary to understand what factors are prevailing.

This study focuses on different factors, condition and constraints existing in organic manure production, application and management to understand the maturity, nutrient contents and pathogenicity of organic fertilizers so that the problems are outlined for better future management.

METHODOLOGY

Site Description

This study was conducted in 11 VDC (Village Development Committee) and 2 municipalities of Dhankuta district (fig.1). These areas were chose on the basis of agricultural land area, population engaged in agriculture and agricultural productivity importance. The topography of Dhankuta district is hilly with minimum elevation at 120 m to highest at 2702 m. Dhankuta district is a major agricultural region with more than 83.45% of people engaged in agriculture whereas the national average is 65.6%.

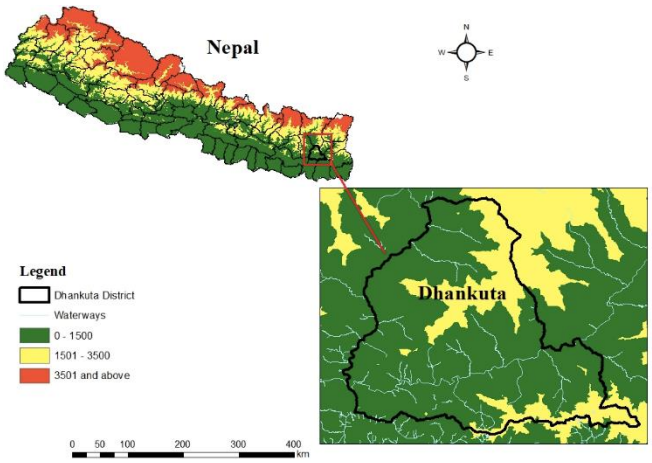

Fig. 1 Map of study area

Household Interviews

Interviews were conducted in 11 VDC and 2 Municipalities' of Dhankuta district. Total of 102 farmers were selected for the interview using simple random method. To minimize the errors due to possible lack of knowledge in managing the fields, only those farmers who owned the field were interviewed excluding farmers working in rented fields. Questionnaire was designed to understand farmers` knowhow in making organic manure, types of fertilizer used, application amount and effects of fertilizers on productivity and soil structure. The results of questionnaire survey are qualitatively analyzed based on the answers and group discussions with the farmers.

Maturity Test of Organic Manure

A total of nine samples of farmyard manure were sampled from various locations in the study area for testing its maturity and stability. The samples collected were more than a year old and ready to use according to the local farmers. The samples were subjected to self-heating test using Dewar's

vessel where water content of samples were maintained at 50-60%, as dryness can limit microbial activity. The Dewar self heating test was first introduced in Europe in 1982 (Jourdan, 1982) and is widely used for measuring maturity and stability of compost as it is easy to use and interpret the results. Self-heating is important because it drives the compost process, and regardless of other traits, the presence of heat in compost is widely held to be a sign of immaturity (Gallenkamper et al., 1993). Composts are commonly recognized to have three states or potentialities; cured, mesophilic and thermophilic. Therefore, maturity of compost can be divided into three categories (Table 1). C/N ratio, which is often used for determining the maturity of organic manures, was conducted for the samples using combustion method by N/C coder.

Table 1 Interpretation of result for self-heating test

Rise of temp. over ambient (° C)	Actual temp. in vessel (° C)	Class of stability	Interpretation
0-5	20-25	A	Matured, cured
5-25	25-45	B	Mesophilic, active
25-50	45-70	C	Thermophilic, very active

Source: 2005-2009 Wood End Laboratory Inc.

Nutrient Test of Organic Manure

The value of compost is determined by its ability to provide soil with organic matter and soil macronutrients nitrogen, phosphorus and potassium. Soils, which have deficiency in these essential nutrients have low fertility, affecting the productivity. Organic carbon and nitrogen content of manure samples were determined by combustion method using N/C coder, phosphorus by absorption spectroscopy and potassium by LAQUA twin potassium ion meter B-731.

Pathogenicity Test for *E. coli*

Pathogenicity test were conducted using Petan check 25 ESCM from EIKEN Chemicals for analyzing the presence of *E. coli* in manure samples. Three replicates of each sample were tested. The plates were put in incubator at 24° C for a period of 48 hours. Presence of pink and blue colonies showed the presence of *E. coli* in the sample. The colonies were counted and categorized into various order of pollution according to the number of colonies detected.

RESULTS AND DISCUSSION

Information on Land Area and Livestock Owned

Sixty three percent of the farmers in the area were small-scale farmers with less than 0.5 ha of land owned and cultivated, which is less than national average of 0.8 ha. Thirty three percent of farmers had land area in between 0.5 to 1.5 ha. Only four percent were large-scale farmers with land area more than 1.5 ha. (Table 2).

Table 2 Area of cultivated land and animals owned

	Small scale farmer (Less than 0.5 ha)	Medium scale farmer (0.5 to 1.5 ha)	Large scale farmer (More than 1.5 ha)
Farmer percentage	63%	33%	4%
Livestock per farmer	15	17	34

Note: Number of respondent =102 farmers. Total number of animals =1662.

With 5.8 heads of livestock and poultry per household, Nepal has one of the highest density of livestock per unit area cultivated area in upland parts of world (Sharma and Subedi, 1994). Livestock plays an important role in Nepalese agriculture, providing farmer with manure, fuel for

household, protein source for consumption and income source with sale of livestock products. Livestock accounted were big animals like cow, buffalo; medium animals like goat, sheep and small animals like hens and chicken. Generally, large-scale farmer had more number of livestock with medium scale and small-scale farmers having comparatively less (Table 2). The results of questionnaire survey showed that the amount of manure produced corresponded to the numbers of animals owned. Also, applications of manure corresponded to number of plantation, irrespective of maturity and stability of it.

Information on Use of Fertilizer and on Production and Application of Organic Manure

Farmers indicated using conjunction of farmyard manure (FYM) and chemical fertilizer as a major supplement for managing soil fertility. Farmers are using chemical fertilizer with FYM as they feel that only FYM cant increase the productivity. The use of chemical fertilizer in the context of mid-hills of Nepal is unsustainable as chemical fertilizer is not accessible easily due to lack of infrastructure like roads and high price. Farmers are using N, P fertilizers but application of K fertilizer was negligible. Farmers for making farmyard manure used indigenous method and lacked training. Table 3 shows the amount of FYM applied, application rate, frequency, method used and preparation period and use of starter. Most of the farmers applied manure twice or more times a year according to the number of plantation. Farmers preferred to heap method than pit method as construction of pit required money and labor. Also, almost all the compost piles were in open, without any cover making it susceptible to loss of heat and nutrients. Due to deforestation and lack of fodder for the livestock, the quality and the quantity of farmyard manure have decreased. The improper handling and making of farmyard manure has resulted in loss of nutrients. Shrestha et al., (2009) suggested that soil fertility is largely maintained through the application of compost and manure but in recent years a decline in soil fertility has been reported. Also, improper handling of manure can lead to environmental and health problems through surface runoff or leaching of nutrients and pathogenic microorganism (Ishikawa et al., 2012).

Table 3 Types, application rate, frequency, method used, time period and use of starter for composting manure

Types of fertilizer used	Application rate of manure	Frequency	Method	Time period for composting	Use of starter
Organic manure (10%)	< 2.5 t/ha (55%)	1/year (16%)	Heap method (61%)	3-6 months (31%)	Yes (2%)
Organic manure and fertilizer (90%)	2.5-5 t/ha (25%)	2/year (54%)	Pit method (35%)	6-9 months (50%)	No (98%)
Only fertilizer (none)	5 t/ha (20%)	3 or more/year (30%)	Others (4%)	9 months and above (19%)	-

Note: Number of respondent =102 farmers.

Farmers' perception on productivity and change in soil structure with application of organic manure and chemical fertilizer

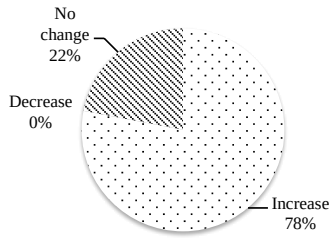

Fig. 1 Farmers' response to productivity with manure application

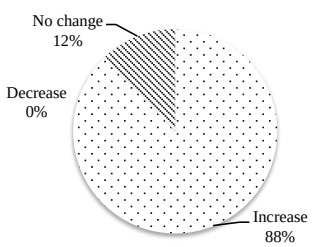

Fig. 2 Farmers' response to productivity with chemical fertilizer application

Figures 1 and 2 shows the farmers' response to productivity with application of organic manure and chemical fertilizer respectively. Seventy eight percent of the farmer have the perception that

application of organic manure, there was increase in productivity, with twenty two percent of farmer saying there was no change. On the other hand, eighty eight percent of the farmer thinks that productivity has increased with application of chemical fertilizer; with twelve percent of farmer answering there was no change. This perception of farmers' can be explained on the fact that organic manure takes longer period to increase soil fertility of the soil, but long-term application of organic manure has positive effect in soil properties such as fertility, structure, and water holding capacity etc. Whereas chemical fertilizer can increase productivity in shorter period, but long-term application can adversely effect soil properties which can be seen in Figs. 3 and 4 which shows farmers' response to change in soil structure with application of organic manure and chemical fertilizer. Seventy percent of the farmer responded with application of manure, soil had softened. Whereas, fifty four percent of farmer replied soil had hardened with application of chemical fertilizer.

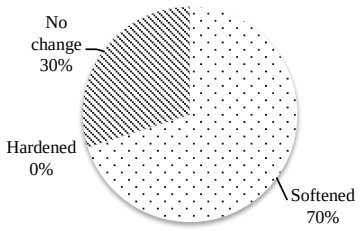

Fig. 3 Farmers' response to change in soil structure with manure application

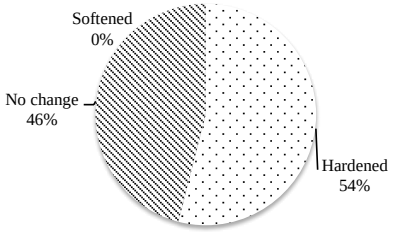

Fig. 4 Farmers' response to change in soil structure with fertilizer application

Maturity of Manure

Biological stability of organic manure is an important aspect of composting because of its effect in utilization in agriculture. Immature and poorly stabilized composts may pose problems during use and storage. Immature composts may contain high amounts of free ammonia, certain organic acids or other water-soluble compounds, which can limit seed germination and root development. Result of maturity test showed (Table 4) all the sample was classified into active or immature compost. C/N ratios of starting material, temperature and moisture content are some of the factors, which can affect the maturity of compost. In the research area it was seen that farmers were not aware of these factors.

Table 4 Results of maturity test

Sample name	Ambient temp. (° C)	Actual temp. in vessel (° C)	Water content maintained at	Class of stability	Interpretation of result
Sample 1 to 9	15±2	25-45	50-60%	B	Mesophilic, active compost

Note: Refer table 1 for interpretation of result.

C/N of Manure

One of the most important aspects of the maturity and total nutrient balance is the ratio of organic carbon to total nitrogen. A C/N of about 25-30 is considered optimum for starting material as microorganism utilizes about 30 parts of carbon to 1 part of nitrogen during metabolism. The result of C/N of the samples is shown in the table 5. The entire sample has C/N ranging from 17 to 12. C/N value from 15 to 20 is considered favorable for compost. But, in the case of cow manure starting C/N may be lower than 20. According to Golueke, (1977), C/N of cow manure is 17. If C/N is lower than 20, loss of nitrogen through ammonia volatilization occurs, reducing the nitrogen content of final product. This process is enhanced by high pH and temperature and is seen during the first two weeks of composting. C/N of starting material should be considered and planned before starting composting as both high C/N and low C/N have adverse effect on the final product of compost, which can hamper soil fertility and plant growth.

Table 5 Results of C/N of samples

Sample name	Sample no.1	Sample no.2	Sample no. 3	Sample no. 4	Sample no. 5	Sample no. 6	Sample no. 7	Sample no.8	Sample no. 9
C/N	12±0.02	13±0.1	14±0.03	17±0.1	16±0.06	13±0.002	13±0.002	12±0.03	14±0.1

Note: Values are mean ± SD (n=3).

Pathogenicity of Manure

The function of organic manure is to provide soil with essential nutrients and be environment friendly, free of pathogenic microbes namely coliform bacteria. Using manure, which contains pathogenic bacteria can cause health and environmental problems. The test of pathogenicity for the sampled manure is shown in table 6. Sample 1 and 2 had moderate pollution, whereas all samples from 3 to 9 were categorized in high pollution category. This result can be attributed to the fact that the samples were not completely matured as shown in self-heating test. Also, as most of the composting is done in open areas without any cover, which increases the possibility of loss of heat generated during composting process. Pathogenic bacteria are killed if heat is around 60℃ for a period of 2 weeks.

Table 6 Results of pathogenicity test

Sample name	No. of colonies	Judgment	Evaluation of degree of pollution
Sample 1 to 2	60-200	++	Moderate pollution
Sample 3 to 9	More than 200	+++	High pollution

Note: Where, no colonies (-) is no pollution, less than 20 colonies (±) is very low pollution, 20- 60 colonies (+) is low pollution, 60-200 colonies (++) moderate pollution, more than 200 colonies (+++) high pollution, uncountable colonies (++++) very high pollution. Source: ES no. 14, Aug- 1999.

Nutrient Content of Manure

The evaluation of agronomic values of manure is depends on the amount of organic carbon and macronutrients available to the plants. Table 7 shows the results of total carbon, total nitrogen, total phosphorus and potassium present in the sampled manure. The total carbon % ranged from 18.9 % to 47.6 %. These result is in agreement with Batjes, 1996 who found that the optimum value of total organic carbon higher than 10%. The high value of carbon content might be also be the result of slow decomposition of carbon, which depends on various factors like climate, organic matter types and microbial metabolism. The total nitrogen present in the manure samples was between 12250 to 27900 mg/kg, which coincides with the average value 25000 mg/kg in mid-hills of Nepal (Tripathi and Jones, 2003). The total phosphorus in the samples were in the range between 1354 to 6310 mg/kg which is less than average value for finished compost which ranges from 6000 to 20000 mg/kg. The value of potassium was in between 150 to 1200 mg/kg, which is less for finished cow compost. Irshad et al., 2013, suggested finished cow compost has around 9000 mg/kg of potassium. The low nutrient content of manure may be due to methods used for composting. Heap method, which is widely practiced, is done in open, which is susceptible to low nutrient content as maintained by Tripathi and Jones (2003).

Table 7 Results of nutrient content

Sample name	Carbon %	Total N (mg/kg)	Total P (mg/kg)	K (mg/kg)
Sample no. 1	22.8±0.03	19400±5.8	3707±7.5	1093±0.0
Sample no.2	27.2±0.06	21000±5.7	5103±32.4	1040±28.1
Sample no.3	18.9±0.02	13250±10.0	1383±30.1	274±5.8
Sample no.4	47.6±0.03	27900±15.3	5820±3.5	150±0.6
Sample no.5	19.0±0.06	12250±5.7	1354±26.2	486±5.8
Sample no.6	30.5±0.01	23790±5.8	5083±32.08	590±5.8
Sample no. 7	25.4±0.03	18980±10.0	6310±10.71	576±10.0
Sample no.8	19.9±0.03	17120±10.0	3525±27.74	970±17.1
Sample no.9	26.2±0.04	19000±5.7	5028±30.24	1200±0.0

Note: Values are mean ± SD (n=3).

CONCLUSION

This study discusses the present conditions and constraints in management of organic manures in mid-hills of Nepal. The result of household interview showed that farmers were using farmyard manure and chemical fertilizer. There was rise in use of chemical fertilizer as farmer felt that only organic manures are insufficient for increasing productivity. Farmers were aware of drawbacks of using chemical fertilizer, but due to low fertility of manure, there was increase use of chemical fertilizer. The methods and immature manure used can be cause of low fertility content of manures. Results of immaturity of sampled manures, supports the above cause. Imbalance of C/N may have resulted in low C/N. C/N of starting material can be increased or decreased as per the conditions with increase of carbon or nitrogen sources. Heat loss during composting and immaturity of manures might be the reason for high pathogenicity. The results of carbon and nitrogen content showed satisfactory results, whereas phosphorus and potassium were low. It should be noted that as manures are kept in open, there is possibility of nutrient loss through runoff and leaching. Better composting methods such as using a cover during composting can reduce loss of heat and nutrient. Using a starter can help in better decomposition and elimination of pathogenic bacteria. Knowledge and training on manure maturity should be taught to farmer to change farmers' perception on manure maturity.

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Research article

The Development of Rotating Rice Grain Dryer Prototype

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Abstract This research focused on the development of the rotating rice grain dryer prototype for Germinated Parboiled Brown Rice (GPBR) grains. The main GPBR producer in this study was Baan Dong Luang community enterprise, Bung Tawai sub-district, Tao Ngoi district, Sakon Nakhon province, Thailand. The producer needs to reduce paddy moistures from above 20%wb down to 15%wb as the packaging and buyer requirements. The original prototype was designed to utilize heat from only the sunlight. It consisted of the driving part, the base and frame and the dryer chamber, which was a smooth-inside-area stainless steel cylinder. In this work, five aluminum fins were installed inside the cylinder to increase the grain distributions. The grain-collecting tray and wheels were attached to the prototype. Experimental investigations were performed repeatedly; 3 times. From the experimental results, the grain distributions observed from the developed prototype were better those from the original prototype. The tray could facilitate the users in taking the dehumidified grains out. The wheels made the prototype movable, the developed prototype could be moved to take the sunlight more convenient. The noticeable experimental result was the drying performance of the developed prototype. The developed prototype took 3 hours to reduce the paddy moistures down to 15%wb while the original prototype could reduce the paddy moistures down within 4.5 hours. On the other hand, the fins could distribute the grains, the heat transfer inside the chamber was enhanced. The reduced drying period was about 33.33%. As the rice dryer is an important tool in household and community rice producers, this dryer prototype could be proved to reduce the drying areas, periods and labors which affects the net incomes of farmers. The famers satisfied with the developed prototype.

Keywords rotating rice grain dryer, germinated parboiled brown rice, GPBR, dehumidifying technology, heat transfer

INTRODUCTION

Nowadays many technologies play important roles in human daily life. One of the technologies, which takes a significant part in Agricultural society as in Thailand, is the post-harvest technology. One of main crops in Thailand is rice, in many post-harvest technologies relating to rice grains or paddies, rice-grain dryers or dehumidifiers are one of those. After paddies are harvested from rice fields, they must be reduced their moisture content. Otherwise, moist rice grains turn rotten faster than dry rice grains in storage containers. In Thailand, paddies are dehumidified traditionally by using heat from sunlight. In Thai communities, rice farmers spread paddies on ground in open wide areas. The reduced moist paddies can be kept in grain silos before the farmers sell or consume them.

The small-scale farmers must find wide areas to dehumidify their paddies, periods of the dehumidifying process rely on the sunlight intensity and ambient relative humidity. Often, the farmers let the moist paddies staying under the sunlight by days and labors are required. Even though, their paddy moistures cannot match acceptable or required levels of their buyers, the acceptable moistures are 15% wet basis (wb) and lower. As the labors are required in the drying process, the labor expenses are still existed, and they seem to be increased continuously. If the rice grain moistures cannot be reached at the acceptable levels, the initial rice production costs of the farmers are high while the selling prices are low, the profits decrease. As mentioned earlier about the important technology, the dehumidifying technology must take part in the small-scale rice farming to reduce the labor costs, processing times and areas. Many rice grain paddy dehumidifiers or dryers are available in world-wide markets. There are many commercial rice-grain dryers, they are big systems with high investment costs and required big amounts of the moist-rice-grain inputs. These commercial rice dryers are suitable for industrial levels more than small community and household levels.

In order to prevent paddies from their deterioration after harvesting, paddies must be dried down to the level of water activity that will enable safe storage by reducing respiration, inhibiting mound growth and preventing production of mycotoxins. These reasons correspond to a moisture content of about 13- 14%wb, which is considered adequate for safe storage, milling and further storage as milled rice (Hall, 1970). Mechanical systems, especially those using hot air for rapid drying of high moist grain are becoming increasingly popular throughout the Asian-Australian region (Hung-Nguyen et al., 1999). Fluidized and spouted bed dryers are examples of high temperature dryers. Due to the high air temperatures used, residence time of grain in the dryer must be short to prevent heat damage (Juliano, 1971; Morey et al., 1981; Naewbanij, 1985; Soponronnarit, et al. 1996).

There was a rotating rice grain dryer prototype (Bancheun et al. 2016) developed for the small community that produced Germinated Parboiled Brown Rice (GPBR) paddies. The main GPBR producer, who utilized the prototype, is Dong Luang community enterprise, Bung Tawai sub-district, Tao Ngoi district, Sakon Nakhon province, Thailand. The prototype was designed to dehumidify these specific paddies by using natural heat from the sunlight transferring to its rotating drying chamber or cylinder. Using the sunlight as the main heat source can reduce heating costs in the dehumidifying process. As the GPBR producer used the prototype, the moisture inside the paddies, which were placed in the chamber, was reduced as the initial objective. The average dehumidifying period, which was obtained from three repeating experiments, was 4.5 hours. However, there were problems occurred, as the enterprise members reviewed, such as its movable ability, an output correcting area and its drying period.

OBJECTIVES

In this current work, the development of the rotating rice grain dryer prototype was reported and discussed. The GPBR paddies so called Khao Hang Ngok in Thai language, were chosen to investigate the performance of the developed prototype since the GPBR producer must utilize the drying process two times. The first drying process is occurred after the paddies are harvested from the fields. The second process is occurred after the rice was germinated and parboiled, the GPBR paddies must be dehumidified before they were stored for any selling purposes. The operating conditions of the developed prototype could be concluded to inform the farmers. The GPBR products with the obtainable and suitable moisture contents could be performed, the low labor costs, short operating periods and smaller areas were concerned mainly.

METHODOLOGY

Since the rotating rice grain dryer prototype as shown in Fig 1 was originally designed to use the natural sunlight to vaporize the moisture out of the paddies, no electric heater or other heat sources would be inserted into the prototype. The prototype design was reviewed to find simple ways to

improve its movement and its performance in dehumidifying the GPBR grains. After the prototype problems were listed and the simple solutions were detailed. All solutions were evaluated for their suitability and possibilities. The development cost should not be increased; therefore, other communities can also utilize this dryer. After the prototype was modified according to the suitable solutions, then, the experiments were carried on finding its improved performance. The Dong Luang GPBR paddies were used in every experiment at Dong Luang community enterprise in this work. The experimental study processes consisted of these following steps;

(1) Measuring the initial moisture content of the grains,
(2) Putting the grains into the drying chamber, measuring the grains for its moisture content and measuring ambient temperature and sunlight intensity outside the drying chamber,
(3) Locating the dryer under the sun in the open area, measuring the ambient temperature and sunlight intensity outside the drying chamber,
(4) Turning on a motor to rotate the chamber for 30 minutes, and
(5) Turning off the prototype and measuring the final moisture content of the grains.

Fig. 1 The original rotating rice grain dryer prototype

RESULTS AND DISCUSSION

From reviewing the prototype in Fig 1, the prototype combined of 3 main parts as a driving part, a base and frame and a cylinder chamber. The dimensions of the prototype were 170x150x130 centimeters. The prototype frame was fabricated from steel bars. The chamber was made from the food grade stainless steel sheet, its dimension was 60 centimeters in diameter and 100 centimeters in length. The chamber was designed to take 100 kilograms of grains with 0.142 cubic meter. The driving part combined of the SAE 1045 steel bar with 3 centimeters in diameter and 152 centimeters in length, the chain system driven by a 1-hp motor (220VAC) with a 10-centimeter sprocket, and the reduction gear. The reduction gear adjusted the chamber rotating speed to be 2.8 revolutions per minute (rpm) from the motor speed of 1450 rpm. The prototype could also be rotated manually. The prototype was utilized by the potential users or farmers in the GPBR community enterprise, Dong Luang community enterprise. The operational information and comments were collected for the improvement in the current work. The first comment was about the grain distributions inside the chamber, there was no tool to distribute the grains inside the chamber as shown in Fig 2. There were some dehumidified grains left inside the chamber after the drying process because the users took the grain out by scooping them out as shown in Fig 3. The prototype movement to find the proper sunlight area was limited because there was no wheel attached on the prototype. After the problems were listed, the improvement plan based on the low budget was selected. Firstly, stainless-steel fins had to be installed along the cylinder length to improve the grain distributions. Secondly, the movable paddy tray had to be attached to collect the dehumidified grains. Heavy-duty wheels were attached to the bottom of the dryer frame for it

movable capability. The developed prototype was shown in Fig 4. Six rectangular aluminum fins (right corner of Fig 4) with the dimensions of 100x10 centimeters were attached inside the chamber in the symmetrical distance among them. The dimension of the collecting tray was 90x140x30 centimeters. The 10-centimeter wheels were chosen according to their ability to support 70 kilograms on each wheel, all wheels could be locked for user safety during the dryer operation.

Fig. 2 A dehumidifying chamber

Fig. 3 An output correcting area of the prototype

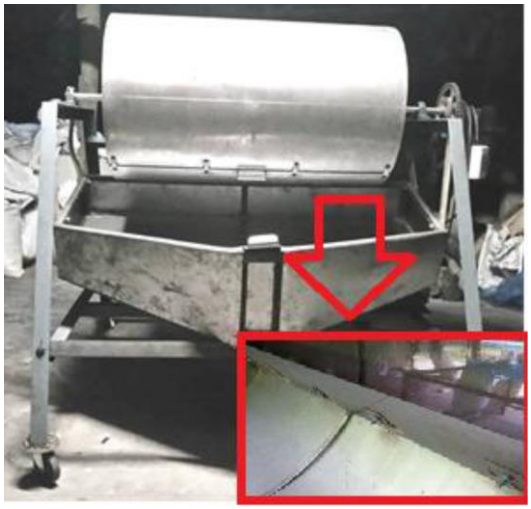

Fig. 4 The developed rotating rice grain dryer prototype

After the prototype was developed by attaching more parts, the experiments were carried out. To find the rice distribution after the fins were installed inside the chamber, 30 kilograms of white rice mixed with one cup of black sticky rice was placed inside the chamber. The developed prototype was turned on at the chamber speed of 2.8 rpm and operated for 30 minutes, 3 repeating experiments. From Fig 5, the black sticky rice was mixed or distributed better with the white rice after the fins were installed inside the chamber. The community members found that the attached tray and the wheels ease them in taking the paddies out and in moving the dryer to face the sunlight, respectively. Then, the community members chose to put 30 kilograms of the GPBR paddies into the chamber in each experiment because this was their normal batch amount. The developed prototype was investigated, the rotating speed was kept the same at 2.8 rpm. Moistures of the paddies in the chamber were measured in 5 different points every 30 minutes, and the aimed moisture was 15%wb. Three repeating experiments were performed for the same measurement conditions. The interesting result, which was found from the GPBR drying investigations, was the average dehumidifying period. The average dehumidifying period was reduced from 4.5 hours (the

original prototype performance) to be 3 hours in this current work. This result could also imply that the fins played the important role in the grain distribution causing the better heat transfer to the paddies and the higher dehumidifying rate. The fin installation cost was less than that of the heater installation. Next, average moisture values of the paddies in different ambient conditions were shown in Table 1. The results revealed that the sunlight intensity still played the important role in dehumidifying process, the higher the intensity, the faster the drying process could be performed. The developed prototype could be used to dehumidify the paddies; from 21%wb moisture to 15%wb within 3 hours. Since there were rainy days during the investigation periods. The developed prototype was investigated its performance in this rainy condition while the original prototype was not investigated in this condition. The rainy weather affected the drying process, because of the high relative humidity of the ambient air; the slower the drying process could be carried out at average of 5 hours. We noticed that the developed prototype should be improved for its better performance in the high relative humidity conditions. An extra heating set may be attached to improve the developed performance in the rainy season.

Table 1 Information obtained from the experimental investigations of the prototype in different operating conditions

Ambient conditions	Prototype	Average moisture (%wb)	Sunlight intensity (W/ m^2)	Operating time (hrs.)
No rain 26 ^oC 26%RH	original	from 21% to 15%	532	4.5
No rain 29 ^oC 24%RH	developed	from 21% to 15%	507	3.0
Rain 30 ^oC 85%RH	developed	from 21% to 15%	311	5.0

Fig. 5 Rice distributions in 30 minutes of the prototype operation observed by dark grain distributions among the white grains

CONCLUSION

The household GPBR grain dryer prototype was developed to be suitable with the GPBR dehumidifying processes before the GPBR products could be sent to the buyer or be stored in their containers. There were three parts of the original prototype; the driving part, the drying chamber and the base and frame. The chamber was designed to hold 100 kilograms of rice grains and driven by the 1-hp-AC motor at 2.8 rpm (the chamber velocity) through the sprocket and chain system. The developed parts, which were installed on the prototype, consisted of 1) the tray for collecting the grains outside the chamber, 2) four wheels to make the prototype movable and to take the proper sunlight and 3) 5 fins attached inside the chamber to increase grain distributions during the drying process. The experimental results of the developed prototype showed that the developed prototype could dehumidify the GPBR grains from 21%wb down to 15%wb. Apparently, the fins

helped the dehumidifying process shortened by 33.33%. The ambient relative humidity also affected the dehumidifying period, the higher relative humidity the longer drying period. The developed household dryer prototype was proved to be practical for the GPBR drying process. The dryer users were satisfied with the improved performance.

ACKNOWLEDGEMENTS

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Research article

Comparative Study on the Determination Methodology of Total Suspended Solids by Using the Microwave and the Laboratory Standard Methods

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Abstract Total Suspended Solids (TSS) was an important parameter used to control biomass in an aeration tank during the activated sludge process also known as Mixed Liquor Suspended Solids (MLSS). The weighed standard glass-fiber filter and the residue retained on the filter are dried to a constant weight at 103 to 105°C. There were major steps in a standard method, which take time to analyze. Therefore, microwave method was an attractive technique because rapid determination of total suspended solids. This comparative study was made on the analysis of total suspended solids between the use of microwave and standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF). It was conducted to examine the appropriate condition of microwave power 800-watt at two levels including medium-high and high levels at 10, 15 and 20 minutes. Synthetic wastewater was prepared by Cellulose power of thin layer chromatography at concentrations 100 mg/l. The result show on that the optimum condition was using high level at 10 minutes. Mean of total suspended solids was at 97.39 mg/L. The sample of wastewater was collected from Conventional Activated Sludge, CAS of Sakon Nakhon Hospital. After comparison, it was found that total suspended solids with microwave and standard method had an average concentration at 156.2 and 150.4 mg/L, respectively. There was no significant difference of total suspended solids from the two methods at a 95% confidence level.

Keywords total suspended solids, microwave, standard methods, conventional activated sludge

INTRODUCTION

Total Suspended Solids (TSS) was an important parameter used to control biomass in an aeration tank during the activated sludge process. Also known as Mixed Liquor Suspended Solids (MLSS). The weighed standard glass-fiber filter and the residue retained on the filter are dried to a constant weight at 103 to 105°C. There were major steps in a standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF)'s long-time analysis but treatment processes require sufficient time for the wastewater to be treated.

For many years, Microwave (MW) techniques have known to offer faster, simpler, and more cost-effective processes, often affording high-yield, high-purity products. (Adam, 2003) The efficiency of the microwave oven heating is internal. In a conventional oven, the substance is heat from the outside, and it must be left to heat until its center has raised to a high temperature. In microwave heating, the molecules with permanent dipole moment absorb the radiation and rotate. As with many other excited states, the excess rotational energy of these molecules is re-emitted as heat and so heating times reduced. (Banwell et al, 2000)

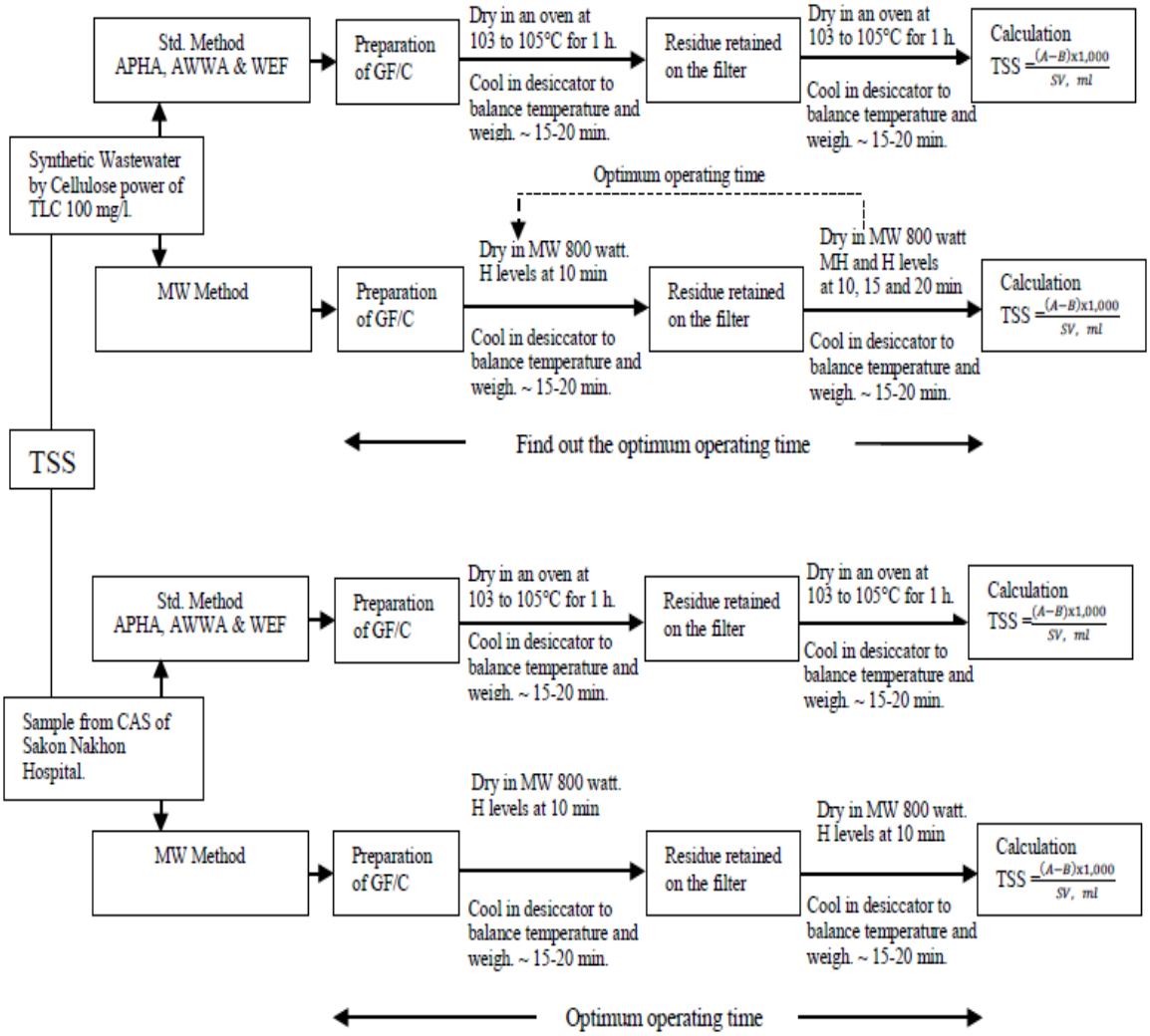
The Microwave has many applications such as determine municipal refuse moisture content compared by APWA method (furnace, 600 degrees ℃ at least 2 hours). The results revealed that the greatest microwave operating time and power combinations were 11 minutes at 500 watts, 11 minutes

at 600 watts, 10 minutes at 720 watts and 9 minutes at 850 watts. (Marinee, 1998) and determine the total solids content of natural rubber latex. The results revealed that the total solids content values for the same sample determined by using the microwave oven heating method are in good agreement with the values obtained by the conventional hot-air oven method. (Zeena et al, 2008) Some unique properties of microwaves have recognized conventional methods.

OBJECTIVE

Therefore, the objective of this study was to find out the optimum operating time of the microwave for the rapid determination of total suspended solids. The total suspended solids content values obtained from Conventional Activated Sludge (CAS) of Sakon Nakhon Hospital by the microwave method was compared to those values obtained from the standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF).

METHODOLOGY



GF/C = Glass Microfiber Filter grade C, MW = Microwave, TSS = Total suspended solids, TLC =Thin layer chromatography

Fig. 1 Analytical process of TSS between MW and APHA, AWWA & WEF standard

Synthetic Wastewater 100 mg/L: Weigh 0.1 g Cellulose powder for TLC, dissolve in distilled water, and dilute to 1000 mL.

Analytical Methods: Analysis of the TSS to find out the optimum operating time of microwave power 800-watt at two levels including medium-high and high for 10, 15 and 20 minutes by using Synthetic Wastewater.

Water sampling: In this study, water samples were collected at Conventional Activated Sludge (CAS) of Sakon Nakhon Hospital and the obtained values of TSS content would compare to those values obtained from the standard method of American Public Health Association, American Water Works Association, and Water Environment Federation (APHA, AWWA & WEF)

Statistical Analysis: The comparison was determined by using SPSS, with which statistical significance was set at 95% confidence interval. The obtained TSS values at 10, 15 and 20 minutes were determined using descriptive statistics technic.

Calculation: TSS **(**mg/L.**)** = **(**Residue retain on filter –filter**)**/volume sample x 1,000.

RESULTS AND DISCUSSION

The Optimum Operating Time of the Microwave

This study used synthetic wastewater prepared form cellulose powder by thin layer chromatography. The TSS at the concentration of 100 mg/L. was analyzed by standard method in the oven which temperature was set at 103 - 105 °C for 1 hour. The analysis was repeated for 5 times resulting the average value of TSS of 95.80 mg/L, SD 3.70, %RSD 3.86, as shown on Table 1.

Table 1 Total suspended solids used synthetic wastewater (**cellulose powder**) **by using standard method**

Repetition No.	Total Suspended Solids (mg/L.)	Average	SD	%RSD
1	97.00			
2	90.00			
3	100.00	95.80	3.70	3.86
4	95.00			
5	97.00			

%RSD = Relative Standard Deviation, SD = Standard deviation

The analysis of the TSS to find out the optimum operating time of microwave power 800-watt in 5 repetitions was found that at the medium high temperature for 10 minutes, 15 minutes and 20 minutes, the TSS was found at 90.20 mg/L, (SD 8.35 and %RSD 9.26), 91.80 mg/L. (SD 6.30 and %RSD 6.86) and 93.60 mg/L, (SD 4.72 and %RSD 5.05), respectively. Meanwhile, at high temperature for 10 minutes, 15 minutes and 20 minutes, the TSS was found at 97.40 mg/L, (SD 1.82 and %RSD 1.86), 93.40 mg/L, (SD 2.88 and %RSD 3.08) and 89.60 mg/L, (SD 5.22 and %RSD 5.83), respectively. The TSS analysis at each temperature levels and time used was found that the microwave method at high temperature for 10 minutes yielded the most adjacent value to the 100 mg/L synthetic waste, i.e. 97.39 mg/L with least SD at 1.86 showing the similarity of the data to the mean value. In addition, the value of %RSD < 5 was more than other data set showing the acceptable high precision in TSS analysis. Therefore, it is accepted as the most relevant for TSS analysis by Microwave methods as shown on table 2. The finding was also congruent with the study of municipal refuse moisture by Marinee (1998) who found that the optimum operating time was 9 minutes at the 850-watt microwave power. This research could, therefore, calculate the operating temperature by microwave method for 10 minutes was approximately 253 °C as in the following equation 1.

$$Power\ (CHU/min) = Power\ (W) \times 0.031593903989083 \quad (1)$$

Generally, Total Suspended Solids; TSS compose of Volatile suspended solids; VSS) and Fixed suspended solids; FSS. When being heated at the temperature exceeding 550 °C for 15-20 minutes, TSS would be ignited resulting to the volatility of organics matter. The residue dried is called volatile suspended solids. Therefore the microwave with temperature at around 253 °C for 10 minutes cannot cause immediate weight losses due to volatilization of organic matter. However, the very slight loss of organic matter by volatilization can usually be happened. (APHA, AWWA & WEF, 2012).

Table 2 Total suspended solids used synthetic wastewater (cellulose powder) by using microwave method at medium high, and high temperature at 10, 15 and 20 minutes

Repetition No.	Total Suspended Solids (mg/L.)					
	Medium high 10min	Medium high 15 min	Medium high 20 min	High 10 min	High 15 min	High 20 min
1	83.00	99.00	90.00	97.00	96.00	82.00
2	100.00	94.00	97.00	100.00	95.00	89.00
3	90.00	88.00	89.00	95.00	89.00	94.00
4	81.00	83.00	92.00	98.00	95.00	95.00
5	97.00	95.00	100.00	97.00	92.00	88.00
Average	90.20	91.80	93.60	97..40	93.40	89.60
SD	8.35	6.30	4.72	1.82	2.88	5.22
%RSD	9.26	6.86	5.05	1.86	3.08	5.83

%RSD = Relative Standarqd Deviation, SD = Standard deviation

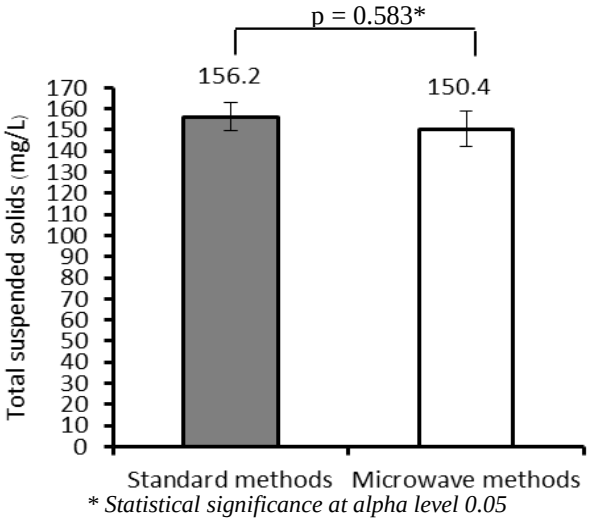
The Comparison of Method of Analysis by Using Sample from Wastewater Treatment

The five repetition analyses of water sampling collected from an aeration tank of Conventional Activated Sludge (CAS) at SakonNakhon Hospital were found that the average TSS value obtained by standard method was 156.20 mg/L., (SD= 6.76, %RSD = 4.32), compared to the average of 150.40 mg/L., (SD= 8.38, %RSD 5.57) by microwave method, as shown on Table 3. Since the result by standard methods had lower SD, **%** RSD than that of microwave methods, it was necessary to conduct hypothesis testing for the difference between the two methods by using t-test of independent sample by setting p-value at 0.05 with 95% confidence interval. The result showed no difference at p-value of 0.583, as shown on Fig 2.

Table 3 The comparison of method for determine total suspended solids between microwave (high 10min) and standard method using sample from wastewater treatment

Repetition No.	Total Suspended Solids*	
	Standard methods	Microwave methods (High 10 min)
1	154.00	150.00
2	155.00	145.00
3	165.00	161.00
4	147.00	140.00
5	160.00	156.00
Average	156.20	150.40
SD	6.76	8.38
%RSD	4.32	5.57

** Water samples were collected at Conventional Activated Sludge (CAS) of Sakon Nakhon Hospital*



** Statistical significance at alpha level 0.05*

Fig. 2 The hypothesis testing for difference of TSS by standard method and microwave

The Independent Sample t-test

Although the t-test showed no statistical difference of TSS value obtained from both methods, it does not mean that the analysis by Microwave methods could stand for standard method since the residues dried at 103 to 105 °C may retain not only water of crystallization, but also some mechanically occluded water. The loss of CO_2 will result in conversion of bicarbonate to carbonate. Because removal of occluded water is marginal at this temperature, attainment of constant weight may be very slow. Residues dried at 180 ± 2 °C will lose almost all mechanically occluded water. Some water of crystallization may remain, especially if sulfates are present. Organic matter may be lost by volatilization, but not completely destroyed (APHA, AWWA & WEF, 2012)**.** Hence, the result of TSS analysis by Microwave methods can be used for immediate monitoring the operation of wastewater treatment plants and help reducing time for TSS analysis from approximately 2 hours to only about 20 minutes.

CONCLUSION

The TSS analysis by Standard methods and Microwave Methods at high temperature for 10 minutes in 5 repetition analyses revealed no statistical difference at 95% confidence interval. With the precision of the Single-laboratory duplicate analyses of 50 samples of wastewater and data set should have standard deviation of differences of less than 2.8 mg/L. Microwave Methods can be considered replacing the Standard methods**.** As future work, we will extend this method to other samples such as domestic wastewater, industrial wastewater, and agricultural wastewater for limitation of qualitative analysis. And weight loss during determination analysis of total suspended solids by microwave.

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Research article

Analyzing Water Harvesting Potentials in Zoned Areas in Qargha Reservoir Watershed

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Abstract In recent years surface runoff water harvesting is gaining more popularity in arid and semi-arid regions such as Afghanistan due to the increasing demand for scarce water resources. In Paghman District growing season starts in March and ends in October; however, in the latter half from June to October, it hardly rains, which causes crop failure and low productivity. So, collecting and stocking a certain amount of runoff water in the wet season and using it as irrigation water during the latter half of the growing season can reduce water shortage problems. Therefore, this study aimed to analyze water harvesting potentials through identifying suitable water harvesting sites and estimating the potential volume of surface runoff based on the rational method and the sorptivity method in the Qargha Watershed of Paghman District, Afghanistan. In this study, weighted overlay in GIS was used to determine suitable water harvesting sites. Sorptivity method and rational methods were used to estimate the volume of surface runoff. Based on the results of suitability analysis only 27.67% of the land was suitable for water harvesting. The estimated potential volume of surface runoff applied the rational method, and the sorptivity method was at 509.4 m^3 and 478.3 m^3. Therefore, it was concluded that water harvesting is possible in the study area. However, these estimated potential volumes of surface runoff needed to be calibrated with the observed data.

Keywords water harvesting, suitability analysis, rational method, sorptivity method, GIS

INTRODUCTION

Accessibility of water is the main preventive factor of agriculture in arid and semi-arid regions, due to low and an equally divide rainfall throughout the growing season (Watanabe et al., 2012). Harvesting surface runoff water from rainfall is getting popularity due to the increasing demand for scarce water resources in arid and semi-arid regions (Amu-Mensah et al., 2013). Afghanistan is often characterized as arid to semi-arid regions. Although water utilization in Afghanistan is mostly for agricultural purposes, hence 75% of agricultural production is based on irrigation activities. Recently, the country is suffering from a serious drought due to climate change, and the magnitude of the drought reached an emergency level in some part of the country. Cropping season starts in March and ends in October. Though, in the latter half of cropping season from June to October, it hardly rains. So, collecting and stocking a certain amount of runoff water in the wet season and using it as irrigation water during the latter half of the growing season can reduce water shortage. Therefore, surface runoff potential was analyzed in the study area. Many methods such SCS-CN method, rational method, sorptivity method, GIS and remote sensing etc. are used for estimating

surface runoff volume. This study focused on the rational and the sorptivity method for estimating surface runoff.

OBJECTIVES

This study aimed to analyze water harvesting potentials through identifying suitable water harvesting sites and estimating the potential volume of surface runoff based on the rational method and the sorptivity method in the Qargha Watershed of Paghman District, Afghanistan.

METHODOLOGY

Study Area

Qargha Reservoir watershed located in Paghman District of Kabul Province, Afghanistan. Average annual precipitation is 280 mm, and the average annual temperature is 11 °C. Most of the farmers are small scale producers with less than 1 ha of land. Irrigation water shortage in the study area is in worse condition, especially in the latter half of the growing season. So, in this study attention have been focused on collecting a certain amount of water in the first half and to used collected water in the dry latter half of the growing season. Location map of the study is shown in Fig. 1.

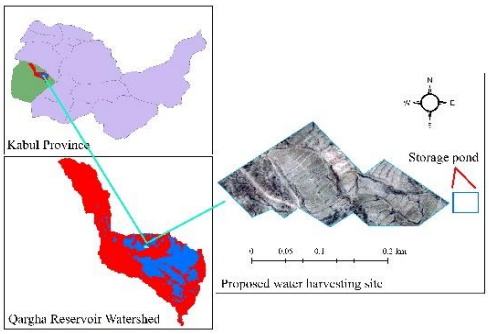

Fig. 1 Location map of proposed water harvesting site in the study area

Suitable Site Selection

The shortage of water resources for irrigation has resulted in the need to identify suitable water harvesting sites. Several factors influence the selection of suitable water harvesting sites. Land slope, digital elevation model (DEM), land use, soil type, annual rainfall, geology, and drainage are the factors used for suitable site selection (Buraihi and Shariff, 2015 and Miana and Raude, 2016).

Table 1 Weightage and ranking for layers and features

Layer	Weight	Feature class	Runoff generation rank
Land use	75	Waterbody	0
		Agriculture	0
		Rangeland	0
		Bare land	1
Soil	10	Rocky land	0
		Haplocambides	1
		Xerorthents	1
DEM	15	<2000m	0
		2000-2200	1
		>2200	0

In this study, weighted overlay among land use, digital elevation model (DEM) and soil type maps in GIS was used to determine suitable water harvesting sites. The necessary data such as digital elevation model (DEM) and soil type maps were collected from the Ministry of Agriculture Irrigation and Livestock (MAIL) (2016). Also, a Landsat image was acquired from an online source and was used to make land use map of the study area using unsupervised classification in ArcGIS. Table 1 shows the different weights and ranks assigned to layer and features and of the layers. The layers were assigned different weights and ranks according to their importance in the suitability analysis. The higher the weight, the more the influence on the results of the suitability map, and the same applies for assigning rank values.

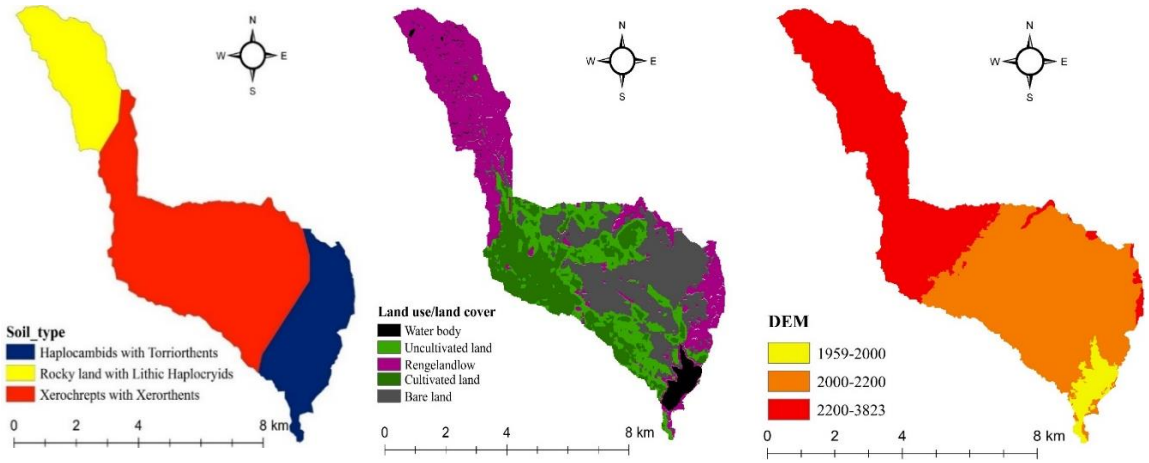

Fig. 2 Layers used in suitability analysis

Surface Runoff Estimation Using the Rational Method

Rational method is a simple and effective method used to estimate surface runoff from a small watershed with scarce hydrological data (Thompson, 2006). Rational runoff coefficient C is part the rational equation relates the amount of runoff to the amount of rainfall. The value getting larger for areas with low permeability and high runoff such as paved, and steep lands, and low value for highly permeable and well-vegetated areas such as forest, flat land (WRCB, 2001). Rational runoff coefficient (C) of this study was based on ODOT (2014) manual, the calculated value for rational runoff coefficient was 0.15. Total 16 rainfall events observed from 18 November 2017 to 6 May 2018 for 170 days were also selected for runoff volume estimation. Rational runoff equation is expressed below:

$$Q=C\times P\times A \qquad \text{Equation (2)}$$

Where Q is direct runoff (m^3), C is the rational runoff coefficient, and P is the rainfall amount (m) and A is area (m^2). The rational equation has been modified, I rainfall intensity (m/h) has been replaced with rainfall (m). The modification was carried out for making the equation simpler for calculating surface runoff volume.

Surface Runoff Estimation Using Sorptivity Method

Unite State Department of Agriculture (USDA)-Soil conservation service (SCS) (1972), developed a method (SCS-CN method) for measuring the volume of surface runoff from rainfall. However, the SCS-CN method doesn't consider rainfall intensity, so there were doubts if it is applicable in other areas outside of the United States (Yamashita et al., 2006). Chong and Green, (1983), developed a method which is the combination of SCS rainfall runoff equation and potential maximum retention to estimates surface runoff volume of a watershed. The difference between the SCS-CN method and sorptivity method is in calculating maximum retention potential (S). Chong

and Green introduced an equation based on soil sorptivity, saturated hydraulic conductivity, and rainfall intensity to calculate maximum retention potential (S) values. Philip (1957b), introduced the term sorptivity and define it as a measure of the capacity of a soil to absorb and desorb water by capillary. Also, Hall and William (2012), describe it as the tendency of soil to absorb and transmit water by capillary. The Chong equation is shown below:

$$S=1/2\times R_i^{-1/2}\times K_{sat}^{-1/2}\times[Sp(\theta)]^2 \quad (1)$$

$$Q=\frac{(P-0.2S)^2}{P+0.8S} \quad (2)$$

Where, S is the maximum potential retention, Sp (θ) is soil sorptivity, K_{sat} is saturated hydraulic conductivity, R_i is rainfall intensity and θ is initial moisture content. And surface runoff was calculated using equation (2) or (SCS rainfall runoff equation), where Q is surface runoff in (m^3), P is rainfall in (mm).

Sp (θ) and K_{sat} were measured in the Laboratory and rainfall intensity data was collected from installed rain gauge in the study area. Mini-Desk infiltrometer was used to measures the soil sorptivity of control and clayey dressed soils. Since different soil types infiltrate water at different rates, measuring the change of volume in Mini-Desk infiltrometer vs time can often be difficult. According to Decagon Device, Inc. (2016), for most type of soils a suction rate of 2 cm is adequate, so the suction rate was adjusted to 2 cm. Soils collected from various locations in the study area were used for sorptivity measurements. Soils from Deh Arbab, Hakim Khel and Doda Mast was used. Soil moisture contents of the soil used in soil sorptivity tests were adjusted to 0, 0.05, 0.10 and 0.15 cm^3 cm^{-3} for control conditions. The average soil moisture content at 0.125 cm^3 cm^{-3} calculated from average moisture content was used as initial soil moisture content (θ) in surface runoff estimation using the sorptivity method.

RESULTS AND DISCUSSION

Suitability Map

Based on the results of suitability analysis only 27.67% and 11.16 km^2 of the land was suitable for water harvesting and the remaining 72.33% and 29.17 km^2 of the land was not suitable for water harvesting as shown in Table 2. Fig. 3 shows the water harvesting suitability map (zoning map) of the Qargha Reservoir Watershed.

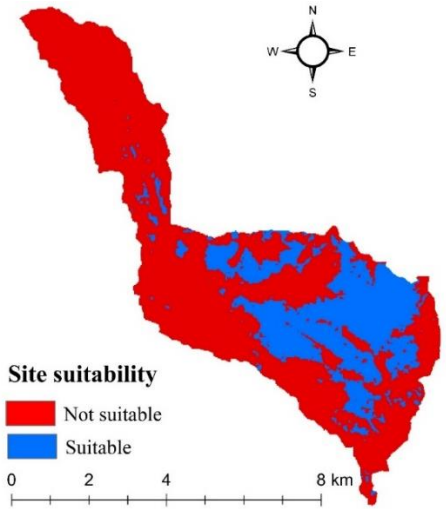

Fig. 3 Suitable water harvesting map

Table 2 Water harvesting suitability categories

Category	Area (%)	Area (km^2)
Not suitable	72.33	29.17
Suitable	27.67	11.16
Total	100.00	40.33

Suitability analysis or suitable water harvesting site selection can be used to facilitate and make water conservation scheme management and planning easy and simple engineers and planners. According to Buraihi et al., (2015), suitable site selection using GIS and remote sensing is a cost-effective and environmentally friendly way of recovering rainfall water.

Relationship Between Soil Moisture Content and Soil Sorptivity

Based on the results of sorptivity analysis sorptivity values decreased with an increase in soil moisture content. Fig. 4 shows the relationship between soil sorptivity values and soil moisture contents. The following equation (3) can be used to determine values of sorptivity when rainfall event occurs in control conditions.

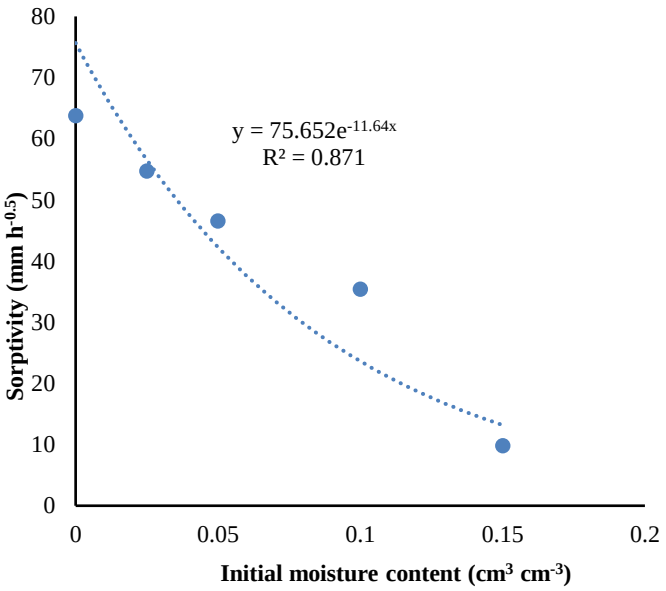

Fig. 4 Relationship between soil moisture content and soil sorptivity

Figure 4 shows the relationship between soil sorptivity values and initial moisture contents which was measured in the laboratory. Soil sorptivity values decrease with increasing soil initial moisture content. The following regression equation (3) can be used to determine the values of sorptivity when rainfall occurs.

$$Sp(\theta) = 75.625e^{-11.64(\theta)} \quad (3)$$

Where Sp(θ) is o soil sorptivity and (θ) is the volumetric initial moisture content.

Potential Surface Runoff Volume

Based on the results of suitable water harvesting site map, a land of 20,000 m^2 was proposed inside suitable areas for estimating potential surface runoff volume. Based on the results of surface runoff volume estimated using the rational method and sorptivity method was at 509.4 m^3 and 478.3 m^3,

respectively. Surface runoff estimated based on the rational method was comparatively higher than that the sorptivity method as shown in Table 3.

Table 3 Surface runoff volume estimated using the rational method and sorptivity method

Rainfall event	P (10^{-2}*m)	S	Area (m^2)	C	Qsp (10^{-2}*m)	Qsp (m^3)	Qra (m^3)
1	14.8	20.2	20000	0.15	3.7	74.6	44.4
2	12.8	18.1	20000	0.15	3.1	62.0	38.4
3	8.0	31.7	20000	0.15	0.1	1.7	24
4	14.2	25.9	20000	0.15	2.3	46.5	42.6
5	11.4	22.2	20000	0.15	1.7	33.3	34.2
6	16.8	26.9	20000	0.15	3.4	68.2	50.4
7	3.2	0.0	20000	0.15	0.0	0.0	0.0
8	15.6	27.7	20000	0.15	2.7	53.6	46.8
9	11.2	46.2	20000	0.15	0.1	1.6	33.6
10	22.6	35.7	20000	0.15	4.7	93.4	67.8
11	6.8	23.9	20000	0.15	0.2	3.2	20.4
12	17.4	42.8	20000	0.15	1.5	30.3	52.2
13	8.0	28.4	20000	0.15	0.2	3.5	24
14	10.2	33.4	20000	0.15	0.3	6.7	30.6
15	3.8	0.0	20000	0.15	0.0	0.0	0.0
16	2.2	0.0	20000	0.15	0.0	0.0	0.0
Total						478.34	509.40

Qsp= Surface runoff volume based on sorptivity method Qra= Surface runoff volume based on the rational method P= rainfall S= maximum retention potential C=runoff coefficient

The viability of the estimated volume of runoff cannot be confirmed. Accordingly, Watanabe et al., (2012), reported that the surface runoff estimated using sorptivity method overestimate surface runoff compare to observed values. Chong and Green, (1983), Watanabe et al., (2012), Chong and Teng (1986) and Gan (2002), reported that the equation could be adjusted in accordance with the observed value of a given soil. Based on their method, the maximum retention potential can be recalculated using optimized parameters. Therefore, necessary adjustments are needed to clarify the accuracy of estimated surface runoff volume in the field. The recalculation of maximum retention potential using the optimized parameters is only possible if we access to observed surface runoff values in the study area.

Table 3 shows the comparison between the sorptivity method and rational method estimated potential surface runoff volume. There is a tendency between the sorptivity and the rational method estimated potential surface runoff volume using sorptivity values. However, the rational method overestimated the values of surface runoff, but the difference was not very big.

CONCLUSION

Collecting and stocking a certain amount of runoff water in the wet season and using it as irrigation water during the latter half of the growing season or dry season can reduce water shortage problems. Based on the suitability analysis only 27.67% of land in Qargha Reservoir Watershed was suitable for water harvesting. So, a small area at 20,000 m^2 was proposed inside suitable areas in Qargha Reservoir Watershed. The estimated volume of surface runoff applied the rational method was at 509.4 m^3 was larger than that applied the sorptivity method at 478.3 m^3 from the 16 rainfall events observed from 18 November 2017 to 6 May 2018 for 170 days. It was recognized that there was a relationship between soil sorptivity and initial moisture content in the catchment area. The volume of each rainfall event could be estimated using sorptivity values measured in the

laboratory. The rational method can also be used to estimate valume of surface runoff in case of scarce data conditions. It was concluded that water harvesting is possible in Qargha Reservoir Watershed, means that there is enough amount of rainfall for water collecting and stocking a certain amount of water. However, these estimated volumes of surface runoff should be calibrated with the observed data. According to the finding of this study, the application of water harvesting strategies is highly recommended. So, the government should design and apply certain projects to reduce irrigation water shortage in the study area

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Research article

Competitive Ability and Potentiality for Business Operation of Pon Yang Khram Livestock Cooperative Limited

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Abstract Pon Yang Khram Livestock Cooperative Limited (PYK Coop) is a business organisation located in Sakon Nakhon Province, Thailand. PYK Coop has an essential economic role in assisting the farmer and the community by creating a fair income distribution. The present study aimed to analyse the competitive ability and potentiality for business operation of PYK Coop and to establish strategic planning to improve PYK Coop business that has an impact on social and community. Porter's five forces of competitive analysis were applied by using primary and secondary data collecting from an in-depth interview with 30 cooperative stakeholders and available annual PYK production reports. The results reveal that PYK Coop has somewhat highly competitive ability and potentiality for business operation. PYK Coop has strength on the bargaining power of suppliers and buyers. Whereas, their weakness is on the underlying technology in the cattle business. PYK Coop has faced with the threat from the external factor on free trade agreements. Overall, the strategic planning suggested for PYK Coop is a co-planning between all stakeholders in the whole supply chain to identify target customers and to create a product differentiate. The suggested strategies will help to improve the competitive ability and potentiality for the business operation of PYK Coop.

Keywords five forces of competitive analysis, Pon Yang Khram Livestock Cooperative Limited, fattening cattle, Thailand

INTRODUCTION

In Thailand, the cooperative is a crucial business organisation that involves all shareholders staring from growing, processing, retailing/selling and till consuming. If the cooperative has a competitive ability and potentiality for business operation, they will be the vital driving force for economic growth in Thailand or other developing or under-developed countries. This is because the cooperative provides the members with considering incomes through a reasonable price and fair trading. The organisational structure of cooperatives is based on the self-help, self-responsibility, democracy, equality, equity and solidarity. This makes the cooperative a vital tool to develop the country in the areas of economic, social and political.

Pon Yang Khram Livestock Cooperative Limited (PYK Coop), was established in 1980, located in Sakon Nakhon province, North-eastern of Thailand. It aims to produce good quality beef products to the market. In 2017, PYK Coop consisted of 6,400 members, who are mainly from Sakon Nakhon province and some come from the neighbourhood, Nakhon Phanom province. Based on available data from 2013-2017, the number of fattening cattle in PYK Coop is on the rising trend; however, there is a decline in the number of fattening cattle being slaughtered (SeFig.1). In 2017, there were approximately 6,500 from 11,800 fattening cattle being slaughtered, which was only accounted for 50% of the total fattening cattle. As a consequent, the members of PYK Coop have been facing financial problem due to an increase in feeding expenses as they must prolong the feeding periods costing as high as 125.30 million Thai Baht. This reflects the lack of competitive ability and potentiality for the business operation of PYK Coop that has an impact on the whole community. The current study aimed to analyze the competitive ability and potentiality

for business operation of PYK Coop and to establish strategic planning to improve PYK Coop business that has an impact on social and community.

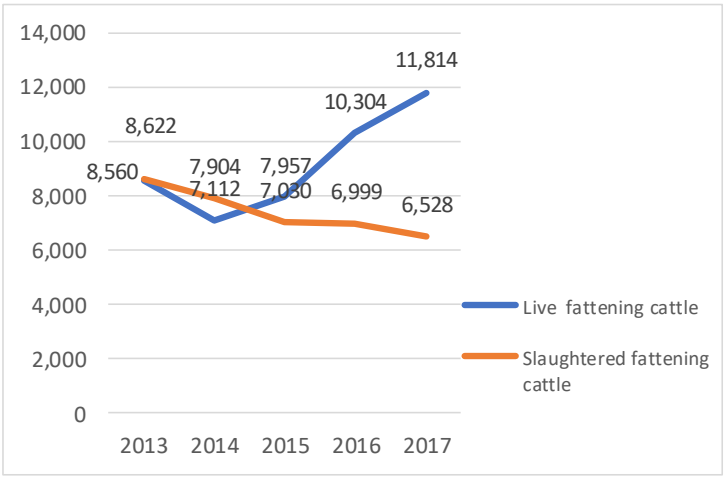

Fig. 1 the number of live and slaughtered fattening cattle at PYK Coop
Source: PYK Coop Annual Report (2018)

METHODOLOGY

Evaluation of Conceptual Framework

Porter's five forces of competitive analysis (1979) was applied to assess the competitive ability and potentiality for the business operation of the cooperative. The model describes five forces that determine the competitive intensity and attractiveness of the markets. The five forces are as follows;

1. Competitive rivalry. The rivalry among existing competitors or the industry concentration can be measured by the number of firms and their size. There are three factors used as the measurement: competitive structure or market structure, demand conditions and industry exit barriers.
2. A threat of new entry. The risk of new entrants in the industry is the barrier protecting the business from the new competitors. The barrier to entry arises from many sources such as brand loyalty, absolutely cost advantage, economies of scale, switch cost or government regulation.
3. The threat of substitution. The risk of substitute products, the substitute products are the competing products that meet the market or consumer needs in term of the quantity, price, and change of consumer attitude and behaviour.
4. Supplier power. The bargaining power of suppliers depends on the degree of monopoly or substitution of the inputs, as well as the quantity of purchased raw materials.
5. Buyer power. The bargaining power of buyers depends on the number and size of consumers. The customer has high bargaining power when they are a few buyers with significant market share.

Besides Porter's five forces, the present study included another five factors to Porter's five forces. These five factors were the macro environmental factors consisting of macroeconomic, technological, social, political and legal, and demographics. The five macro environmental factors are summarised as follows (Piputsitee, 2009; Jaturongkakul, 2004);

1. The macroeconomic environment is the most important and influential factor to the business operation of the cooperative, including economic growth rate, interest rate, foreign exchange rate, and inflation rate.
2. A technological environment can be an opportunity or a threat. The threat from a new competitor is the most influential factor that directly relates to the technological environment.
3. Social environment can be classified into various aspects such as people's attitude, lifestyle or health issues.

4. Politic and legal environment can be an opportunity or a threat depending on the change in rule or regulation in legal issues.
5. Demographic environment is a change in population size. Changing in population size is also affected by an opportunity or a threat of business operation.

Research Methodology

The present study was qualitative research that used primary and secondary data. The primary data involves in-depth interviews with staff of PYK coop, experts and PYK coop members with a total of 30 stakeholders. The secondary data were collected from available research papers, operation report and the financial statements of the PYK coop. All data were descriptively analysed using the extended Porter's five forces. The criteria used to evaluate the competitive ability and potentiality for business operation consists of five dimensions: the intensity of competitive rivalry, the threats of the new entry, the threats of substitute products, the bargaining power of suppliers and customers.

RESULTS AND DISCUSSION

The competitive ability and potentiality for business operation of PYK Coop were assessed using the extended Porter's five forces model. Two types of data set were the primary and secondary data obtaining from in-depth interviews with 30 PYK Coop stakeholders and the annual PYK Coop performance report, respectively. The results obtained from the extended Porter's five forces model are as follows.

1. The Intensity of Competitive Rivalry

Based on the data reported by the Department of Cooperative (2017), there were in a total of 94 fattening cattle cooperatives in Thailand. Among them, 87 out of 94 (92.5%) were operated solely on selling live fattening cattle. Whereas the other seven cooperatives (7.5%) had fattening cattle as well as a slaughterhouse, so they had more variety of beef products such as retail and wholesale cuts. PYK Coop was one of these seven cooperatives, which was capable of beef production and marketing.

2. The Threat of New entry Competitors

The ability and potentiality of PYK Coop to protect themselves from the threat of new entry were assessed. PYK Coop was registered under the Thai Cooperatives Act 1999, meaning to say that they could raise the funding as much as they could do. The fundraising under the Act could benefit them from the threat of the new entry in case the new entry had limited funding, and so-called an investment limitation.

Further analysis showed that PYK Coop has been operated from 1980 and they have gain knowledge and know-how on farming technology and fattening feed. These know-how technologies appeared to be rather simple. So, other competitors could be easily implemented similar technology and could produce similar marbled beef quality.

Interestingly, it was observed that PYK Coop had an advantage on the investment limitation, but the cooperative could not wholly exclude the threat of new entry competitors. It can be explained that PYK Coop used simple farming technology and simple feeding formulae for fattening cattle that are easy to mimic. Hence, there is no significant difference in meat quality of PYK when compared with new competitors.

3. The Threats of Substitute Products

Overall, PYK Coop only had a moderate capability to prevent the threat of product substitution. Because of similarity in feed formulae used for fattening cattle, there were not much different in the consequent marbled beef qualities as compared with other cooperatives. The major marbled beef produced by PYK were normally in grade 3.0-3.5, which were above the average quality but

not yet in the high-quality marbled beef. Looking at the medium-high quality beef market in Thailand, there was other marbled beef with a softer texture and lower fat content that could substitute the PYK marbled beef products. These substituted marbled kinds of beef were obtained from cattle fed in a pasture and natural grassland and were cured to soften the beef after slaughtering. Furthermore, these substituted products could meet consumers' demands and requirements on healthy food, which is the trend of the current market (Mekhora and Theingtham, 2012; Kittikarnkul et al., 2016). However, PYK marbled beef products were still considered superior as compared with other marbled beef in the northeast region.

4. The Bargaining Power of Suppliers

The bargaining power of suppliers can be considered in two levels, which are 1) at the cooperative and farmer level and 2) at the cooperative and input supplier level. At the cooperative and farmer level, the cooperative set the price of the live fattening cattle, which was 125 Thai Baht/kg. Furthermore, the farmers had to buy the feed, molasses and animal medicine as well as receiving the animal medicinal services from the cooperative. All the prices were set by the cooperative. In this case, the bargaining power was in the hand of the cooperative. At the cooperative and input supplier level, the cooperative signed a contract with the feed mill industry with an agreement to produce the cooperative with the feed formulae for fattening cattle that meet the agreeing feed standards and the required amounts and price. In other word, the cooperative ordered a big amount of feed, so the bargaining power, in this case, was in the hand of the cooperative.

5. The Bargaining Power of Buyers

It has been suggested that consumers paid more attention to quality and sensory properties of beef (Boleman et al.,1997). The beef tenderness was the most influential property on the consumers' decision to buy the product and the consumers were willing to pay more for the improved tenderness. It is possible, therefore, that PYK marbled beef products could fit in the middle-income market. The middle-income market was a big market sector in Thailand amounting 42% of the total market sectors (Mekhora & Theingtham, 2012; Kittikarnkul et al., 2016). It is therefore likely that there was a high demand for premium beef products, so the PYK Coop had more bargaining power than the buyer. Regarding the PYK's annual report, 55.24% of their products were sold in wholesale cuts, the rest 44.76% were the retail cuts. When there was a big order, which the amount and price was deal in advance. There are, however, other possible explanations, the bargaining power was more on the buyers (customers) side. Overall, PYK Coop had moderate bargaining power with the buyers.

6. The Impact of An Environmental Factor

Based on the situation of marbled beef market in Thailand during 2013-2017, there was an increasing trend in imported live cattle and retail cuts from aboard. In 2017, the number of imported live cattle and retail cuts increased by 19.34%. At the same time, the number of exported live cattle and retail cuts decreased by 72.67%. The declined in the exports was due to the neighbourhood countries imported more beef products from Australia. As a consequence, the number of beef products in Thailand were higher than the domestic's demands. These mays impact the market share of PYK Coop marbled beef products in the future.

From the study of Sub-committee on Agricultural Productivity Examination, The Commission for Agriculture and Cooperatives, National Legislative Assembly (Thailand) (2017), the results suggested that the Thai fattening cattle business should improve their productivity, product quality and food safety, value-added products, marketing research, as well as improving the potentiality of all personnel or organizations along the whole food chain. As a consequence, three national strategic plans were launched including maintaining the domestic markets, increasing cattle population and feeding management. These strategies support the operation of the cooperative for a successful business.

The key production technology for fattening cattle is the feeding technology because the concentrate feed is a significant production cost for fattening cattle. It was found that the farmer had to shoulder the concentrate feed cost about 10,347.22 Baht/cattle/year. Hence, each fattening

cattle cooperative or community enterprise had developed their own feeding formulae to reduce the feeding cost, increasing competitive opportunity on feeding price with PYK Coop.

Overall, the important external environmental factors are the legal environment and the macroeconomic factor from the Thai-Australian Free Trade Agreement (reducing cattle and products tax to 0% as of 2020). All of the environmental factors have a direct impact on stakeholders in the Thai beef industry. Especially at the cooperative producer level, they need effective management on production, processing and distribution to improve their competitive ability and potentiality for business operation.

7. Competitive Ability and Potentiality for Business Operation of Cooperative

Fig. 2 shows the competitive ability and potentiality for the business operation of PYK Coop analyzed by using Peter's five forces. The horizontal axis is the potential level of cooperative operation. The high score means high potential. The vertical axis is the ability to defend against various factors, the high score means the high potential to defend the treat from competitive factors. The circle size is the degree of the competitive impact on the PYK Coop operation. This graph can divide to 4-channel diagram, the top-right channel shows that the cooperative had high operation potential and defence potential from competitive factors. In the opposite, the bottom-left channel shows that the cooperative had low operation potential and defence potential from competitive factors.

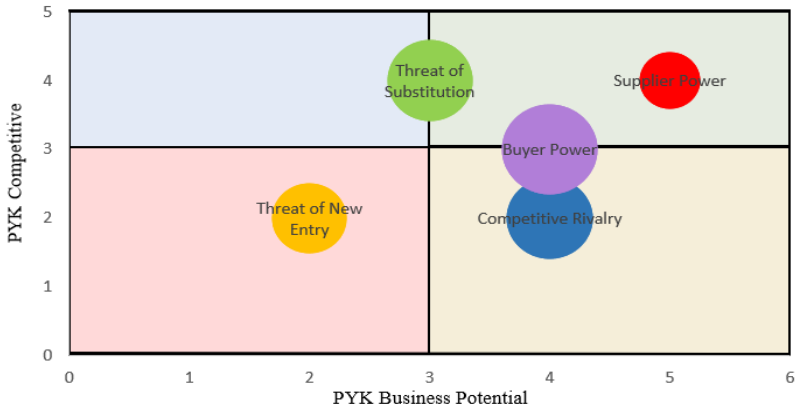

Fig. 2 The competitive ability and potentiality for business operation of Pon Yang Khram Livestock Cooperative Limited

When assessing the business operation of PYK Coop, the strength of PYK Coop operation was the high degree of bargain power to the suppliers, farmer and feed supplier. Furthermore, PYK Coop had the power to negotiate with the consumer and set the price for the products (price maker). PYK Coop is a big fattening cattle cooperative in an oligopoly market that has a few numbers of competitors and high similarity in products. Meat product quality of PYK Coop was a bit higher than other competitors. However, this advantage might not last long as PYK Coop used necessary technology that is easy to mimic. This finding is consistent with that of Bryant and White (2000) who found that there are external and internal factors involved in the cooperative business. It can be classified into three main aspects: the direct impacts, such as cooperative employment or income generated (1), the indirect impacts, such as changes in income in the community, society or industry (2), and the induced impacts, such as the local community spending that effect to gross province product and gross domestic product (3).

8. Development Strategies to Increase the Competitive Ability and Potentiality for Business Operation

It may be that PYK Coop benefitted from the immediate and essential business strategy. The co-planning strategy between cooperative and suppliers to produce products that meet the marketing

demand should be taken into consideration. It may be the case therefore that this strategy will be able to reduce the production costs and the overstock of input and livestock. Therefore, the farmer will benefit from the active production and marketing plan that prevent unnecessary expenses in feeding. The PYK Coop will have to improve their ability and business potential to protect themselves from an external factor such as 0% import tax from Thai-Australian Free Trade Agreement. Besides the co-planning strategy, other valuable strategies that will help PYK Coop to improve their ability and business potential are consisting of;

1. It can thus be suggested that PYK Coop should develop a different product or make the product differentiation that meets customers' demand, so that enables identify target customers who have different product demand.
2. It is possible that PYK Coop should make use of the marketing data including market demanding and supplying for decision making in order to improve the supply chain by implementing information technology. It seems that if PYK Coop could implement these strategies, the farmers could entirely benefit from the mentioned strategies. It is; therefore, likely that the farmers in the community or society in Sakhon Nakhon Province could improve their incomes and it could boost local economic growth.

CONCLUSION

The present research aimed to examine the competitive ability and potentiality for the business operation of PYK Coop by using Porter's five forces of competitive analysis. This study has shown that the competitive capacity and potentiality for the business operation of PYK Coop was quite high. The market structure of PYK Coop was the oligopoly with a few competitors in the market. There was a similarity in PYK Coop product with other competitors, but the PYK Coop product was a bit higher in product quality. PYK Coop used simple feeding technology that it is easier for a new entry competitor to mimic. When considering the bargaining power of suppliers and buyers, PYK Coop had all both control over the suppliers and buyers as PYK was the price maker. However, PYK Coop has faced with the threat from the external factor on free trade agreements, reducing the competitiveness of cooperative. The results of this study indicate that the business development strategy for PYK Coop should be introduced. In so doing, the co-planning between all stakeholders in the supply chain, from input suppliers, farmers, cooperative, wholesaler and retailer may be incorporated with a logistic information system. The current data highlight the importance of the strategy in which it will be able to predict the amount of beef production that meets the market demand. To bring about social and community impact, PYK Coop must define marketing strategies by identifying target customers and creating a product differentiate to meet the customers' requirements. When the cooperative has competent management and has a competitive ability and potentiality for business operation, they will improve the well-being of all members in the community or society.

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Research article

Seasonal Distribution Maps, Management Practices and Profitability Analysis of Vegetables in the Selected Area, Nay Pyi Taw

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Abstract Detailed information on seasonal distribution of vegetable growing areas and comprehensive study on cultural practices of some commercial vegetables are still lacking in Myanmar. This study was done to produce seasonal distribution maps of vegetables for the selected area and to analyze crop management practices and profitability of the selected commercial vegetables. Kyee Inn village tract, Pyinmana Township, Nay Pyi Taw was selected and studied from May 2016 to December 2017. Total study area was 483 ha and DJI Phantom 4 drone, Lichi software, GPS device, pix 4D software and ArcGIS were used to draw the maps. A total of 50 vegetable farmers were interviewed to analyze crop management practices and profitability for selected five commercial vegetables; okra, chilli, yard long bean, cucumber and ridge gourd by using descriptive analysis and profit function. The result showed that 15 kinds of vegetable were distributed year-round and total vegetable production areas ranged from 3.69 acres (0.31%) to 17.61 acres (1.44%) of total cultivable land. Farmers used hybrid seeds except for chilli and practiced their preferable spacing, not following the recommended one provided by Department of Agricultural Research (DAR). Farmers commonly used high dosage of urea and some farmers used wrong pesticides to control green leaf hopper, leaf miner, powdery mildew and rust. Moreover, most farmers had no awareness on using pesticide. Okra production gives the highest Benefit Cost Ratio (BCR) of 2.5 if it was grown in less than average acre. But, in chilli and ridge gourd production, BCRs (2.7 and 3.7) were the highest in 'average growing acre'. Yard long bean and cucumber production give the highest BCRs (2.5 and 2.5) in 'above average growing acre'. In total cost of production, labor cost was the highest followed by fuel cost for irrigation.

Keywords vegetables, distribution maps, management practices, profitability

INTRODUCTION

Myanmar has rich sources of plant biodiversity and more than 100 kinds of vegetables are growing in Myanmar depending on suitable growing seasons (MOALI 2014). Vegetables are the most important of crops because they are an excellent source of minerals, vitamin A, folic acid and beta-carotene. They play a key role in solving the problems of food production and providing a balance diet. Although many different vegetables are grown in Myanmar depending on the suitable growing seasons, the detailed information on their distribution for three seasons (summer, rainy and winter season) throughout the country is still lacking. In order to know the distribution of vegetables for an area, the new science tools such as Geographic Information System (GIS) and Global Positioning System (GPS) should be introduced with innovations and modern technologies based on satellite data. At present, the development and implementation of precision agriculture (planning, field mapping, soil sampling, crop scouting, variable rate applications, and yield mapping) has been possible by combining the GPS and GIS but has not being published.

Vegetable production is important not only for national economic development but also for rural household income generation. Therefore, vegetable growers must use cultural practices that optimize yields, maximize returns and profits, and minimize environmental impacts (Colquhoun et al., 2018). But there have been no detailed studies about the cultural practices of each vegetable in Myanmar.

OBJECTIVES

The study was carried out as a first step with the following objectives:

1. To create seasonal distribution maps of vegetables of the selected area in Nay Pyi Taw
2. To analyze crop management practices and profitability of the selected commercial vegetables in the study area

METHODOLOGY

Study Duration and selected area

The research was conducted from May 2016 to December 2017 at Kyee Inn Village, Pyinmana Township in Nay Pyi Taw of Myanmar. Total study area was 483ha and vegetables covered about 7.28 ha (1.52% of cultivable land) in 2016.

Data Collection

The primary data collection was done from November 2016 to December 2017. Coordinate points of each vegetable growing field were collected depending on the crop changes and drone flying above the study area was done to draw the seasonal distribution map. All kinds of vegetables scattered year-round were studied. Five most commercially grown vegetables (okra, chilli, yard long bean, cucumber and ridge gourd) were selected based on high growing percentage, year-round production and high benefit according to the preliminary survey. All farmers who grow vegetables in the study area (50 persons) were interviewed with structured questionnaire sets to analyze crop management practices and profitability of five selected commercial vegetables. The secondary data comprising field base map hard copy, weather data, total crop growing area and total population were obtained from Township Administration Office, Department of Agriculture (DoA) and Department of Agricultural Land Management and Statistics (DALMS), Pyinmana Township in Nay Pyi Taw.

Data Analysis Methods

DJI Phantom 4 drone manufactured from SZ DJI Technology Co. Ltd, Shenzhen, Guangdong in China was programmed to fly at a constant altitude of 120 meters above the ground to get the ground images of the study area. For drone flying, DJI Phantom 4 drone supplied from SkyLink Company, Japan and Lichi software were used. Location coordinates of each vegetable growing field were recorded with GPS device (GARMAN, GPSMAP 62). Drone photos were consolidated and prepared for digitizing and analyzing with pix 4D software to provide digital base map of the study area. Mapping for spatial distribution of crops were provided using ArcGIS Desktop (software) from Environmental Systems Research Institute (ESRI). The collected crop management data were entered to Excel program. Means and percentages were calculated to know the management practices comprising seed type, spacing, fertilizer application and pesticide usage. The concept of enterprise budget was used to compare the profitability of different vegetables. Gross return was calculated by multiplying the total volume of production of an enterprise by the average prices of that product in the harvesting period (Dillon and Hardaker 1980). Variable costs of production included cost for land preparation, seeds, fertilizers, fuel, pesticides, poles and labors. Return of vegetable production was based on average yield and sale at average current price of

vegetable during that period. Profitability measures were calculated by using the following formula:

Benefit Cost Ratio (BCR) = Total Gross Benefit (GB) / Total Variable Cost (TVC)

RESULTS AND DISCUSSION

In the study area, 15 kinds of vegetable were produced year-round, and vegetable fields cover about 0.31-1.44% of total cultivable land (Table 1). They were okra, chilli, yard long bean, cucumber, ridge gourd, water convolvulus, mustard, French bean, onion, coriander, rosella, bitter gourd, mint, kai-lan and Asiatic pennywort. In the summer season, 11 kinds of vegetable were grown, and the production area ranged from 15.1 to 17.06 acres covering 1.27 %-1.43 % of total cultivable land. In the rainy season, the production area of vegetables (11 kinds) declined to 3.69-13.37 acres. This is because most farmers grew monsoon rice in this season. In the winter season, 7 kinds of fruit vegetables, 6 kinds of leafy vegetables, one kind of bulb and herb vegetable were grown. Kinds of leafy vegetables increased because of winter season crops such as mustard, kai-lan and coriander. Figure 1 shows the sample distribution map of vegetables in the winter season in which 15 kinds of vegetables were produced. This kind of distribution map can be used to compare species distribution and location changes of vegetables from season to season and year to year. Since maps can show the accurate positions of vegetable growing areas, they can be useful for the future study of scientists and vegetable production data are also essential for effective planning assessment.

Table 1 Distribution of Vegetables from November 2016 to December 2017

Items	Summer	Rainy	Winter
Fruit vegetables	Okra	Okra	Okra
	Chilli	Chilli	Chilli
	Yard long bean	Yard long bean	Yard long bean
	Cucumber	Cucumber	Cucumber
	Ridge gourd	Ridge gourd	Ridge gourd
	Bitter gourd		Bitter gourd
	French bean		French bean
Leafy vegetables	Water convolvulus	Water convolvulus	Water convolvulus
	Rosella	Rosella	Rosella
			Mustard
			Kai-lan
Bulb vegetables	Onion	Onion	Onion
Herb vegetables	Mint	Mint	Mint
		Coriander	Coriander
		Asiatic pennywort	Asiatic pennywort
Total growing acre	**15.1 - 17.06**	**3.69 - 13.37**	**3.94 - 17.16**

In Table 2, most of the farmers (76%) used local variety for chilli production because of market demand and high price but all the farmers used the hybrid seeds in okra, yard long bean, cucumber and ridge gourd production. Moreover, farmers used the F_1 population seeds (i.e., seeds come from the hybrid seed at the first season) obtained from their fields because hybrid seeds were very expensive and they could save money by using them. The most commonly used spacing of okra, chilli, yard long bean, cucumber and ridge gourd were 3' x 0.5', 3' x 1.5', 4.5' x 3', 3.5' x 1.5' and 4' x 3'. The spacing of okra, chilli, yard long bean, cucumber and ridge gourd recommended by DAR (Department of Agricultural Research) were 3' x 1', 2' x 2', 3.5' x 0.7', 4' x 1' and 20' x 2'

respectively. In fertilizer usage, most farmers used more urea fertilizer rate than the recommended one in all selected vegetables. Although farmers did not use the recommended spacings and fertilizer rates provided by DAR, they got the profits. However, extension workers should share the knowledge on the application methods and time of fertilizer usage to be more effective.

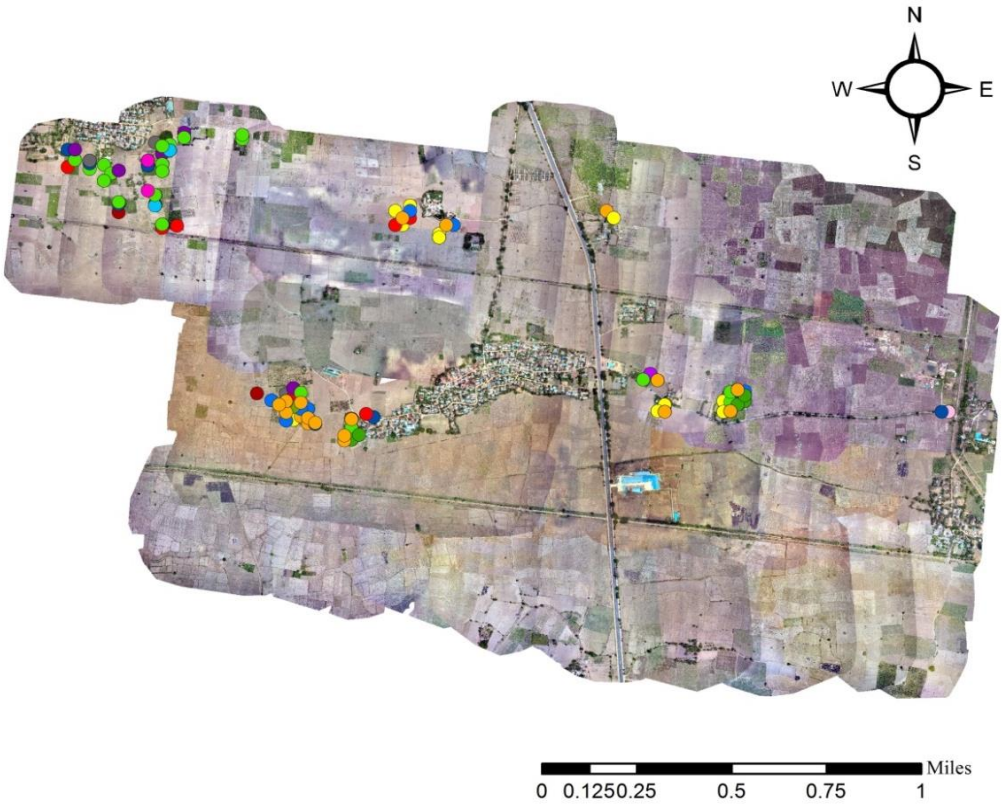

Fig. 1 Distribution of vegetables in the winter season, 2017

Table 2 Comparison of seed type, spacing and fertilizers between farmers'practices and recommended ones by DAR

Crops	Seed type			Plant spacing (ft)		Fertilizer usage (kg/ac)							
	Hybrid	F_1 popu;	Local	RP*	FP**	Urea		T-super		Potash		Cowdung manure	
						RP*	FP**	RP*	FP**	RP*	FP**	RP*	FP**
Okra	44	56	-	3 x 1	3 x 0.5	50	426	50	23	50	30	1000	235
Chilli	14	10	76	2 x 2	3 x 1.5	100	286	50	15	50	20	3000	208
Yard long bean	53	47	-	3.5 x 0.7	4.5 x 3	50	328	25	52	25	67	1000	310
Cucumber	100	-	-	4 x 1	3.5 x 1.5	50	465	50	56	50	73	1000	262
Ridge gourd	100	-	-	20 x 2	4 x 3	50	658	50	150	50	96	1000	750

** = Recommended practice, ** = Farmers' practice*

The most common pests and diseases in the selected vegetables were green leaf hopper, white fly, pod borer, leaf miner, powdery mildew and rust (Fig 2.). In the controlling of green leaf hopper, 80% of farmers used various insecticides correctly. For the control of white fly and pod borer, all farmers (100%) used the insecticides correctly. Also, in controlling of leaf miner, 92% of farmers used correct insecticides. Though 74% of farmers used the fungicides correctly to control powdery mildew, 100% of them used the insecticide incorrectly instead of fungicide to control rust.

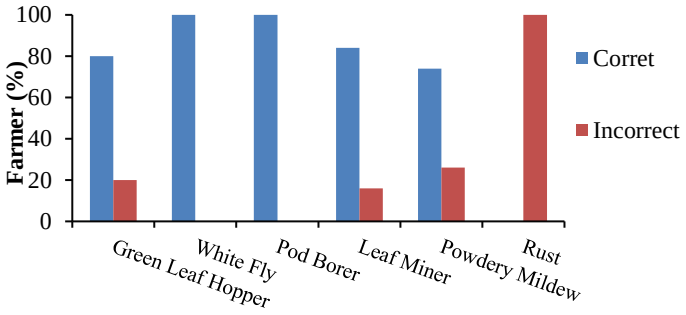

Fig. 2 Pest and disease incidence and pesticide usage in the selected vegetables

In Fig 3, most of the farmers harvested all selected vegetables except chilli only one day after pesticide application; 100 % in okra, 94 % in yard long bean, 77 % in ridge gourd and 95 % in cucumber. In chilli production, all farmers harvested the crop seven to ten days interval after pesticide application. Therefore, most vegetable farmers did not follow the pre-harvest waiting period and they applied the pesticides near harvesting time. Misuse of pesticides can cause poisoning, human and environmental hazard. So, farmers should imply the pre-harvest waiting period instructed on pesticide package accurately during pesticide handling.

Figure 4 shows the results of personal protective equipment used by the farmers such as long sleeves (34%) and boots (8%) and gloves (2%). But all vegetable farmers did not use masks during pesticide handling and spraying that can maximize exposure and increase the risk of pesticide poisoning. Pesticide poisoning has been a major problem worldwide, but the estimates vary among the reports. Rajendran (2003) mentioned that nearly 500,000 illnesses and 20,000 deaths can be attributed annually to chemical pesticides worldwide. Likewise, World Health Organization (WHO) data showed that each year 3,000,000 cases of pesticide poisoning including 220,000 deaths are reported across the globe (Down to Earth 2001). To solve the pesticide usage problems, educating the village pesticide retailers and farmers on knowledge of pest and pest management, proper pesticide handling and safety measures is needed.

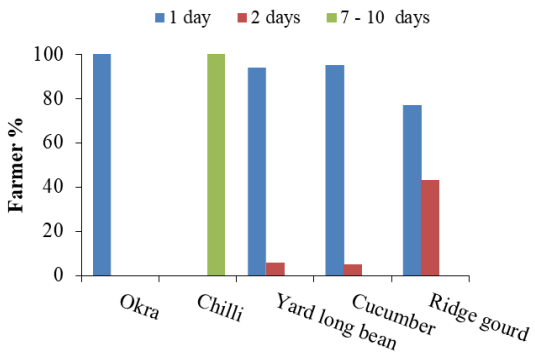

Fig. 3 Pre-harvest waiting period (days) after pesticide application

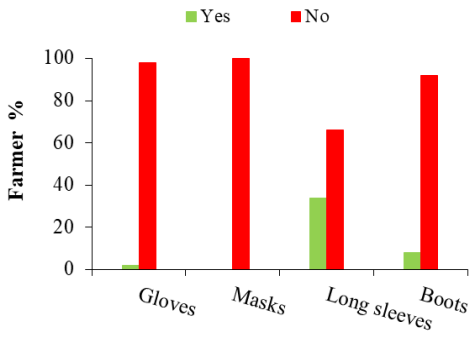

Fig. 4 Protective equipment usage

Cost and return analysis were calculated depending on average, below average and above average growing area (Table 3). The average growing areas of okra, chilli, yard long bean, cucumber and ridge gourd production were 0.30 acre, 0.40 acre, 0.15 acre, 0.10 acre and 0.10 acre respectively in the study area. Okra production gives the highest BCR (2.5) if it was grown in less than 'average acre'. But, in chilli and ridge gourd production, BCRs (2.7 and 3.7) were the highest in 'average growing acre'. And then, yard long bean and cucumber production give the highest BCRs (2.5 and 2.5) if they were grown in above 'average growing area'. In the cost of inputs and

labor as a percentage of total vegetable production cost, labor cost share was the highest among other cost share followed by fuel cost.

Table 3 Benefit cost ratio and cost share analysis of selected vegetables production

Crops	Benefit cost ratio (BCR)			Cost share of inputs and labor (%)						
	< Average	Average	> Average	Seed	Fertilizer	Pesticide	Land pre;	Labor	Fuel	Pole
Okra	2.5	1.8	1.7	6.10	8.55	7.91	13.37	47.06	17.01	0.00
Chilli	2.5	2.7	1.8	4.64	2.76	2.08	6.66	61.15	22.80	0.00
Yard long bean	2	1.8	2.5	5.55	7.90	13.68	6.74	41.44	10.01	14.68
Cucumber	2.2	2.4	2.5	7.18	9.62	7.66	8.38	38.47	6.27	22.42
Ridge gourd	2.2	3.7	3.2	9.03	4.44	12.43	9.46	38.48	10.54	15.61

CONCLUSION

Distribution maps can be used to compare species distribution and location changes of vegetables from season to season and year to year for the selected area. Since mapping can show the accurate position of vegetable growing areas, it can be useful for scientists and planners in the future. Therefore, this kind of research should be extended.

In fertilizer application, farmers used higher amount of urea fertilizer than the recommended rate. In pesticide application, the farmers used pesticide incorrectly to control green leaf hopper, leaf miner, powdery mildew and rust. Most of the farmers harvested the crops at one day interval after pesticide application in okra, yard long bean, cucumber and ridge gourd production. Moreover, most farmers did not use the personal protective equipment during pesticide handling and application.

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Research article

Needs Analysis for English Communication Skills of Thai Officers, A Case Study: Department of Fisheries

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Abstract This case study investigates the need of English for intercultural communication for government officers, Department of Fisheries, Thailand. 50 respondents including 25 government officers, 16 government workers, and 9 contracted office temps were purposively selected based on their duties which directly handle with international activities relating to fisheries via questionnaires. The findings portrayed that respondents realized the importance of English however most training courses were available only for government officers and English training courses were arranged by some divisions due to their budget limitation. Speaking and reading were found to be the most two critical skills which participants wanted to improve. In terms of qualitative data half of the respondents wanted more opportunities to practice English and requested a training in General English (GE) and English for Specific Purposes (ESP). Factors related to English as a Lingual Franca (ELF), cultural knowledge and communicative strategies should also be considered. Further suggestions are presented in the final part.

Keywords English for professional communication skills, ELF, Thai government officers

INTRODUCTION

Department of Fisheries is a Thai official bureau under Ministry of Agriculture and Cooperatives which administers and monitors all related aquatic businesses within and outside of Thailand and it plays a vital role in aquatic animal business in Thailand. It consists of many divisions and offices around the country. The Headquarter, Bangkok, comprises of at least 27 different divisions. There are also the inland fishery offices in the provinces with no access to the sea, the coastal aquaculture research and development centers in the provinces with the access to the sea, research and development centers, law enforcement units and checkpoints. In sum, the department has two major responsibilities i.e. in academic aspect researching, developing, analyzing and experimenting to gain better knowledge in fishery issue and to pass the knowledge to Thai people via supporting and developing the fishery-related professions in the country (Department of Fisheries, 2019).

Regarding Kachru (1992), users of English worldwide are categorized into three different circles namely the Inner, the Outer and the Expanding Circle. Countries which English is used as the mother tongue like the US, the UK, Australia, and New Zealand are categorized in the Inner Circle whereas the Philippines, Malaysia, and Singapore are categorized in the Outer Circle which English is placed as a second language and plays a vital role in the countries. Besides countries like Thailand, Indonesia and Vietnam are grouped in the Expanding Circle where English is perceived as a foreign language and is aimed to be used for communicating mainly with native English speakers. To deal with international issues, Thai government officers need to use English to communicate with countries from different Circles above. When looking at the linguistic reality, majority of the world citizens who use English nowadays are non-native English speakers (NNESs) and in comparison numbers of the native English speakers (NESs) which are around 350 million, numbers of NNESs are around one billion people (Jenkins, 2009, p. 16). English usage among these NNESs is functioned as a lingua franca or "a contact language" (ELF) in at least two

contexts: within a country with multiracial citizens like Singapore or between people from different non-native speaking countries e.g. a Thai communicates with a Malaysian (Firth, 1990, p. 270) and as a result of ELF, many studies are conducted to analyze how English functions in intercultural contexts and how it is used effectively to lessen communication breakdowns e.g. Nickerson (2005) illustrated how ELF has been used in international negotiations, correspondences and advertisements while the term "Business English as a Lingua Franca" or BELF portrays how English is "simplified, hybridized and highly dynamic communication code" for doing business internationally (Kankaanranta & Planken, 2010). As ELF is characterized as the way of using English for communication among countries in the European Union, a recent study by Modiano (2017) investigated the influences and functions of English after Brexit. Among the Association of Southeast Asian Nations (ASEAN) membered countries, English is officially the working language of the community (ASEAN, 2008). Thus, in this study there are two related issues regarding needs analysis to focus on due to the international communication of Thai government officers and these two issues are 1) their English proficiency skills and 2) their knowledge and understanding about the intercultural communication, the characteristics, and usages of ELF. The term English for communication in this study refers to three abilities namely the English proficiency, the cultural knowledge (Myles, 2009, pp. 3-4) and the communicative abilities as Al-Mahrooqi (2012, p. 125) stated that "communicative ability involves more than mere knowledge of grammar and vocabulary. It involves the ability to express oneself clearly and appropriately depending on the situation, interlocutors, topic, time, and place". Besides, to be able to express oneself in ELF setting, the communication strategies in the conversation relies mainly on the communication accommodation (Giles, 2007) which both interlocutors try to adjust themselves to have a better understanding and code-switching (Jenkins, 2009, p. 145).

Another point worth mentioning when talking about international communication is "culture". As Scollon, Scollon, and Jones (2012, p. 3) illustrated that culture is "a way of dividing people up into groups according to some feature of these people which help us to understand something about them and how they are different from or similar to other people". In intercultural communication situations, a person from a country communicates with his interlocutor from another country and they both are confronting either with the "high context cultures" or the "low context cultures" situation. In the "high context cultures", it is the culture that using less speaking or writing documents but the understanding is formulated from the members' internal understanding whereas in "low context cultures" people are likely to follow the rules and communicate and deduce the meanings from verbal messages situations (Hall, 1977). Hall also categorized cultures in Asian, Latin American and southern European contexts as the "high context cultures" and cultures from North American and northern European are considered as the "low context cultures" (ibid, 2012: 40). In the Thai context, English is used as a foreign language to communicate with foreigners who, in general, share different cultures from Thais. Scollon et al. (2012, p. 16) stated that achievement in communication will happen when two interlocutors share a similar worldview and knowledge level. In the Thai context, there are chances that some mistakes might occur when two parties from different cultures have to use a lingua franca to communicate. Therefore, to be able to communicate effectively in the international context, the differences in these two context cultures should be carefully concerned. In this study, Thai officers include 1) full-time government officers, 2) government workers and 3) contracted office temps, who are working for the Department of Fisheries, Kingdom of Thailand and the department refers to the Department of Fisheries, Kingdom of Thailand.

OBJECTIVES

This study aims to investigate English for communication skills of Thai government officers who work at the Department of Fisheries and to observe English for specific skills required by these Thai officers to achieve the goals in their duties.

RESEARCH QUESTIONS

1. What skills in English that the respondents feel that they have a problem with?
2. In what aspects that English for communication skills are used to achieve Thai government officers' goals in their duties?

METHODOLOGY

This present study comprised of two sections; quantitative and qualitative. The questionnaire was adapted from Luankanokrat (2011) and an online questionnaire from www.ideasneed.com, where learners need to complete a needs analysis form before entering into their English language training. Questionnaires are distributed to officers who are now working in different divisions in the Department of Fisheries. Sixty questionnaires were distributed and 53 were returned and 50 questionnaires were usable. The questionnaire consists of 5 parts; 1) General information of the respondents, 2) The importance of English, the respondents usage of English and their English training courses, 3) Needs of English for communication skills and 4) The necessity of English communication skills and 5) An open-ended questions asking the respondents opinions about their problems in using English for communication in their professions and how their organization can help them solve these problems.

RESULTS AND DISCUSSION

Respondents comprised of 14 males and 36 females. 4 gained vocational diplomas and vocational certificates, 33 gained bachelor degrees, 12 had Master degrees and 1 had a Ph.D. Twenty-five of them were government officers, 16 were government workers and the other 9 were contracted office. The importance of English to their careers, 26 placed English at the "very important", 19 people stated that English was "important" while 5 people suggested that English was "moderately important". Almost half (n=21) claimed that they sometimes used English in the other 20 were frequent users of English and 9 did not have many chances or never used English in their jobs. Later respondents were asked to complete the questionnaire, the results were illustrated in Table 1

Table 1 English Language Skills that caused the problems based on respondents' opinions (can choose more than one skill)

Problems	Frequency (n = 50)	Percent
Listening	9	18
Speaking	33	66
Reading	17	34
Writing	12	24

Speaking seemed to be the most serious problem when respondents claimed that they were unable to speak with correct grammar (96%), confused with word choices (90%), pronunciation accuracy (86%). The second most serious problem was their reading when they were unable to understand the various meaning or idioms when reading (92%), their grammar weakness that directly affected their interpretation when reading (74%) and unable to understand a complicated message (70%). The third serious problem was their writing. 96 percent of the respondents claimed that they had a problem when conveying their message according to their intention and the complexity of English grammar. They also could not choose the right vocabulary or idiomatic expressions when writing (88%) and unable to compose the sentences that meet their intention (70%). The listening was the skill that respondents claimed to have the least problem. Still, it was found that they were unable to understand slangs, idiomatic expressions or colloquialisms (92%), unfamiliar with the accents and pronunciation (88%) and unable to catch words or conversation (68%). Later the necessities of English communication skills were investigated. In this part, respondents were requested to rate their necessities of using English in their duties. The Likert- 5 point scale was applied to gather the data and the outcomes are illustrated in Table 2.

English skills for reading reports/ corresponding via letters, the reading skills for reading handbooks and technical articles and the skills for informal or small group discussion were three necessary aspects for performing duties at the department ($\bar{x}$ = 2.58), ($\bar{x}$ = 3.08) and ($\bar{x}$ = 2.56). The fifth and eighth comments that S.D values were over than 1 were also observed. Training course on negotiation and presentation in the conference may be needed for some groups of officers (S.D. = 1.0398), and the document and e-mail composing skills may be required for some officers who deal with the international organization only (S.D. = 1.4033). From open-ended questions, the lack of opportunities to practice English was mentioned as the cause of their ineffective usage of English and there were requests for more frequent training courses in General English and English for specific purposes for staff. Officers should be encouraged to use more English in their daily lives via having a small group discussion for practicing English conversation.

Table 2 The Necessity of English Communication Skills

Necessity	Levels of necessity					$\bar{x}$	S.D.	Level of necessity
	Most	High	Moderately	Slightly	Least			
1. For reading reports and corresponding via letters	13 (26%)	10 (20%)	17 (34%)	5 (10%)	5 (10%)	2.58	1.2631	Moderately
2. For reading handbooks and technical articles	8 (16%)	5 (10%)	21 (42%)	7 (14%)	9 (18%)	3.08	1.2752	Moderately
3. For telephone conversation	6 (12%)	23 (46%)	17 (34%)	4 (8%)	0 (0%)	2.38	0.8053	Slightly
4. For informal and small group discussion	9 (18%)	13 (26%)	21 (42%)	5 (10%)	2 (4%)	2.56	1.0333	Moderately
5. For attending formal conferences	20 (40%)	14 (28%)	12 (24%)	3 (6%)	1 (2%)	2.02	1.0398	Slightly
6. For welcoming speech and presentations	25 (50%)	16 (32%)	8 (16%)	1 (2%)	0 (0%)	1.70	0.8144	Slightly
7. For recording minutes of meetings/seminar	26 (52%)	12 (24%)	11 (22%)	1 (2%)	0 (0%)	1.74	0.8762	Slightly
8. For composing official documents/ e-mails	21 (42%)	9 (18%)	10 (20%)	4 (8%)	6 (12%)	2.30	1.4033	Slightly
9. For writing reports	24 (48%)	10 (20%)	14 (28%)	2 (4%)	0 (0%)	1.88	0.9613	Slightly
10. For traveling (use at hotels and airports)	7 (14%)	18 (36%)	22 (44%)	2 (4%)	1 (2%)	2.44	0.8609	Slightly
11. For staying abroad and for socializing	27 (54%)	10 (20%)	10 (20%)	3 (6%)	0 (0%)	1.78	0.9750	Slightly
12. For taking care of foreign visitors who use English to communicate	12 (24%)	21 (42%)	15 (30%)	2 (4%)	0 (0%)	2.14	0.8332	Slightly

English is an asset for Thai workers as every respondent had shown their perceptions and expressed their intention to improve their English proficiency skills. Problems occurred by the lack of English proficiency among Thais mostly presented in the educational contexts and it is inevitably affected the learners when they go to the workforce after their graduations. Findings from this study agreed with Piamsai (2017) which conducted a needs analysis to develop different English training courses at Chulalongkorn University Language Institute (CULI) that 321 learners comprising of students, government officials and employees of private organizations expressed their needs to improve their four skills particularly in speaking for their daily activities, they also needed to have reading skill to find the main ideas and searching for the information when reading and wanted to attend English for Specific Purposes courses to improve their English for their occupations. A study conducted by Jindathai (2015) also portrayed that motivation and attitude toward English were not the cases when the Thai learners learned to speak English but what caused problems to master a speaking skill was the class management, the lack of opportunity for learners to expose to English and the learners' personality. The study from Chitpupakdi (2014) also illustrated the needs to improve English speaking and listening skills among executives in a private

company. In writing skill, findings also agreed with Malathong (2015) that grammar and language barrier were two main problems when respondents could not write as they intended to. Other findings from the survey portrayed that reading and speaking were two key skills that were needed to succeed in working at the department. Reading skill was required mainly for handling reports and corresponding via letters and to read handbooks and technical articles as the department's responsibility to deal with fishery-related researches and development and the communication with foreign institutions are mainly through the document forms. The speaking skill was needed for the informal and small group discussion. Findings also clearly illustrated the working contexts of Thai government officers in Thailand which they do not have enough opportunity to expose to English at work when everything is done in Thai. Some duties i.e. attending a formal conference abroad, releasing the welcoming speech, presenting in English, traveling and staying abroad and taking care of foreign visitors may be seen as the administrators' duties, besides, these duties that involving speaking skill are not in Thai government officers' routine in general. A study conducted by Jeharsae (2012) also portrayed that Thais employed similar communicative strategies when using English to communicate with NESs and NNESs which is rather contradicted to the reality that NESs and NNESs shared different cultures and beliefs as mentioned earlier about the high and the low contexts, English that is strictly followed the western norms and usage may not fully suitable for communicating with NNESs.

CONCLUSION

This study investigated the needs of English for communication for Thai government officers at the Department of Fisheries, Bangkok, Thailand. Findings showed that reading and speaking were required to achieve the duties at the department. Reading was used for the research and development duties and to receive the messages from the official documents in the forms of paper and email. The speaking skill was needed to fulfill a small group discussion mainly. Even though respondents had realized the importance of English in general but there were also other factors that govern their usage of English in their workplace i.e. their duties, the available training courses and their opportunity of using the language in real situations. Problems relating to speaking, reading and their concern with grammar were the key obstructions to be successful in English. The point that should be made here is to adjust their mindsets about that concentrating too much on grammar and increasing more opportunity for practicing the speaking skill. Another point is that in ELF context, the two interlocutors differ in cultures and native languages are using English as the communication tool in this regard, they must accept the fact that mistakes and miscommunication sometimes occur. Additionally, apart from English proficiency, they also need to have the cultural knowledge and ability to apply communicative strategies to communicate successfully. In terms of training arrangement for speaking, a course in English presentation and daily activities should be arranged and supported by having in-house activities e.g. knowledge sharing presentation from the officers who have experience doing the presentation in English. For listening, different varieties of English from both NESs and NNESs should be introduced in the training, trainees can familiarize and tolerate when they face with various accents. For writing, an online correspondent course needs to be arranged to help improve writing skill. In the future, a survey should be conducted to investigate the English skill that requires for each job position in the organization to provide more precise training for the government staff.

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Research article

Diffusion of Innovation in Fighting Disparities among Localities and Ethnicities: A Case Study of the Project on Food Security Improvement for Small Scale Farmers in Central Vietnam

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Abstract The purpose of this paper is to demonstrate how the reduction in poverty and improvement of food security in ethnic minority areas can be realised by the diffusion of agricultural innovation with a social networking system, established through a case study of the Project on Food Security Improvement (PFSI) for Small Scale Farmers in Central Vietnam. The project had developed and expanded the PFSI model, which consists of three components of technical, network, and monitoring submodels. The model was promoted to distribute an innovative agricultural technique of the System of Rice Intensification (SRI) method to local farmers, as well as strategic arrangements to identify talented key adopters, who are constructing effective networks among traditional minority group communities. The results of the project implementation revealed dramatic improvements in the capacity for food self-supply, by improving rice productivity with an average yield increase of 1.4 ton/ha, compared with the conventional method. Moreover, the arrangement of identifying key adopters and establishing a network system had led to further diffusion of innovation to the minority groups. The paper explains the importance of understanding the heterogeneous features of Vietnamese localities and ethnicities, pointing out how participation of minority groups can influence others in their community. The lesson learned from the case gives an important insight towards solving the issue of disparities between rural and urban, among regions, and between ethnic majorities and minorities in Vietnam, which may be hidden easily in the face of the country's recent rapid economic growth and "average" improvement of the country's social welfare.

Keywords Vietnamese ethnic minorities, food security, poverty reduction, system of rice intensification (SRI), diffusion of innovation

INTRODUCTION

Background: A Widening Gap among Localities and Ethnicities

Vietnam has experienced rapid economic growth, transforming from one of the poorest developing countries into a lower middle-income country. Vietnam has turned out to be one of the largest rice exporters in the world. Agricultural growth was accelerated in recent decades through improved land use with price liberalisation, land titling policies, irrigation, and technology adoption.

Despite the county's growth, Vietnam's rural populations continue to face challenges in overcoming income and food-security inequality. Vietnam's poorest households, in particular, are concentrated in highlands and mountainous areas. Rural villages in the upland and central region of the country even face frequent natural disasters, being vulnerable to extreme weather conditions. Vietnamese ethnic minority groups typically live in such difficult situations in mountainous areas. Vietnam has 54 ethnic groups. The Kinh or Viet (ethnic Vietnamese) is the largest group, accounting for 86% of the population, followed by the Tay, the Thai, the Muong, the Khmer (ethnic Cambodian), the Hoa (ethnic Chinese), and the Hmong, which together account for 10% of the population. The remaining 4% consists of remaining ethnic groups (Dang, 2010). It has been

reported that as much as 72% of the population of ethnic minority groups fall into the poorest three consumption deciles; 88% of ethnic minority groups fall into the lower half (50% of the population consumption distribution; General Statistical Office (GSO), 2006).

Project for Spreading the PFSI Model

Recognising the food shortage problem in the mountainous areas of central Vietnam, where most residents are classified as ethnic minorities, the Project on Food Security Improvement for Small Scale Farmers in Quang Nam Province (PFSI-1) had been implemented in the period 2012–2015, under the agreement between the Foundation for International Development/Relief (FIDR) and the Quang Nam provincial government, to establish a model to alleviate food shortages among small-scale farmers, transferring the cultivation technique known as the SRI method, targeting the three poorest mountainous districts, namely Nam Giang, Dong Giang, and Tay Giang districts in Quang Nam Province, Vietnam. After three years of project implementation, the PFSI-1 had developed the PFSI model, which was evaluated as a successful model to alleviate food shortages with the climate-smart SRI method. It received attention from local authorities and potential beneficiaries to deepen and extend the model to other areas. This paper reviews and extracts lessons learned from the project in ethnic minority communities.

OBJECTIVES

The purpose of the paper is to demonstrate how poverty reduction and improved food security in ethnic minority areas can be realised by the diffusion of agricultural innovation with a model designed to diffuse not only innovation but also strategic social arrangements to identify key adopters and to promote communication. Specifically, the paper examines elements of diffusion by describing the model design and its outcome; it explains the strategic benefits of ensuring the involvement of grassroots-level actors, who can actually influence the diffusion in their community. To do so, the paper (1) discusses the context of diffused innovation and the background of adopters, (2) states the results (i.e. how poverty and food security improved) of diffusion initiatives in the target areas, and (3) describes how key adopters functioned to diffuse innovation by analysing social aspects during the diffusion process.

METHODOLOGY

The paper follows the definition of "innovation" as stated in Rogers (2003), "an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption". In the framework of the PFSI model, the SRI method is considered as an agricultural innovation as it was perceived to be a new agricultural technique for target people of the project area.

To understand the local reality and contexts, the author conducted fieldwork, including qualitative surveys with semi-structured and structured surveys in September 2018, and collected data on rice productivity and the SRI areas from the project's monitoring data. The interviews were conducted with key adopters known as key farmers (KFs) of the project areas, project officers, and local government staffs.

CONTEXT

PFSI Model: Agricultural Innovation (SRI method), Networking, and Monitoring

The PFSI model has three critical features, namely a technical model for transferring the SRI method, a network model, and a monitoring model. The technical model is meant to increase the rice productivity for the small-scale farmers through the farmer field school, with an open-ended approach. The network model is meant to disseminate and exchange information on rice cultivation among relevant stakeholders. The monitoring model is meant to monitor the application of

techniques, surrounding environment, and impacts on households, etc., in the mountainous area. A detailed description and implementation method of each submodel is summarised in Table 1 and Figure 1. Figure 1 shows that the model is equipped with three vectors to promote project effectiveness, (i) productivity improvement to improve food security with technical transfer efforts of the SRI method with farmer field schools (FFS), (ii) further expansion of the SRI method adoption involving related stakeholders with networking people with different roles and responsibilities, and (iii) introducing the monitoring system to ensure productivity improvement and expansion. Importantly, the submodels of the PFSI model interact with each other, deepening the quality of each model and improving project effectiveness together with efficiencies.

Table 1 Key features of the PFSI model

Submodel	Description
Technical model for transferring the SRI method	• Determining the rate/proportion of the target farmers who adopted SRI, with the experience of approximately 30% of FFS registers and SRI adopters with project intervention leading to subsequent autonomic expansion. • There is no financial support, and any material is provided to farmers focusing on capacity building. • Transferring SRI techniques through (i) FFS, (ii) field tours, (iii) sharing workshops, and (iv) information-education-communication (IEC) materials.
Network model	• The purpose of networking is to exchange and share information about SRI among farmers, KFs, agricultural departments in the government sector, and stakeholders in the academic and private sectors. • With regular activities of (i) study tours, (ii) sharing workshops, and (iii) regular meetings, strategies, policies, initiatives and innovation, and any related events and information are to be shared.
Monitoring model	• Monitoring of farmers' participation, adaptation of SRI techniques and rice yield, and productivity are monitored by different levels of stakeholders, including KFs, commune agricultural staffs, district staffs, and provincial staffs, in addition to external human resources.

Source: Project Document "Model Guideline for Alleviation of Food Shortage"

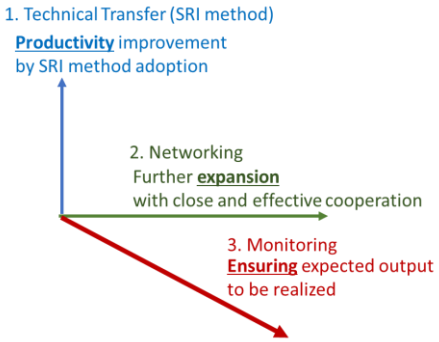

Figure 1 Function of each component of the PFSI model

Ethnic Minorities and their Agricultural Skill

Vietnam's household poverty rate fell to 7% in 2015 from 12.6% in 2011. However, the rapid economic growth of recent decades brought widening income disparity between rural and urban residents and among ethnicities. For example, the 2015 Household Living Standard Survey of the GSO indicates that the poverty rate in urban areas was 2.5%, whereas it was 9.2% in rural areas. For project areas, Table 2 gives several insights into how ethnic minority groups still have poverty rates much higher than the national poverty level. In addition, the baseline survey of 2015 (n = 180), which was conducted in Bac Tra My, Nam Tra My, and Nam Dong districts, revealed that each household uses small-scale wet-rice land (e.g. less than 1,000 m^2, approximately 2,000 m^2 per household, depending on localities) with relatively low yield. Such disparity in rice productivity was observed among localities even within the same province. Quang Nam had the highest average yield at 5.993 ton/ha in Dai Loc district (located near Da Nang city and in the lowlands). The

lowest average yield of 1.901 ton/ha was in Nam Giang district (one of the project targets, located in a mountainous and remote area), found in the Quang Nam statistic year book 2013 (Project Document "Master Plan").

Table 2 Ethnicity and poverty situation

District	Ethnicity	Poverty situation
Dong Giang	Co Tu ethnic: 63.46%; Kinh: 27.84%; Others: 0.97%	46% (2014)
Nam Giang	Ca Tu/Ko Tu, Gie, Trieng: approximately 80%	53%(2014)
Tay Giang	Ca Tu/Ko Tu: More than 90%	46% (2014)
Bac Tra My	Mainly Kinh, KaDong, Cor, etc.	50% (2014)
Nam Tra My	Mainly Ca Dong, Xe Dang, M'Nong, Cor, and Kinh	72% (2013)
Hiep Duc	Ka Dong & Mo Nong	23% (2014)
Nam Dong	Kinh: 56%; Co Tu and others: 44%	7% (2014)

Source: Project Document "Master Plan for the period from December 2015 to March 2019" and project data "General information of district" prepared from the Statistical yearbook of districts

Key Farmers (KFs) as Lead Innovation Adopters

In the PSFI-1, from the outstanding performance observed during the farmer field school, 36 KFs were identified in three districts, which were the target districts under Phase 1, namely Dong Giang, Tay Giang, and Nam Giang districts. During Phase 2 starting in 2015, the number of KFs has increased, and the certificate system to acknowledge the advanced level of KFs was introduced as 16 Level A KFs, and 182 Level B KFs were certified in 2017. By identifying KFs in the area, even without a technical transfer effort brought from outside the locality, KFs in their community or neighbouring community are able to transfer the SRI method to non-SRI adopters. By means of such KF development, empowerment of grassroots resources with internal arrangement became possible.

The SRI Method

The SRI method was first tested in Vietnam in 2002, and it has been greatly popularised in Northern Vietnam since 2007 (Inoue and Yamaji, 2011). The principles of SRI in Vietnam include: (i) transplanting young seedlings with two or three leaves, (ii) transplanting single seedlings and spacing them widely, giving them maximum access to the sun and room to grow to their full potential, (iii) managing water carefully, providing intermittent irrigation to keep the fields moist, but not continuously flooded, (iv) weeding frequently, either by hand or with mechanical weeding devices, and (v) using organic fertilisers, such as animal and plant waste, to promote the development of a healthy soil ecosystem (http://vietnamsri.wordpress.com/). SRI allows plants to grow efficiently through soil that is more fertile and to produce healthier plants with greater root growth. Although the SRI method is simple and understood as described above for practitioners, the effects with people's focus vary depending on location and characteristics of SRI evaluators. Table 3 shows how the SRI method was evaluated by different stakeholders who have their own expectations of different aspects.

Table 3 Multidimensional aspects of the SRI method

Good-match with	Effects and/or characteristics of SRI
1. Poor farmers to save input cost	Reduce amount of seeds (single seedling) – lower cost
2. Farmers to produce chemical-free/safe crop	Reduce/avoid the use of chemicals (i.e. pesticides, chemical fertilisers)
3. Farmers in disaster-prone areas (climate-change adaptation)	Healthy and strong paddy – resilient to disaster, pest and disease management
4. Farmers with less experience in rice cultivation	Increased productivity (accelerated tilling)
	Simple and flexible in SRI application rules

RESULTS

Diffusion of Agricultural Innovation and Changes in Minorities' Livelihood

Figure 2 shows the transition of the number of SRI households and total SRI areas of project sites. The figure indicates widespread diffusion in the project area. According to project monitoring data, the total number of SRI households was 1,360 in 2015, 2,222 in 2016, 2,986 in 2017, and 3,641 in 2018, a total of 10,209 households. These numbers are considered the minimum number of SRI households that the project could count within the project frames. Automatic and autonomous diffusion through people's interaction with non-project sites seems to occur, which is exactly what the model was expected to influence in the mountainous/remote areas. As the number of SRI household increases, the SRI areas also expand. The total area of SRI applied in the project areas amounted to 346.8 ha by 2018.

Regarding the change in yield owing to adoption of the SRI method, "with" and "without" data is presented in Figure 3. Figures of average rice yield in each district for the years 2015, 2016, and 2017, for SRI sites and non-SRI sites (i.e. 1 plot/district/year x 2 versions (one with SRI, and the other with non-SRI) x 7 districts x 3 years => 21 samples with SRI, and 21 samples without SRI) are compared. The average yield of the SRI sites is 5.3 ton/ha with standard deviation of 1.0 ton/ha, while the average of yield of non-SRI areas is 3.93 ton/ha with standard deviation of 0.9 ton/ha. The difference between "with" and "without" is 1.4 ton/ha, and it is statistically significant, $t = 4.73$ and $p = 0.000014$, <5%. Thus, it can be concluded the productivity of the project area was improved.

The survey conducted during fieldworks included interviews with farmers in Phu Mua village of the Dong Giang district, who have joined the project since 2013; the rice production and rice shortages were explained by farmers as summarised in Table 4. It can be understood from the interviews that farmers had to work upland to earn money for their food, and such a difficult situation became harsher because people are poorer in the remote mountainous areas. The adaptation of agricultural innovation for those people is confirmed to be very important for their livelihood reducing their cash spending, not forcing them to invest their time and labour in the upland for their subsistence.

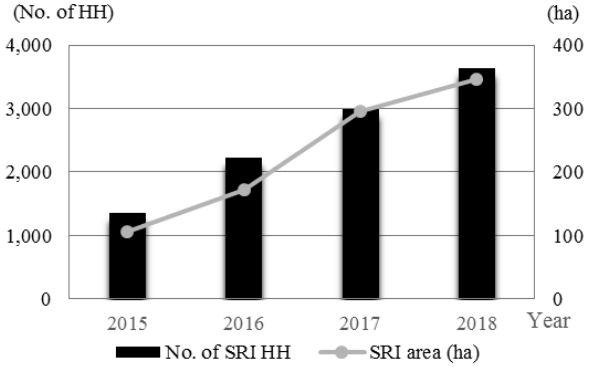

Figure 2 Number of SRI households and SRI areas of project sites

Source: Author calculation from Project Data

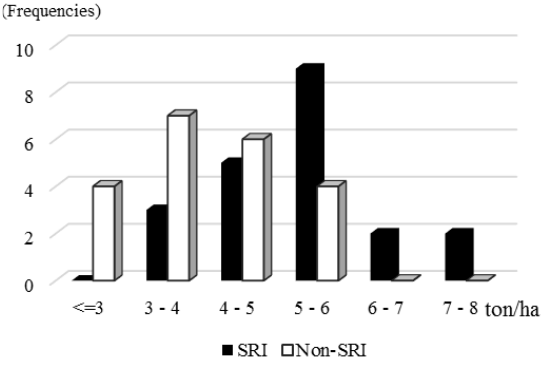

Figure 3 Rice productivity of "with" and "without" project

Source: Author calculation from Project Data

Table 4 Food security before and after

Before project	After project
• About 50% of their rice was self-supplied by rice production: volume of produced rice was 1.2 bag (1 bag = 10 kg). • The remaining 50% was bought from others. It cost 140,000 dong/bag/month x 4 bags x 10 kg/bags, spending a total of 560,000 dong/month. To earn money to finance rice purchases, farmers typically sold their labour to work upland, planting banana, acacia, casaba, etc., earning 150,000 dong/day (female), 180,000 dong/day (male). • The duration of the rice shortage was 6~10 months/year.	• Of 34 households in the village, approximately 50% of households have a sufficient level of rice available throughout the year, and the remaining 50% of households lack rice for 2–3 months. • With the SRI method, farmers can save seed cost and labour for transplanting and weeding, as they were spending much time for those activities, and traditionally not using herbicides.

Key Adopters as Social Communicators

To understand the community-specific characteristics of the target beneficiaries, two kinds of questions were asked of KFs during the survey: (i) what was the happiest moment, and (ii) what was the most difficult moment. This section describes some findings on social relations with diffusion of innovation in the target areas, by showing the survey results. The survey was conducted on three groups of key farmers in Tay Giang, Dong Giang, and Hiep Duc districts. The first group in Tay Giang consists of 12 KFs, all young females, mainly of the Co Tu ethnic minority. The second group in Dong Giang consists of 11 KFs (5 males, 6 females), mainly of the Co Tu ethnic minority of a younger generation, except one landless Kinh woman. The third group in Hiep Duc consists of 7 KFs (2 males, 5 females), Kinh senior farmers, aged 50–60, with a total sample size of n = 30. The first and second groups did not have much rice cultivation experience before the project, whereas the third group in Hiep Duc had long experience in rice cultivation, having used many agro-chemicals previously. The answers received from KFs in their happiest moment and the most difficult experience are summarised in Tables 4 and 5. Table 4 indicates that groups of ethnic minorities place a relatively higher value on others' success and the opportunity to meet others, which was not the case with Hiep Duc's KFs, who are mainly Kinh people, whereas KFs of all groups expressed their happiness when they shared knowledge with other farmers, teaching others. Such results are consistent with the nature of the Co Tu ethnic minority community, who are closely united internally and care for other members' happiness together. Also, from the interviews with Kinh KFs in Hiep Duc, farmers shared their experience of visiting mountainous areas to teach the SRI method to ethnic minorities, who had less confidence at the beginning, but later win trust from the villagers he taught. Moreover, KFs seem enthusiastic about meeting others (including government officials and visiting other regions through the study tours), which may be the indication of increased opportunities to interact with outside communities. Table 5 shows that KFs' main concerns were coming from relations with others (e.g. the difficulty of inviting other farmers to participate in the training activities). Such results indicate that they are playing an important role in connecting farmers in remote areas, leading to inclusive training opportunities, although government sectors were not so easily accessible previously.

Table 4 The happiest moment

Nature of answer	Social capital			Human-capital		Welfare
Answer	Other's success	Teaching others	Meeting others	Learning opportunity	Improved capacity	Yield & SRI merit
Tay Giang (*n* = 12)	3	3	3	4	1	4
(All women, minorities, and young)	25.0%	25.0%	25.0%	33.3%	8.3%	33.3%
Dong Giang (*n* = 11)	0	2	6	3	2	4
(Gender mixed, mostly minorities and young)	0%	18.2%	54.5%	27.3%	27.3%	36.4%
Hiep Duc (*n* = 7)	0	3	0	0	1	5
(Gender mixed, Kinh, relatively older)	0%	42.8%	0%	0%	14.3%	71.4%

Table 5 The most difficult moment

Nature of answer	Social capital	Human capital	Others	
Answer	Relation with others	Own mind and attitude related	Pests and natural conditions	Others
Tay Giang (*n* = 12)	5	0	5	1
(All women, minorities, and young)	41.7%	0%	41.7%	8.3%
Dong Giang (*n* = 11)	5	4	1	5
(Gender mixed, mostly minorities and the young)	45.5%	36.4%	9.1%	45.5%
Hiep Duc (*n* = 7)	3	2	0	1
(Gender mixed, Kinh, relatively older)	42.9%	28.6%	0%	14.3%

DISCUSSION AND CONCLUSION

The review of the components and functions of the PFSI model, together with its results, reminds us that (1) ethnic minorities have the potential to improve their food shortages by adopting agricultural innovation (even if innovative methods for minority groups may not be new to ethnic majorities), saving their time and cost to work upland for their subsistence; and (2) minorities themselves can play an important role in influencing their community, improving communication within minority communities.

Vietnam is now the world's leading rice producer, and often, Vietnamese farmers are rich in their rice production experience. However, such a perception is based on stereotypes formed from the performance of ethnic majorities, which strongly influences the country's average agricultural output; however, this study indicated that some groups are still not familiar with cultivation techniques, because they typically lived upland in mountainous areas and were not used to practising farming in the wet-land. Recognising such minority people's characteristics and potential for diffusion of agricultural innovation, it is meaningful to conduct a project to diffuse such agricultural innovation.

In addition to such an effort to diffuse agricultural innovation, we should reconsider why such initiatives were not possible in the past. The areas where minorities live are typically located in remote areas, where it is difficult for government and/or private sectors to reach them. Also, a socio-cultural barrier stood in the way of connecting with minorities, because their culture is unique and difficult for the majority to understand. Under such conditions, the identification of KFs from their community or neighbouring communities allowed the project to bring innovation more easily via KFs, who played an important role in communicating with minorities, leading to further diffusion of agricultural innovation through the establishment of faster communication channels.

In conclusion, the paper described how poverty and food security of ethnic minorities in the remote and mountainous areas in central Vietnam were improved by providing data and experience of the PFSI model. The lessons learned from the case provide important insights towards solving growing concerns about disparities among ethnicities and localities in Vietnam; the heterogeneous features of Vietnamese localities should be recognised, with more participation from ethnic groups to be enforced in the effort to fight the disparities among localities and ethnicities.

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Research article

Repayment Performance in Group Lending: The Case of BRAC in Tanzania

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Abstract Tanzania is a low-income country, with a high proportion of its population below the poverty line. Like most developing countries, access to financial services from formal microfinance institutions (MFIs) is limited. Recently, however, access to financial services in both rural and urban areas has increased, with group lending programs playing a significant role in this transformation. To assess the repayment performance of group lending programs, this study highlights the case of BRAC Tanzania, a leading non-governmental organization. Primary data were collected through questionnaires administered to 177 members of ten randomly selected groups and interviews with BRAC Tanzania officials, whereas secondary data were obtained from BRAC Tanzania reports and other documents. Repayment performance is measured by the proportion of the portfolio that is overdue (arrears), the proportion of the portfolio that is overdue by 30 days or more (portfolio at risk), and the percentage of the loan portfolio that is written off. The results indicate remarkably low levels of arrears, portfolio at risk, and write-offs, implying high repayment performance. This success reflects good institutional design, such as frequent client visits, frequent repayment schedules, and a strict loan approval process. In addition, from the member side, this success is owing to several factors such as sanctions, contributions by other group members, and the protection of future access to credit.

Keywords repayment performance, group lending, Tanzania, BRAC Tanzania

INTRODUCTION

The lack of access to credit from formal microfinance institutions (MFIs), is one of the major obstacles faced by developing countries such as Tanzania (World Bank, 2014). However, semi-formal MFIs, including non-governmental organizations (NGOs), significantly contribute to the microfinance sector in the country. They offer small, collateral-free loans with group lending. Group lending generally refers to arrangements made by individuals without collateral, who get together and form groups to obtain loans from the lender (Armendariz and Morduch, 2010). It is cited as an innovation to overcome imperfect information in financial markets by addressing four main problems: adverse selection, moral hazard, monitoring, and enforcement (Besley and Coate, 1995; Ghatak and Guinnane, 1999).

One of the issues extensively discussed in group lending programs is repayment performance (Sharma and Zeller 1997; Wenner 1995; Hill and Sarangi, 2012). Repayment of loans is an important measure for the success and sustainability of these programs. Some group lending programs, such as those of Grameen Bank and BancoSol, have shown great success, achieving high repayment rates. However, this does not imply that repayment rates are uniformly high for all

institutions. Yang (2012) pointed out that in some areas of China, default rates of group loans has reached 50%. This study analyzes the repayment performance of group loans, referring to the case of BRAC Tanzania, one of the largest microfinance NGOs operating since 2006. It is a replica of BRAC, one of the world's largest NGOs, which originated in Bangladesh. The contents of the group lending programs in both countries are similar. For example, both programs target rural women and provide small loans (under 120 USD). They have weekly meetings, and weekly payments are made in groups. A big difference between the two lending programs is that BRAC Bangladesh offers saving services, unlike BRAC Tanzania. This is because NGO MFIs in Tanzania are not allowed to accept saving deposits.

OBJECTIVE

This study focuses on BRAC Tanzania's Microfinance Program (MF), the most important and oldest among the organization's programs. The objectives are to understand the functions of the group and assess the repayment performance of the microfinance program.

METHODOLOGY

A field survey was conducted from December 2017 to April 2018 in the Arusha region (shown in Fig. 1). It is one of the 30 administrative regions located in the northeastern part of the country. According to the 2012 census data, the region had a population of 1.7 million people, with 67% living in rural areas, and 33% in urban areas. The majority of residents work in farming (38%), and raising livestock comes in second place (16%) (NBS, 2016). The region is economically important to the nation in terms of GDP per capita. Its contribution to the country's GDP in 2012 was 4.8%, the seventh-largest contributor (UNDP, 2015). It is also a well-known hotspot for NGOs that operate in various fields, including microfinance. At the time of the survey, there were fifteen BRAC Tanzania branches in the region. The number of groups and members was 992 and 19,109, respectively (Survey, 2018).

Fig. 1 Location of Arusha Region in Tanzania

This study uses both primary and secondary data. The primary data were obtained through interviews with key informants of BRAC Tanzania, including a microfinance program manager, the Arusha regional manager, branch managers, and community organizers (commonly known as credit officers). The group member survey questionnaires were administered to 177 members of ten

randomly selected groups. Several questions were asked regarding socioeconomic characteristics, loan amounts, loan purposes, and repayment performance. Secondary data were obtained from BRAC Tanzania's headquarters, regional, and branch offices. These include trend reports and group members' general information.

In this study, the data were analyzed descriptively, and financial ratios were applied for the evaluation of repayment performance. These ratios include the arrears rate, portfolio at risk, and the write-off ratio.

RESULTS AND DISCUSSION

BRAC Tanzania Group Lending Programs

At the time of the survey, five group lending programs were operating in BRAC Tanzania: Microfinance Program (MF), Empowerment and Livelihood for Adolescents (ELA), Adolescents Development Program (ADP), Agrifinance, and *Pembejeo* (agriculture inputs). Most programs target women in rural areas and have common features regarding the lack of need for collateral, interest rate setting, frequency of repayments, and the length of the loan. The three programs namely, MF, ELA, and ADP, target women from two age groups. MF targets women aged 18–65, while ELA and ADP target younger women aged 18–25. The remaining two programs target farmers. Agrifinance targets maize and poultry farmers, and *Pembejeo* targets maize farmers. Table 1 shows the characteristics of these group lending programs.

Table 1 Characteristics of BRAC Tanzania group lending programs

	MF	ELA	ADP	Agrifinance	*Pembejeo*
Year started	2006	2012	2012	2014	2016
Collateral needed?	no	no	no	no	no
Target clients	women	women	women	farmers	farmers
Repayment schedule	weekly	weekly	weekly	monthly	monthly
Number of branches	138	8	22	43	2
Total number of members	193,648	2,646	6,590	23,016	160
Rural Borrowers	130,207	1,190	4,193	15,944	113
Urban Borrowers	20,679	764	624	2,982	0
Total number of borrowers	150,886	1,954	4,817	18,926	113
Minimum loan size (Tshs)	250,000	200,000	200,000	200,000	200,000
Maximum loan size (Tshs)	5,000,000	2,500,000	2,500,000	2,500,000	2,500,000

Source: Field survey, 2018

Notes. (1) 1USD was equivalent 2240 Tanzania shillings (Tshs) at the time of the survey. (2) Pembejeo is a Swahili word which means agriculture inputs. This is a pilot program which is planned to be implemented after it is successful. (3) All the data on the number of branches, members and borrowers are as of January 2018.

Group Formation and Peer Selection

Groups are formed after research is conducted by community organizers in the targeted area. The research aims to identify eligible community members. Interested individuals are instructed to form groups according to geographical location (i.e., neighbors or people who live in the same community). The eligibility criteria are as follows: (i) must be female, (ii) in rural areas, the applicant has to remain a permanent resident while in urban areas and have had residency in the area for at least three years, and (iii) willing to be committed to BRAC Tanzania's principles, such as attending weekly meetings, on-time repayment, admission fees payment, etc. Groups start with 20–30 members when they are formed. However, some grow in size when new members are admitted. Others shrink due to dropouts. For example, the minimum and maximum for the surveyed groups were 8 and 38 members, respectively. Based on observations during the survey, there were several groups with over 40 members.

Most members of the surveyed groups were absent during the initial group formation. The current members joined after the formation of the group, and most of the initial members left the

program. New members can join the group through a recommendation or introduction from a current member. The most important criteria for selecting new members is simply whether current members know the person well. If a woman lives in the same place, works in the same place, conducts the same business, or has a close relationship with current members, then there probably is no obstacle to joining the group. Of course, there are some people wanting to join the group that get rejected. The survey indicates that all groups revealed cases of peer screening. On average, about three individuals per group were rejected for various reasons, such as they were not well-known by other members, did not conduct any business that could guarantee repayment, or had a record of not paying debts in the village.

Characteristics of the Group Members and Loans Based on Field Survey

According to the group members survey, the member's average age was 40 years old and had completed primary education. Members reported an average household size of four, with two working household members. Business (68.5%) and agriculture (13.5%) were the main occupations. The businesses conducted by most members involved selling banana (plantain), fruits, and vegetables. Half of the respondents (50.8%) had multiple occupations.

The maximum loan size obtained by members of surveyed groups was 982 USD, with an average of 375 USD. 10% of the loan is usually deducted during disbursement as a loan security deposit; however, this is refundable after the full repayment of the loan. These loans are progressive, meaning successful loan repayment gives access to another loan. Furthermore, BRAC Tanzania provides individual loans through its small enterprise program (SEP) for members who need bigger loans for their businesses.

All loans are short-term and repaid on a weekly basis. As shown in Table, 2 most members had 40 week loans (83.6%). The lending interest rate for 20 and 40 week loans is 13% and 25%, respectively. Members reported various purposes for the loans, including purchasing stocks for retail businesses, such as vegetables, fruits, grains, and so on (38.5%), education expenditure (20.6%), and construction (17.9%).

Table 2 Loan term and purpose

	Frequency	Percent
Loan term		
20 weeks	54	16.4
40 weeks	276	83.6
Total	330	100.0
Loan use (Loans from BRAC Tanzania only)		
Purchasing stocks for retailing businesses	127	38.5
Purchasing livestock	16	4.9
Purchasing land	16	4.9
Purchasing motorcycle	4	1.2
Crop production	15	4.6
Construction	59	17.9
Education expenditure (school fees)	68	20.6
Others	25	7.6
Total	330	100.0

Source: Field survey, 2018 Note: Group members were asked information of the two latest loans.

Repayment Performance of BRAC Tanzania's Microfinance Program

Before discussing repayment performance, it is important to understand the loan classifications since the definitions differ from one institution to another. According to BRAC Tanzania, loans are classified as either current or overdue. Current loans are those paid on maturity due dates or not yet due. Loans are overdue when one or more installments (i.e., both principal and interest) have not been paid on time. "On time" in this context refers to the exact date as stipulated in the loan agreement given to the member at the time of disbursement. Overdue loans are classified as current

payment missed, late loans, and non-interest-bearing loans (NIBL). Late loans are further classified as "late one" and "late two." Loans will be considered as late one after remaining unpaid for six months. After that, it will be considered as late two for the next period of six months. A penalty of 3% of the unpaid amount (principal and interest) is charged monthly for late loans. After late two, overdue loans are considered as NIBL, and no interest is charged on these loans. After being NIBL, the loan can be submitted for write-off. Apart from that, any loan can be written-off due to death or any other disaster affecting the livelihood of the member.

Repayment performance, in this study, is measured by the proportion of the portfolio that is overdue (arrears), the proportion of the portfolio that is overdue by over 30 days (portfolio at risk), and the percentage of the loan portfolio that is written-off. For the group members, repayment performance is measured as the percentage of members with any repayment delays or defaults. It is important to mention that in 2016, BRAC Tanzania followed the lead of many microlenders, such as BancoSol and Grameen Bank, by converting to individual liability. By removing group liability, no member is held liable for another member's repayment. According to interviews with BRAC Tanzania officials, the reason for this change is to avoid the dropout of good clients.

The average of all three ratios used in the analysis of repayment performance as shown in Table 3 were less than 5%. In the case of group members, there was a delay in only three loans, which represents 0.9% of the total loans, and no defaults. Even though the average repayment performance of the Arusha region is lower compared to the national average, it is still regarded as good. According to Stauffenberg and Jansson (2003), any portfolio at risk (PAR30) figure exceeding 10% should be cause for concern, and in this case, all PAR30 are below 10%.

Table 3 Repayment performance

	2010	2011	2012	2013	2014	2015	2016	2017
BRAC Tanzania (all regions)								
Arrear rate (%)	3.5	0.9	1.6	1.5	0.4	0.2	0.6	1.2
PAR30 (%)	3.3	1.0	1.9	1.4	0.4	0.2	0.7	1.2
Write-off ratio (%)	2.0	2.0	1.5	1.7	1.3	0.5	0.3	0.5
Arusha region								
Arrear rate (%)	N.A.	3.7	4.7	9.1	5.3	0.6	0.3	2.8
PAR30 (%)	N.A.	4.8	4.9	9.6	4.9	0.5	0.4	3.2
Write-off ratio (%)	N.A.	1.5	2.2	0	4.3	0.3	0.2	0.4
Group members(177members)	frequency		percentage					
Any delay in repayment	3		0.9					
No delay in repayment	327		99.1					
Default	0		0					
Total	330		100					

Source: Author computation based on secondary and field survey data, 2018

Notes (1) Arrear rate is the ratio of overdue loan to the total outstanding (2) Portfolio at risk refers to outstanding balance of all loans that have an amount overdue in this case the amount overdue over 30 days is used (3) Write off ratio represents the loans that the institution has removed from its books because of a substantial doubt that they will be recovered and is computed as amount written off over outstanding loan. (4) N.A. means data were not available.

Factors that Determine Repayment Performance

According to findings of this study, repayment performance is determined by both institutional and group-based factors. For institutional side, repayment performance depends on following three factors.

(i) Frequent client visit: BRAC Tanzania staff visit clients once a week to ensure on-time weekly collections; in case of any problems related to repayment, they are to be resolved as soon as possible. In their study of group lending programs in Eritrea, Hermes et al. (2005) found that regular visits by the group leader reduced the probability of moral hazard. Despite the fact that in their study the frequency of visits was tested for the group leader and not the microfinance staff, it still showed the role of frequent client visits. In contrast, Wenner (1995), in a study of FINCA's group credit program in Costa Rica, found that the number of FINCA extension visits was

positively correlated with delinquency, indicating that FINCA may sense that a group is in trouble and attempt to visit more often.

(ii) Weekly repayment: The weekly repayment schedule implemented by BRAC Tanzania makes it easier for group members to repay in small installments. Weekly collection of repayment installments by bank personnel is one of the key features of microfinance that is believed to reduce default risk in the absence of collateral and make lending to the poor viable (Field and Pande, 2008). When BRAC in Bangladesh experimented with moving from weekly repayments to biweekly repayments, delinquencies rose, and BRAC quickly retreated to its weekly scheme (Armendariz and Morduch, 2010). In the interviews with BRAC Tanzania officials during the survey, the officials reported that BRAC Tanzania also implemented the biweekly repayment schedule in some of its branches, but the results were not impressive.

(iii) Strict loan approval process: BRAC Tanzania staff approves new loans by visiting the business or home to confirm the presence of income-generating activities. The staff visit prior to loan approval ensures the borrower's creditworthiness. For example, one microlender in Russia relies heavily on staff visits to applicant homes and businesses, rather than just on business documents (Zeitinger, 1996). In addition, for BRAC Tanzania, larger loans, from 760 USD to 2,231 USD, are approved by top management, such as regional managers and senior regional managers.

On the group side, there are three approaches used by group members to ensure high repayment performance.

(i) Sanctions: This approach includes the exclusion of defaulters. Although the results from the group members' survey show no defaults, this does not imply that default does not occur. Defaults happen, but the defaulting members are always excluded. This exclusion of defaulting members was observed in six groups. In addition to exclusion, there are cases where members sold the defaulter's physical assets to get money to repay the amount. During the survey, one group reported selling the defaulter's mattress to repay the unpaid amount. Field studies in Burkina Faso indicate that repayment rates are high because peer pressure is carried to extremes and has even resulted in the forced sales of household items in order to recover the loan amount (World Bank, 1997). Similar results were found by Ahlin and Townsend (2007) and Hill and Sarangi (2012), which show that greater pressure among group members reduces the number of days for late payments.

(ii) Members' contributions: Joint liability is officially not used in BRAC Tanzania anymore, but some form of joint liability still exists in groups. Members still have to contribute to the repayments of other members. In some cases, contributions are voluntary, where members help other members repay hoping they will be helped in turn when in need. In some cases, BRAC Tanzania staff forces members to contribute for those who have delayed or defaulted. During the survey, it was common to hear the community organizers saying that a meeting cannot end until all the money is paid, or they could not take merely half the money to the office. Such statements force members to contribute for others to finish the meetings and go on with their activities. There was also a case where a member took out a loan to repay for a member who had defaulted and run away. The question of joint liability or individual liability still has mixed results in the empirical research. Giné and Karlan (2014), through two experiments in the Philippines, found that removing group liability did not affect repayment rates. Utilizing the exogenous shift from individual to joint liability lending by a microfinance organization in Pakistan, Mahmud (2015) found a significant improvement in borrower discipline.

(iii) Protection of future access to credit: In order to get access to loans in the future, members must maintain a good repayment record. Group members cannot obtain a new loan if there is any default in a previous loan. As MFI loans are not backed by collateral, the client's main motivation for repaying is their expectation of future loans from the MFI if they repay promptly (Field and Pande, 2008). When members were asked if they want access to loans in the future, all members responded that they wished to borrow in the future. Loss of future access to credit is often cited as an explanation for high rates of loan repayment (Churchill, 1999).

CONCLUSION

This study uses primary and secondary data to discuss the repayment performance of the BRAC Tanzania group lending program, one of the largest group lending programs in the country. High repayment performance is important for the sustainability of group lending programs. A variety of measures like arrears, portfolio at risk, and write-offs were used for the analysis. Results show a low level of arrears, low portfolio at risk, and fewer write-offs, implying high repayment performance. The members of the surveyed groups represent the best-performing groups in the study area with no defaults and very few delays.

From the institutional side, this success reflects elements of good institutional design such as frequent client visits, a frequent repayment schedule, and strict loan approval processes. On the member side, this success is because of sanctions by other group members, contributions by other group members, and the protection of future access to credit. However, group members face challenges despite the good loan recovery. In some cases, they are forced to contribute for other members in cases of delays or defaults. If this continues, it can lead to a drop-off of the good members. The factors for good repayment performance of BRAC Tanzania described here cannot be directly replicated in other areas. What works for BRAC Tanzania might not work in other areas. For that reason, this study recommends that institutions wanting to replicate these factors should conduct research or trial experiments before applying them in their local contexts.

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Research article

Effects of Vermicompost and Rice Husk Ash on the Change of Soil Chemical Properties and the Growth of Rice in Salt Affected Area

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Abstract Soil rehabilitation is needed for salt affected area which is the problem of soil in wide world. Salt affected areas damage agriculture production and soil fertility. The objective of this research was to study the effects of vermicompost and rice husk ash on the change of soil electrical conductivity (EC) and the growth of rice in salt affected area in Khon Kaen, Thailand. The experiment plan was randomize complete block design 4 treatments with 3 replications 1) saline soil 2) saline soil+rice husk ash (rate 1000 kg per Rai) 3) saline soil+vermicompost (rate 1000 kg per Rai) 4) saline soil+vermicompost and rice husk ash (rate 1000 kg per Rai for both), and used two rice varieties (KMDL 105 and Rice berry). The results found that EC was lowest in the treatment mixed with vermicompost and rice husk ash followed by mixed with rice husk ash and mixed with vermicompost, respectively. The rice tillers number and height were found higher in the treatment mixed with vermicompost and rice husk ash followed by mixed with rice husk ash and mixed with vermicompost, respectively. The results of this study concluded that using vermicompost and rice husk ash helped reducing EC and increasing the rice's growth in salt affected area.

Keywords salt affected area, vermicompost, rice husk ash, rice production

INTRODUCTION

Soil degradation resulting from salinity is a major obstacle to the optimal utilization of land resources. Salt-affected soils are widely distributed thought the world, with around 20% of the world's cultivated land affected (Summer, 2000). In the Northeast of Thailand, an area of 17.81 million hectares or about 17 percent of the region faces this problem. The soil in the Northeast has a low fertility rate due to the dry weather. The nature of the soil in the area has been caused by salt bearing rock underground Due to the corrosion, decay, and disintegration of rocks, the salt is dissolved in groundwater and is extracted. When the water evaporates at a tremendous rate, salt dissolved in the groundwater moves up to the surface through a small gap. Concentration of salt increases on the surface (Topark-ngarm, 2006) resulting in the clay particles sticking together. The soil becomes dense, plant nutrient uptake is less thus needing more water. Soil salinity has become a serious threat to crop productivity, especially rice productivity.

At present, we have developed a solution by focusing on reducing salinity and increasing soil fertility. In order to increase the yield of crops and to increase the fertility of the soil, an effective method has been discovered and that is the use of compost and vermicompost soil because the vermicompost contains nutrients and organic compounds that are useful for plants. The decomposition process of the earthworm itself possesses their ability to thrive. Which is used to condition the soil (Iwai et al., 2011). In addition, (Singh, 2017) has reported using rice husk ash can absorbent sodium chloride in water.

Jatorongcakul et al. (1985), studied about using organic matter (rice husk) for recover saline soil found that using rice husk rate 1,000 kg/rai mixed with chemical fertilizer highest rice production and profit. Demonstrator was objective to study the effected of using vermicompost combine rice husk ash for rehabilitation saline soil and growing rice by experimental design in pot and field to find the way to used vermicompost and rice husk ash for sustainable developed.

Vermitechnology has been developed as a means of using earthworm changing wastes into value-added products which can be utilized for improving soil structure and fertility. Agro wastes could effectively be tapped for resource recovery through vermicomposting technology to produce a product for use in land rehabilitation. Adding compost or vermicompost to soils can help to replenish soil organic carbon which can help to improve soil health and promote further primary productivity (Iwai et al., 2010; 2011; Lal, 2004;).

Earthworms are known to have beneficial effects on the physical, chemical and biological properties of soils, and thereby contribute to increased plant growth and crop yield in both natural and managed ecosystem (Edwards and Bohlen, 1996; Edwards, 1998). Their beneficial effects have been attributed to improvements in soil properties and structure, greater availability of mineral nutrients to plants (Gilot, 1997), and enhanced microbial populations and activity, thereby producing biologically active metabolites such as plant growth regulators (Doube et al., 1997).

Iwai and Kruapukdee (2017) had conducted the research on using vermitechnology in soil rehabilitation for rice production in plot experiment and rice (Pathumthani 1), the result showed vermitechnology could increase rice production. Therefore, this research aimed to study of using vermicompost combine rice husk ash in the field condition.

OBJECTIVE

To study the possibility of using vermicompost and rice husk ash in rehabilitation salt affected area for growing rice and the effect of vermicompost and rice husk ash amendment on changing soil quality (EC and pH) and the effect of vermicompost and rice husk ash amendment on the growth of two varieties of rice (KDML 105 and Rice berry).

METHODOLOGY

Study Area

The study area location was Hua-Bung village, Ban-Phai district, Khon Kaen province. Electrical conductivity (EC) and salt distribution in salt-affected area were surveyed by EM 38 machine, for collecting data and decision to experimental design.

Experimental Design

Field experiment

The experiment design was randomized complete block design (RCBD) include 8 treatments and 3 replications

- Saline soil plot and growing KDML 105
- Saline soil mixed with rice husk ash plot and growing KDML 105
- Saline soil mixed with vermicompost plot and growing KDML 105

- Saline soil mixed with vermicompost and rice husk ash plot and growing KDML 105
- Saline soil control plot and growing Rice berry
- Saline soil mixed with rice husk ash plot and growing Rice berry
- Saline soil mixed with vermicompost plot and growing Rice berry
- Saline soil mixed with vermicompost and rice husk ash plot and growing Rice berry

Plant Data Collection

The growth and rice production were measured.

Soil Analyses

Soil sample were collected at a depth 0-15 cm. from each pot and plot between 30 day and 60 day after growing rice. The soil samples were analyzed for soil physical and chemical properties at the laboratory of the Land Resources and Environment section, Faculty of Agriculture, Khon Kaen University. Soil texture was determined by a hydrometer (Bouyoucos, 1951). Soil pH was determined in a 1:2.5 soil to water solution by a pH meter. Electrical conductivity (ECe) in saturated paste extracts was measured following the method described by the United States Department of Agriculture (USDA, 1954).

Statistical Analysis

The data collected were analyzed statistically using analysis of variance (ANOVA) techniques. Treatment means were compared by the Least Significant Difference (LSD) method at the 5% level. All data analysis was done using Statistix 10 (Analytical Software, 2013).

RESULTS AND DISCUSSION

The result found that vermicompost and rice husk ash could reduce electrical conductivity after filled it in saline soil when compare with control, saline soil added vermicompost mixed with rice husk ash rate 1,000 kg per Rai can significantly reduce electrical conductivity in saline paddy soil. The rice growths of both varieties were increased by vermicompost and rice husk ash especially tillers per clump of Rice berry. However, Height of rice two varieties are non-significant that mean vermicompost and rice husk ash weren't enhance stalk stretching whereas could increase tillers of rice and the results were similar to Singh et al (2017) found rice husk ash can absorbent Na^+. Accordingly, above result using vermicompost and rice husk ash could apply to beneficial to organic agriculture or sustainable agriculture for conservation ecosystem and fertility of soil.

Table 1 Results of vermicompost and rice husk ash on electrical conductivity and KDML 105 growth in saline paddy soil

treatment	EC (dS/m)	Tillers/clump	Height
Saline soil	2.93a	3.67c	88.55a
Saline soil add rice husk ash (RHA)	2.04b	6.00a	91.02a
Saline soil add vermicompost (VC)	2.06b	4.33bc	86.07a
Saline soil add VC + RHA	2.07b	5.67ab	88.97a
f-test	**	*	ns
CV %	4.66	13.98	7.72

Note: Values are mean ± standard deviation. Means with the same letter in the same column are not significantly different (P>0.05)

Table 2 Results of vermicompost and rice husk ash on electrical conductivity and Rice berry growth in saline paddy soil

treatment	EC (dS/m)	Tillers/clump	Height
Saline soil	2.93a	3.33c	90.83b
Saline soil add rice husk ash (RHA)	1.99b	5.67ab	96.03a
Saline soil add vermicompost (VC)	2.00b	5.33b	93.33ab
Saline soil add VC + RHA	2.07b	6.67a	97.87a
f-test	**	**	ns
CV %	5.63	12.70	2.47

Note: Values are mean ± standard deviation. Means with the same letter in the same column are not significantly different (P>0.05)

CONCLUSION

The data of soil analysis showed the using vermicompost combined with rice husk ash could reduce electrical conductivity in saline paddy soil. Saline soil adds vermicompost combine rice husk ash significantly reduced electrical conductivity and increased tillers per clump of both rice varieties. The results showed saline soil add rice husk ash could reduce the most electrical conductivity and saline soil added with VC + RHA could increase the most tillers per clump and height. This research results were similar to Xu et. al., (2016) that found out vermicompost could improves the physiological and biochemical responses of blessed thistle and peppermint. Furthermore, vermicompost could increase exchangeable K^+, Ca^{2+} and Mg^{2+} in soil.

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Research article

Changes in Physical Characteristics of Bamboo in Response to Its Degradation in Water and Soil Environments

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Abstract The utilization rate of bamboo in Japan is still very low, leading to the formation of abandoned bamboo forests. To reduce the area of abandoned bamboo forests, the use of bamboo as a construction material has been gaining attention in recent years. To use bamboo as a construction material, its physical characteristics (e.g., bending and compressive strengths) and chemical (e.g., degradation and organic matter) characteristics must be understood. Previously, the compressive strength and degradation of bamboo had been reported. To the best of our knowledge, the relation between the physical and chemical characteristics is still unclear. The first objective of this study is to clarify the degradation characteristics of bamboo in water and soil environments. Another objective of the study is to examine changes in the physical characteristics of bamboo, i.e., compressive strength, in response to its degradation in water and soil environments. Regarding the experiments performed in the laboratory, the bamboo samples with and without creosote oil treatment were placed in deionized water, soil, and ultraviolet light environments. Then, the temporal changes in mass loss on ignition, water content, and compressive strength of each sample were examined. Soil organisms were observed at the end of the experiments. The degradation of bamboo seemed to be higher in soil and UV light environments compared with its degradation in deionized water. Soil organisms and the destruction of cell walls of bamboo due to UV light may partly contribute to the higher degradation of bamboo in soil and UV light environments. It is noteworthy that the compressive strength seemed to decrease with the bamboo degradation. Fortunately, treating bamboo with creosote oil could reduce the rate of reduction in compressive strength of bamboo due to degradation. From the observation made on soil organisms, bamboo degradation could activate heterotrophic bacteria in soils, and treating bamboo with creosote oil had no negative effects on soil organisms.

Keywords Bamboo, degradation, loss on ignition, compressive strength, soil organisms

INTRODUCTION

Although bamboo has been used in many different fields in Japan, the utilization rate of bamboo is still very low, leading to the formation of abandoned bamboo forests. According to a report by the Forestry Agency of Japan, bamboo forest area was approximately 1600 km^2 in 2007, which was 10% greater than in 1981. This bamboo forest area covered approximately 0.6% of the total forest area in Japan. However, 66% of the total bamboo forest area was unused. To reduce the area of abandoned bamboo forests, many countermeasures have been proposed for increasing the utilization rate of bamboo. Previously, bamboo was primarily used as a material for construction and household furniture. In recent years, bamboo has been used as a fertilizer in agriculture (Cui and Wu, 2010; Liu et al., 2014), and as an absorbent for contaminant removal (Liu et al., 2012; Mohamed et al., 2015).

It is noteworthy that when using bamboo as a construction material, the physical (e.g., compressive strength) and chemical (e.g., the degradation of organic matter) characteristics must be

understood. Many studies have focused on the compression, tension, shear, and flexural strength of bamboo under different treatments (Sharma et al., 2015; Penellum et al., 2018). Because bamboo is an organic material, the degradation of bamboo produces organic acids, phenolic compounds, and heterocyclic compounds (Huo et al. 2016). Therefore, degradation of bamboo has been extensively studied (Xiao et al., 2014).

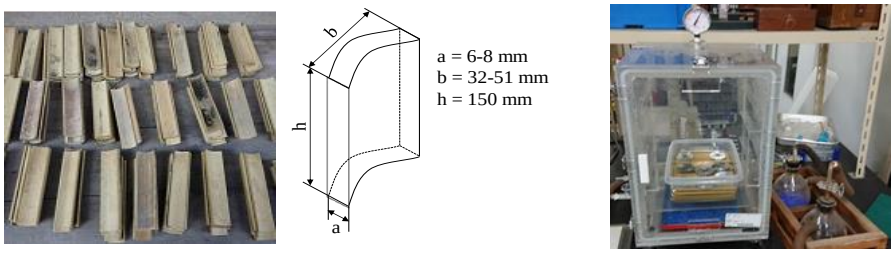
To date, degradation and physical characteristics of bamboo have been examined separately. To the best of our knowledge, changes in the physical characteristics of bamboo owing to its degradation have not yet been reported in the literature. When bamboo is used as a construction material in soil and water environments, understanding the relation between the physical and the degradation characteristics of bamboo is very important. Hence, the first objective of this study is to examine bamboo degradation in soil and water environments. The second objective is to evaluate changes in the compressive strength of bamboo owing to its degradation. In previous studies (Wang et al., 2012; Jessada, 2014), it has been reported that bamboo vinegar influences bacterial communities. Thus, the final objective of this study is to examine the effects of bamboo degradation in soil environment on soil organisms.

OBJECTIVE

To examine the points as follows: 1) degradation of bamboo in soil and water environments; 2) the changes in the compressive strength of bamboo owing to its degradation; and 3) the effects of bamboo degradation on soil organisms.

METHODOLOGY

Bamboo Used for the Experiments



(a) Bamboo specimens (b) Creosote oil treatment

Fig. 1 Bamboo specimens and creosote oil treatment (JIS A 9002)

Bamboo (*Phyllostachys bambusoides*) sample used for the experiments was cut from a bamboo forest located in Kozaki-Machi (Chiba Prefecture, Japan). The bamboo was cut into several pieces of 150 mm in height each to make the bamboo specimens used for the experiments as shown in Fig. 1a. Two kinds of specimens were prepared, i.e., those with and those without creosote oil treatment (JIS A 9002). During the creosote oil treatment, the specimens were placed in a container filled with 800 mL of creosote oil (Fig. 1b). Then, the container was placed in AS ONE vacuum desiccator (VLH). To enhance the penetration of creosote oil into the bamboo specimens, the desiccator pressure was decreased to approximately 40 kPa for 5 h. This process for pressure decrease was performed in duplicate repetition.

Experimental Procedures and Measurements

The bamboo specimens with and without creosote oil treatment were placed in different containers (360 mm × 510 mm × 290 mm) that contained black soil (Emata, Kurotuti) and deionized water.

(a) Black soil environment (b) Deionized water environment (c) Ultraviolet light environment

Fig. 2 Bamboo specimens with/without creosote oil treatment in different environments

(a) Specimen species (b) Compressive strength measurement

Fig. 3 Specimen species for water content, LOI, and compressive strength measurement

Furthermore, the specimens were placed in a plate and kept under ultraviolet (UV) light (AS ONE, TY-33N) environment, as shown in Fig. 2c. When using black soil, the outer side of the bamboo specimen was made to get in contact with soil. The inner side of the bamboo was exposed to either air or UV light. When using deionized water, the specimens was submerged in water.

At the 1st, 2nd, 3rd, and 4th week after starting the experiments, some specimens were taken out from each container to measure mass loss on ignition (LOI), compressive strength, and water content. Each specimen was sliced into small pieces (Fig. 3a) and heated at 100°C for 24 h (Advantec, FS-605) to measure water content; the specimen was also heated at 800°C for 1 h (Advantec, KL-420) to measure LOI. The compressive strength was measured using an unconfined compression apparatus (Maruto, S56A) based on JIS Z 2101 (Fig. 3b).

On week 4 after starting the experiments, soil organisms were observed using the colony count method. Briefly, 1 g of surface soil was randomly extracted from the container, and it was then mixed with 100 mL of deionized water. The mixed sample was filtrated using 1.2 μm-membrane (Whatman, GF/C). The colony count plates (3M Health Care, Petrifilm™ Aqua 6457 for coliform bacteria, Petrifilm™ Aqua 6450 for heterotrophic bacteria, and Petrifilm™ Aqua 6408 for yeast and mold) were made to get in contact with the filtrates of the samples, placed in 35 ± 1°C for 24 ± 2 h in the cultivation of coliform bacteria, 35 ± 1°C for 48 ± 3 h in the cultivation of coliform heterotrophic bacteria, and 20-25°C for 3 to 5 days in the cultivation of yeast and mold.

RESULTS AND DISCUSSION

Bamboo Degradation in Soil, Water, and UV Light Environments

Herein, the degradation (decaying) characteristics of bamboo are discussed based on the change of their LOI (Fig. 4). Figure 4 shows the LOI of each specimen increased in comparison with the LOI of bamboo used. After 4 weeks, the increase in LOI of the specimens without creosote oil treatment were 2.0%, 1.2%, and 0.8% for soil, water, and UV light environments, respectively (Fig. 4a). The reason behind the increase in LOI may be partly due to the decay of bamboo. Interestingly, for the specimens with creosote oil treatment, the increase in LOI was 1.3%, 0.7%, and 0.3% for soil, water, and UV light environments, respectively (Fig. 4b). The reduction in LOI increase was confirmed with creosote oil treatment, which indicates that creosote oil treatment can retard the decay of bamboo.

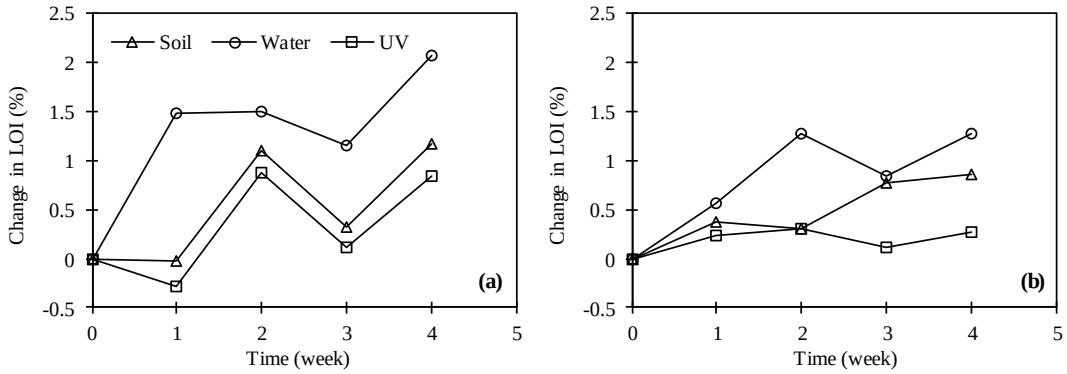


Fig. 4 LOI Change of the specimens (a) without and (b) with creosote oil treatment

Another important fact that should be noted here is the variation trend of LOI. In Fig. 4a, large temporal variations in LOI were confirmed in the soil and UV light environments compared with those in the water environment. This ensured that the decay of bamboo was activated in the soil and UV light environments than in the water environment. It is thought that soil organisms and the destruction of cell walls of bamboo by UV light play an important role in the bamboo decay process. The increase in LOI of the specimens in the UV light environment was lower than in the soil environment (Fig. 4a). It is evident that the decay of bamboo was enhanced in the UV light environment. In addition, the temporal changes in LOI seemed to be restrained by creosote oil treatment (Fig. 4b). This implies that creosote oil treatment can retard the decay of bamboo.

Changes in Compressive Strength Owing to Bamboo Degradation

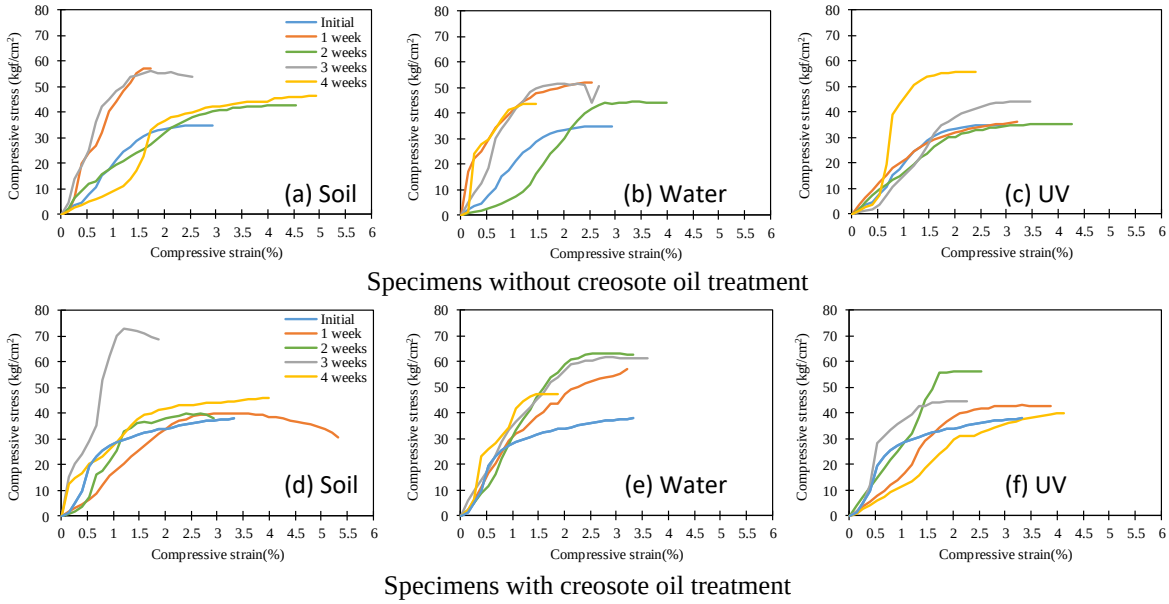


Fig. 5 Temporal changes in compressive stress

From Fig. 4, it can be seen that the degradation of bamboo in the soil environment was higher than that in the water environment. In addition, creosote oil treatment could retard bamboo degradation. It is expected that the compressive strength of bamboo decreases due to bamboo degradation. In other words, the compressive strength of bamboo in the water environment is expected to be higher than in the soil environment.

Figure 5 shows the temporal changes in the compressive stress of the specimens with and without creosote oil treatment in soil, water, and UV light environments. As the water content of

specimens in the UV light environment was very low compared to the water content of the specimens when placed in other environments (Fig. 6), only the results regarding when the specimens placed in soil and water environments would be discussed. As expected, the compressive stress of the specimens in the water environment seemed to be higher than its value when the specimen was placed in the soil environment at 4th week (Fig. 5a&b). This suggests that the compressive strength of bamboo becomes smaller as the degradation of bamboo advances.

Moreover, the compressive stress of the specimens with creosote oil treatment in the water environment seemed to be higher than those without creosote oil treatment. It can be said that the retardation of bamboo degradation using creosote oil treatment can improve the decreasing compressive strength of the bamboo due to degradation. Unfortunately, a clear difference in the compressive stress between the specimens with and without creosote oil treatment in the soil environment was not verified.

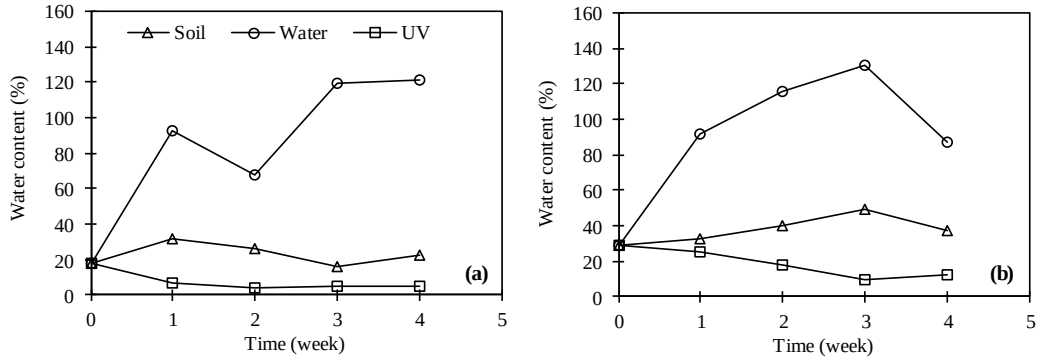


Fig. 6 Water content of the specimens (a) without and (b) with creosote oil treatment

Effects of Bamboo Degradation on Soil Organisms

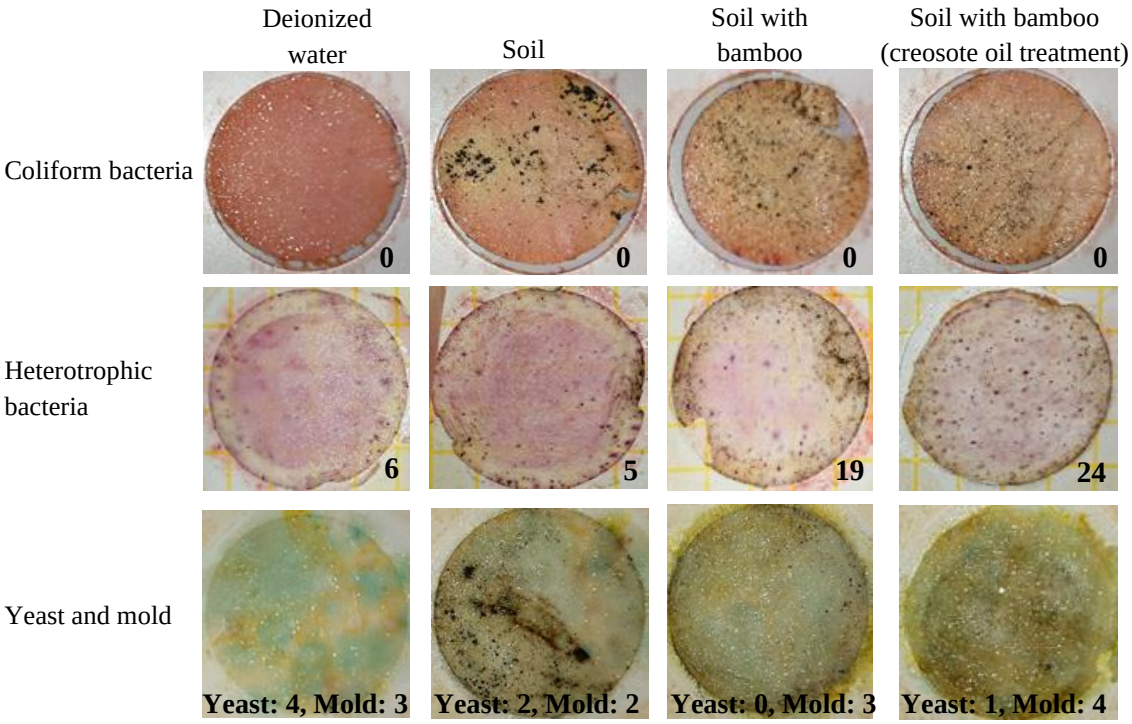


Fig. 7 Comparison of soil organisms (Number refers to the cell abundance of the organism)

Figure 7 depicts the observations on the effects of bamboo degradation on soil organisms. The number in the figure refers to the cell abundances of the organisms. As can be seen from the figure,

coliform bacteria were not observed, suggesting that coliform bacteria do not exist in the black soil used in the experiments. For yeast and mold, the cell abundances were almost of the same order, which ensures that bamboo degradation and creosote oil treatment had no negative effects on the inhabitation environment of yeast and mold.

Interestingly, large differences in the cell abundance of heterotrophic bacteria were observed. The cell abundances in deionized water and soil environments were 6 and 5 cells, respectively. On the other hand, the cell abundance in the soil environment with bamboo was found to be 19 cells (24 cells when using the bamboo with creosote oil treatment). It can be said that bamboo degradation can activate heterotrophic bacteria in soils. Moreover, the cell abundance when using bamboo with creosote oil treatment was higher than that without creosote oil treatment. This further strengthens the fact that creosote oil treatment has no negative effects on soil organisms.

CONCLUSION

In this study, experiments were conducted to examine the degradation (decay) of bamboo in soil, water, and UV light environments. Changes in the compressive strength of bamboo owing to its degradation, and the effects of bamboo and creosote oil treatment on soil organisms were also examined. A large variation in LOI in the soil and UV light environments were observed, indicating that soil organisms and the destruction of cell walls of bamboo due to UV light play an important role in enhancing bamboo degradation. The compressive stress of bamboo in the soil environment seemed to be lower than when placed in the deionized water environment, suggesting that the compressive strength of bamboo decreases as the bamboo decays. Furthermore, the cell abundance of heterotrophic bacteria was higher when in contact with decaying bamboo, which implies that bamboo degradation can activate heterotrophic bacteria in soils. The cell abundance of soil organisms (heterotrophic bacteria, yeast, and mold) was of the same order when the experiments were conducted using bamboo with and without creosote oil treatment. This means that creosote oil treatment has no negative effects on soil organisms.

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Research article

Monitoring of Riverbank Erosion and Shoreline Movement at Amu River Using Remote Sensing and GIS: A Case Study in Jawzjan, Afghanistan

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Abstract This study examines the quantification of riverbank erosion trend, by detecting the shoreline changes and river migration of Amu River, during the recent 14-years period in Qarqin district of Afghanistan. In this study, Landsat images (TM/ETM/OLI TRI) from 2000 to 2014 were used to categorize eroded area and identify shoreline change locations. Furthermore, the images were classified into five different classes, i.e., water, built-up, barren land, sand bank, and agriculture land. River boundaries were digitized from the shorelines on the images from 2000 to 2014. Digital Shoreline Analysis System (DSAS) was applied to calculate shoreline movement. End point Rate (EPR) and Linear Regression Rate (LRR), were used to compute long term changes for the analysis. The study found that the river movement was toward Afghanistan side, i.e., south-word. The threat of losing land of Afghanistan was estimated to be ca. 362.4 ha/year. The total eroded area was calculated to be 1,984 ha, 1,410 ha, and 1,680 ha during period of 2000-2005, 2005-2010 and 2010-2014, respectively. The shoreline was demarcated in each image and the area was categorized into three zones correspond to the erosion trend, i.e., lower as moderate eroded zone, central as high eroded zone and upper as lower eroded zone. This research work can provide the advocatory input to policy makers in war torn countries to manage Riverbank erosion.

Keywords Amu River, Afghanistan DSAS, GIS, morphology, remote sensing, riverbank erosion, shoreline analysis

INTRODUCTION

Riverbank erosion and channel shifting are geomorphological phenomenon related to the bank navigation change in bed elevation, bank line change, and modification of the flow condition in the topographic reaction. The effects of river erosion are various, e.g., social, economic, health, education, and sometimes political. Homelessness is the most important factor, which forces people to migrate due to Riverbank erosion from residential areas, and this increases poverty and involves the people into criminal activities. Due to the luck of proper management, hundreds of hectares of agriculture land and residential lands near the riverbank of Amu River changes to the river bad

every year. In last three decades, riverbank erosion is has become a serious issue in the northern part of Afghanistan. Heavy rainfall and melting stored snow on the mountainous areas make the water flow of Amu river very fast and vast. The riverbank erosion on the left side of the Amu river occurs every year and destroys a lot of agricultural land and houses in Qarqin, Jowzjan Province and changed the riverbed drastically. In Qarqin district, 60% of the land was washed away and consequently only four villages out of 14 villages remained over the last six decades. If the case is ignored and no serious work is done, Qarqin district people will face more serious land loss, in the near future. So, for no studies have been conducted to estimate the land lost and analyses the river shoreline migration. The overall objective of this research is to estimate riverbank erosion effect on the land use change, categorizing shoreline movement.

METHODOLOGY

Study Area

The study area is located in the northern part of Qarqin district along the Amu (Darya) river with elevation of 249 m a.s.l. and the coordinates of 37.24 46° N 66.2525° E. The Qarqin district, covers an area of around 1,275 km^2 with the population of 21,400 (2006). The Qarqin district borders with Turkmenistan to the north. It also borders Khamyab district to the west, Mardyan and Mingajik districts to the south and Shortepa district of Balkh province to the east.

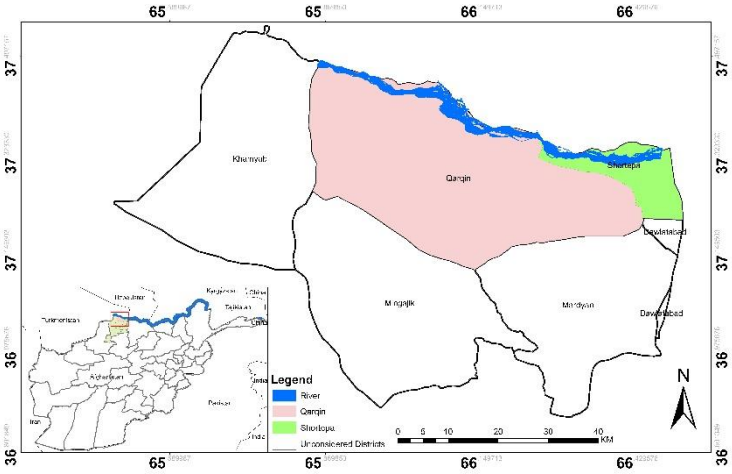

Fig. 1 Study Area in Qarqin District, Jowzjan, Afghanistan

General Methodology

To evaluate the river migration of Amu river during the 14 years, Landsat images (TM/ETM/OLI TRI) from 2000 to2014 have been considered for the analysis. Pre-processing, including atmospheric noise correction, contains data process which usually precedes most of the manipulation and analysis of the image data to extract exact information. Scan line corrector (SLC) and geometric corrections were performed. Most of images in the study area were required to fill the gaps by SLC. The gaps were removed from those images by SLC implemented in ENVI software. Geometric correction was applied for each year's image and taken 2014 image as a base image to adjust all 14 yeas images into exact the same location with the sufficient RMS error (RMS < 1 pixel). Finally, The Landsat imagery was set as 185 km X 185 km, i.e., 34,225 km^2. However, in order to avoid a large data set and save analysis time duration image was subsided into 1,258 km^2 subset imagery, adjacent to the banks of the Amu river in the study area.

Remote sensing and GIS application is very powerful tools to study river geomorphology and channel shafting studies in the different time. In this research supervised classification was

performed and all areas was classified in to the five classes, water, Built-up, Barren land Agriculture and Sand Bank. Furthermore, the classified area was verified with very high resolution IKONAS images.

Table 1 Overall accuracy of image classification based on the very high resolution

Landuse	Built-up	Water	Barren Land	Agriculture	Sand	Row Total	Producers Accuracy
Built-up	11	0	0	0	0	11	100.00%
Water	0	5	0	0	0	5	100.00%
Barren Land	0	0	1	0	2	3	33.33%
Agriculture	0	0	0	4	2	6	66.67%
Sand	0	1	0	0	4	5	800.00%
Users Accuracy	100.00%	100.00%	33.33%	66.67%	50.00%	30	
Overall Classification Accuracy = 83.33%							

Vector overlay, and human interpolation were done to identify the shoreline change. The river shoreline was extracted from the available satellite imagery in different period, based on spatial overlays techniques. Digitization was performed to collect shoreline or bank line layers from individual year basis. Digital shoreline analysis system (DSAS), developed by USGS, was used for baseline measurement and calculation of the statistical change rate from the time series of shorelines. DSAS (ver. 4.4) is a computer software it can calculate morphological and statistical change from the historical shoreline positions under ArcGIS system. The baseline is considered as a starting point for all the transects opened by the DSAS program. DSAS creates transect lines that are perpendicular to the reference line, i.e., baseline, at a user-specified distance interval. The distance between the baseline and each point of the intersection of the shoreline with the DSAS transect can be used to calculate the distance measurements such as shoreline change envelope and net shoreline movement (Kannan, 2016). Thus, to calculate the rate of change statistics based on DSAS, 123 transects were generated. All the transects were oriented perpendicular to the baseline at 300 m spacing and ca. 65 km along the Amu River in Qarqin District, with some part of Shortapa District. In this research, linear Rogation Rate (LRR) and End Point Rate (EPR) approaches were used to calculate long term change rate.

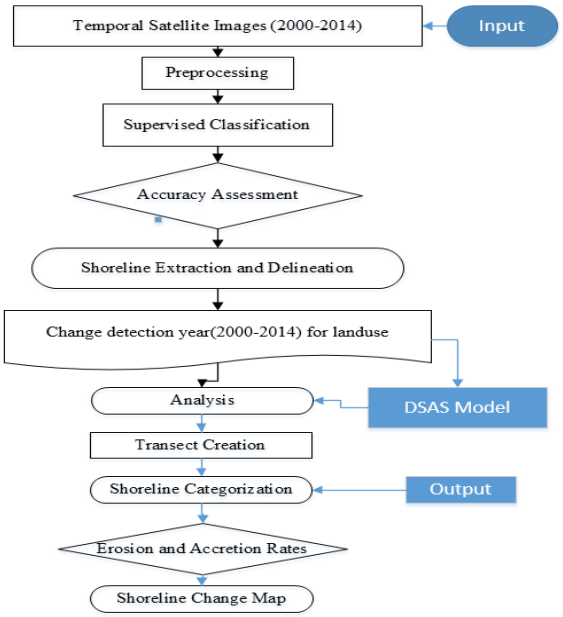

Fig3 General Methodology

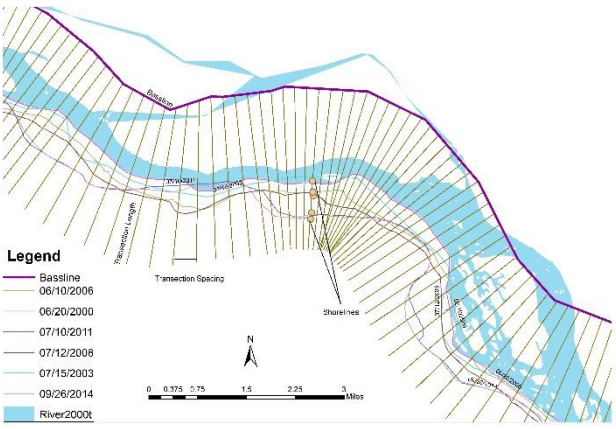

Fig4 Shoreline with transect line

RESULTS AND DISCUSSION

The riverbank line change rate was calculated as shown in Table 1. Shoreline changes are present with an emphasis on shoreline erosion, because it is an important natural disaster for Qarqin district. Shoreline movements from different locations and period were demarcated. The eroded area was calculated based on the most recent and oldest shorelines from 2000-2014 in Qarqin and part of Shortapa districts. The Riverbank erosion had occurred differently in the erosion rate and can be classified into 3 zones, i.e., Moderate, Low, and High eroded zones, from downstream, towards upstream (Fig. 4). The overall migration trend of the present right bank was south- eastward. Similarly, the upper and center part of the Riverbank shoreline shifting to the south-eastward. In the different parts of the study area, it was different rate of shoreline change and erosion activity.

Table 2 Long term shoreline change from EPR for 14 years using different interval of Shorelines

Years	Mean Erosion (m/yr)	Maximum Erosion (m/yr)	Minimum Erosion (m/yr)	S.D (m/yr)	Mean Accretion (m/yr)	Maximum Accretion (m/yr)	Minimum Accretion (m/yr)	S.D (m/yr)
2000-2003	14.7	125.8	0.22	34.8	5.43	68.6	0.45	29.0
2003-2006	15.4	143.8	0.08	36.0	5.97	68.6	0.21	26.7
2006-2008	21.8	127.6	1.77	36.1	7.56	68.6	0.58	23.8
2008-2011	17.9	149.5	0.02	38.4	4.22	40.9	1.05	13.7
2011-2014	11.3	111.1	0.06	32.3	4.89	53.8	0.08	20.9

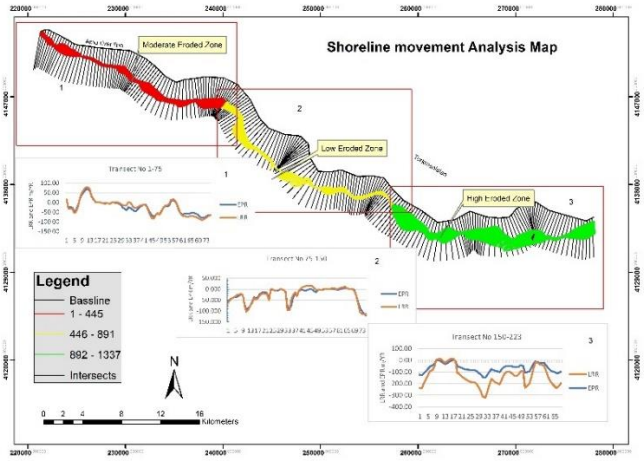

Fig. 4 Shoreline change demarcation (EPRand LRR in meters per year), for year 2000- 2014

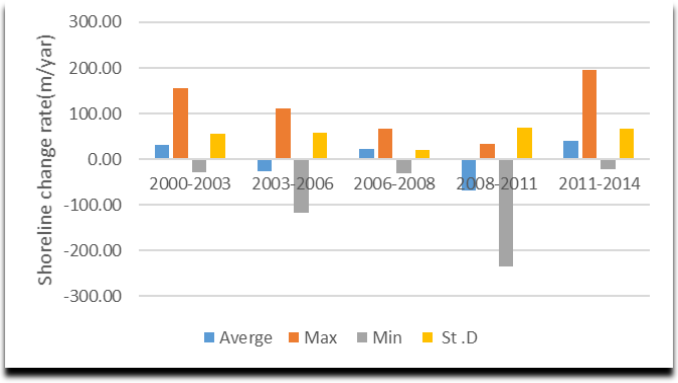

Fig 5 Average shoreline change rate

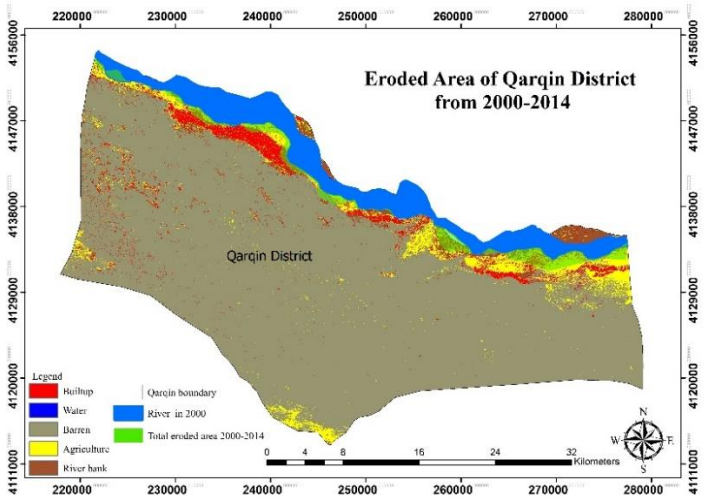

Fig. 6 Total Eroded map from in Qarqin District 2000-2014

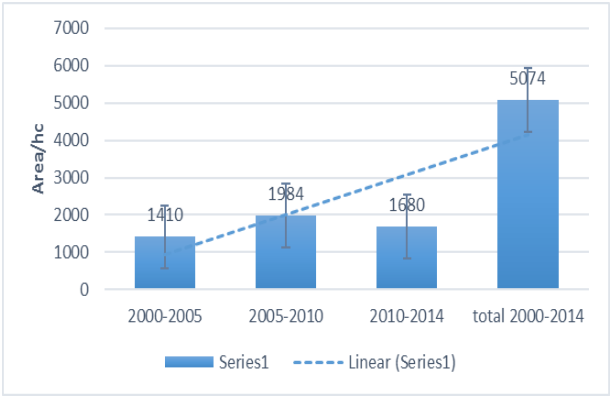

Fig. 7 Total Eroded scenarios of Amu River in Qarqin District

The erosion and accretion activity were calculated at 14.7 m/yr and 5.43 m/yr, respectively, remarked at all the 65 km length within the study area of Amu river. In the period between 2006 and 2008, it had severe erosion in all along the Amu river with the average erosion of 21.8 m/yr and accretion rate of 5.97 m/yr. The calculated eroded area was 1,984 ha, 1,410 ha and 1,680 ha during period of 2000-2005, 2005-2010 and 2010- 2014, respectively (Fig. 7). Visual comparison of the three-time period of land use maps reveals that illustrates the significant changes in land use between 2005 and 2000, that most changes included the incising the water and sandbank and similarly decreasing the agriculture, buildup and barren land (Fig. 6). According to the land use change map analysis, the water and sandbank value increased in the most of time. However, agriculture, buildup and barren land are decreased, it shows that river is expanded, which means the houses and agricultural land which are near to the river had to be changed into the riverbed and sand bank. Therefore, large amount of land loss accounts for a significant loss of income marginal farmers and their livelihood. A progressive river migration of the bank line of the Amu river toward in Afghanistan side and continue channel shafting which is resulted in obvious land lass in the region.

CONCLUSION

In the last three decades' riverbank erosion became a serious issue in Afghanistan, due to rainfall and snow with high flowing water velocity. Every year. a large amount of soil erosion occurrs in the right side of Amu river and destroys large area of Agricultural lands and houses. In this

research, image classification and Digital shoreline analysis (DSAS), were wore used to compute the shoreline change location and land loss due to the Amu Riverbank erosion in Qarqin district. Remote sensing and GIS applications and Statistical technique indicate a suitable method for Riverbank erosion management with geographical approach were applied. According to the classified images and landuse change detection results, large amount land has changed from the agriculture and buildup to river bad. By calculating classified area, the result was found that the water value had increased more than other classes which mean the land loss and river has migrated every year in Afghanistan side. Another outcome which is explored from the calculation of the area from the three-year time period shows that total amount of land loss during the 14 years' period was 5074 hectares of land in the Qarqin district. Finally, using DSAS approaches End Point Rate (EPR) and Linear Regression Rate (LRR), were compute long term changes. The study found that the river movement was toward Afghanistan side i.e., south. The estimated threat of losing land was about 362.42 ha/year. The calculated eroded area was 1,984 ha, 1,410 ha and 1,680 ha during period of 2000-2005, 2005-2010 and 2010- 2014 respectively. The shoreline was demarcated and categorized into three zones i.e., lower as moderate eroded zone, central as high eroded zone and upper as lower eroded zone. This research work can give input to policy makers in war torn country to manage Riverbank erosion.

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Research article

Effects of Drip Irrigation Frequency on Growth and Yield of Melon (*Cucumis melo* L.) under Net-house's Conditions

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Abstract Irrigation plays an important role in melon (*Cucumis melo* L.) production. The study was conducted to compare the influence of irrigation frequency on growth and yield of melon and to identify the irrigation water use efficiencies of each treatment. The experimental plot was designed in RCBD layout divided into four treatments with three replications. They were Treatment 1 (T1), irrigated by drip irrigation 1 time per day, Treatment 2 (T2) irrigated by drip irrigation 2 times per day, Treatment 3 (T3) irrigated by drip irrigation 3 times per day, and Treatment 4 (T4) irrigated by hand-watering 2 times per day. All treatments were applied with the same amount of irrigation water based on crop water requirement calculation. Statistical analysis was done by ANOVA in SPSS software. The results indicate that T3 significantly affected on vegetative development (plant height and plant diameter), water use efficiency (WUE), dried and wet mass and yield of melon. The highest yields were obtained from T3 of 46.75 tons/ha with WUE of 78.18 kg m^{-3}, while the plant height and plant diameters were 164.33 cm and 10.55 mm and the lowest at the T4 of 29.17 tons/ha with WUE of 51.98 kg m^{-3}, while the plant height and plant diameters were 148.33 cm and 9.63 mm. However, there were no significant differences in water use efficiency between T1, T2 and T4 which are 55.60 kg m^{-3}, 64.10 kg m^{-3} and 51.98 kg m^{-3}, respectively. Therefore, based on vegetative development, yield and quality of melon, T3 treatment would be the most appropriate irrigation for melon growers in controlled conditions.

Keywords drip irrigation, frequency, growth, melon, water use efficiency, yield

INTRODUCTION

Irrigation plays an important role to increase the crop yield or crop productivity (Nut et al., 2017), especially inside greenhouse (Li et al., 2012). The proper irrigation frequency is vital in improving the water use efficiency and the productivity by applying the required amount of water when it is needed. On the other hand, the poor irrigation frequency can lead to the development of crop water deficit and result in a reduced yield due to water and nutrient deficiency. Water saving and higher water use efficiency will be significant factors in agricultural production. In most cases from agronomic, water conservation and economic aspects, drip irrigation has many advantages for crop production, particularly under protected culture condition (Ertek et al., 2006; Kumar et al., 2007;

Fernandez et al., 2007; Nut et al., 2017). Compared with furrow irrigation, drip irrigation can irrigate the crop root from the topsoil to increase water use efficiency.

Melon (*Cucumis melo* L.) is an important horticultural crop in the world, and is often cultivated with irrigation in semiarid or arid regions (Li et al., 2012). In Cambodia, tens of thousands of melons are grown every year by local farmers on increasing local demand. There are some researches showed that melon is sensitive to water stress as the water deficit can reduce fruit yield and quality (Fabeiro et al., 2002). From seed sowing to emergence, excessive soil water can damage melon and cause fruit quality problems (Sensoy et al., 2007). At the same time, the relatively shallow depth of melon roots require soil water to be maintained at a minimum of 65% of capacity in order to avoid water deficit (Sensoy et al., 2007). Excessive irrigation immediately after transplantation can result in long and coarse growth, underdeveloped flower stalks and premature flower death of some plants such as squash, cucumber, watermelon and melon (Fabeiro et al., 2002; Kirnak et al., 2005; Ertek et al., 2006). Therefore, irrigation should be scheduled to avoid excessive water that can lead to reduced yield, lower quality, lower irrigation water use efficiency (IWUE), plant disease and fruit deformation in field or inside greenhouse (Sensoy et al., 2007).

OBJECTIVE

The research aims 1). To compare the influence of irrigation frequency on growth and yield of melon and 2). To identify the irrigation water use efficiencies of each treatment.

MATERIALS AND METHODS

Experimental Conditions: The experiments were carried out at Department of Agricultural Engineering, Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia (Latitude: 11° 34.23' N; Longitude: 104° 52.20' E; Altitude; 280 m above sea level) during the growing seasons 2017/2018. Soil samples at the study area were taken to the laboratory of Royal University of Agriculture (RUA) to analyse pH = 7.21, Soil Organic Matter (SOM) = 0.84%, Electrical conductivity (Ec) = 5,300 μS cm^{-1}, Nitrogen (N) = 0.021%, Phosphorus (P) = 32.90%, and Potassium (K) = 0.47%, Soil bulk density = 1.55 g cm^{-3}, Soil water content = 4.50%, and Soil texture (Sand=77.14%, Silt=14.29% and clay=8.57%) = loamy sand.

Treatments and Experimental Design: The experiments were laid-out in randomized complete block design (RCBD) with three replications. Each experimental plot was raised 15 cm as a ditch above the ground with the size of 2 meters long and 1 meter wide occupying an area of $2m^2$. Melons were planted in two rows on the plot on 28 October 2017. The water budget system for irrigation is relatively straightforward, but must be adjusted for crop growth stage and environmental conditions such as rain. Applied water was calculated by estimating crop evapotranspiration (ETc), which was calculated using the FAO method (Doorenbos and Pruitt 1977) as ETc = ETo x Kc. The same amount of water was applied to all treatments (Table 1).

Table 1 Definitions of experimental treatments of irrigation water

Irrigation treatment	Description	Irrigation frequency	Amount of irrigated water (m^3/ha)
Treatment T_1	Drip irrigation	1 time/day	2,990
Treatment T_2	Drip irrigation	2 times/day	2,990
Treatment T_3	Drip irrigation	3 times/day	2,990
Treatment T_4	Hand-watering	2 times/day	2,990

Data Collection: The cumulative trends of the vegetative growth parameters (plant height and plant diameter) for different treatments was recorded weekly when the plant reached 25 days old after planting (Table 2). Plant heights were determined by measuring the growing point of the main

stem per 7 days, so a total of 9 times during the vegetative growth stage from 28 October to 04 November, 2017 were determined. Four plant samples were chosen from each plot in W-shape in order to measure some parameters such as plant height and plant diameter, blossom rate, fruit weight and fruit diameter, dried and wet mass of the plant.

Water use efficiency (WUE expressed in; kg m^{-3}) on yield basis was determined by dividing the yield (kg ha^{-1}) by the quantity of water applied (m^3 ha^{-1}) (sum of rainfall and quantity of water added by irrigation) during the growth period (Stanhill, 1987).

Statistical Analysis and Data Interpretation: Collected data were subjected to the proper of statistical analysis of variance (ANOVA) of randomized complete block design (RCBD) as mentioned by Gomez and Gomez (1984). The combined ANOVA was carried out according to Steel et al. (1997), to estimate the main effects of the different sources of variation and their interactions. Differences were considered significant at $p<0.05$. Treatment means were compared at 5% level of probability using the least significant difference (LSD) method (Steel et al., 1997), when the F-test for these treatments was significant at 5% probability level. Finally, all statistical analysis was carried out using SPSS computer software package while the graphic design was done with Microsoft Excel.

RESULTS AND DISCUSSION

Combined Analysis of Variance on Vegetative Growth

Table 2 Mean plant height and stem diameter for different treatments during vegetative growth period

Parameters	Days of planting	Treatment			
		T1	T2	T3	T4
Plant height (cm)	25 days	11.7 ± 1.1	12.1 ± 0.2	12.7 ± 1.2	12.5 ± 0.2
	32 days	22.7 ± 0.7	25.7 ± 0.5	28.2 ± 1.1	25.0 ± 0.6
	39 days	33.7 ± 0.3	35.3 ± 0.3	38.8 ± 0.3	30.4 ± 1.2
	46 days	52.7 ± 1.5	58.1 ± 0.5	63.3 ± 0.4	49.3 ± 1.8
	53 days	70.3 ± 1.6	73.3 ± 1.7	81.8 ± 3.0	63.0 ± 1.5
	60 days	95.0 ± 2.5	101.3 ± 4.0	111.7 ± 2.1	87.0 ± 5.1
	67 days	122.3 ± 1.5	137.3 ± 4.2	145.5 ± 6.1	110.7 ± 5.2
	74 days	148.3 ± 4.4	160.0 ± 0.0	176.9 ± 2.0	138.3 ± 4.4
	81 days	164.3 ± 3.5	170.3 ± 2.6	187.0 ± 2.0	148.3 ± 7.3
Plant diameter (mm)	25 days	3.9 ± 0.1	3.8 ± 0.1	3.9 ± 0.0	3.8 ± 0.1
	32 days	5.6 ± 0.1	5.3 ± 0.2	5.5 ± 0.1	5.1 ± 0.2
	39 days	6.8 ± 0.1	6.6 ± 0.1	6.9 ± 0.2	6.2 ± 0.1
	46 days	7.4 ± 0.2	7.1 ± 0.1	8.2 ± 0.2	6.8 ± 0.0
	53 days	8.3 ± 0.3	7.8 ± 0.2	8.8 ± 0.3	7.3 ± 0.2
	60 days	8.7 ± 0.2	8.2 ± 0.1	9.4 ± 0.3	7.8 ± 0.2
	67 days	9.8 ± 0.1	9.4 ± 0.2	10.7 ± 0.3	8.6 ± 0.1
	74 days	10.4 ± 0.1	10.2 ± 0.0	11.2 ± 0.2	9.3 ± 0.2
	81 days	10.6 ± 0.1	10.8 ± 0.1	11.5 ± 0.3	9.6 ± 0.1

Data were shown in mean ± S.E.

Irrigation regimes are one of the essential factors which can significantly affect the crop growth and yield. The plant height growth rate was defined as the ratio of the plant net growth amount for the adjacent measured values and the former plant height values, and the former plant height values is the reference (100%) value. It is an important index to research plants' dynamic growth (Zeng et al., 2009). During the first stage after 25-day-old planting, the plant height were 11.7 cm, 12.1 cm,

12.7 cm and 12.5 cm for T1, T2, T3 and T4, respectively. The plant height gradually increases from 25 to 39 days after planting, and from 46 to 81 days the plant heights grow faster which increases with the frequency of the irrigation water as it is in the development stage. It can be seen that the plant height of T3 (187 cm) was significantly different at $p<0.05$ for all treatments, T1 (164.33 cm), T2 (170.33 cm) and T4 (148.33 cm). There is no significant difference between the applications of irrigation frequency once or twice time per day.

The plant diameter was measured weekly at the third internode uniformly. Table 2 shows that the plant diameter increased with plant growth, and the more frequency of irrigation water applied, the larger plant diameter was obtained. These results are consistent with studies of different irrigation scheduling on melon and cucumber (Mannini, 1988) which found that when the irrigation interval was prolonged and less frequent, it reduced the growth of various parts of the plant. In addition, Wang et al., 2006 found that drip irrigation frequency affected the temporal and spatial distribution of soil water when total irrigation water was the same and influenced the growing stage of potato. Moreover, it is similarly with (Wang et al., 2009) studied on subsurface drip irrigation scheduling for cucumber in solar greenhouse.

Table 3 indicates that the frequency of irrigation had significant effects on fruit yield of all treatments. Total yields of T3 (46.75 t/ha) were higher than other treatments. Moreover, more frequent irrigation resulted in greater numbers of marketable fruit which were statistically significant difference (Table 3). Similarly, Sensoy et al. (2007) found that the highest melon yield was obtained from the treatment with the highest irrigation compensation, which combined more frequent irrigation (6-day intervals) with greater amounts of water.

Table 3 Some parameters of yield and irrigation under different irrigation treatments

Parameters	Treatment				
	T1	T2	T3	T4	S.D
50% Blooming (day)	34b	33b	31a	36c	0.67
100% Blooming (day)	36b	35b	33a	38c	0.70
Numbers of nodes per plant	16a	15ab	16ab	14b	0.56
Plant height (cm)	164.33b	170.33b	187.00a	148.33c	3.59
Plant diameter (mm)	10.55b	10.79b	11.54a	9.63c	0.23
Mean fruit weight (kg)	6.65bc	7.67b	9.35a	5.93c	1.52
Fruit diameter (cm)	107.00b	116.33c	140.00a	95.75d	1.82
Good fruit yield (t/ha)	29.17bc	34.17b	41.67a	25.58c	2.61
Bad fruit yield (t/ha)	4.08b	4.17b	5.08a	3.58b	0.30
Total fruit yield (t/ha)	33.25bc	38.34b	46.75a	29.16c	2.71
Wet mass of stem (g/plant)	106.67b	109.67ab	123.33a	90.00c	5.67
Dried mass of stem (g/plant)	9.33ab	9.79ab	11.48a	7.76b	0.91
Wet mass of leaf (g/plant)	148.33c	167.67b	190.00a	127.67d	5.81
Dried mass of leaf (g/plant)	15.51ab	16.17ab	19.33a	11.33b	0.83
WUE (kg/m^3)	55.60b	64.10b	78.18a	51.98b	5.37

The values with the same letter are statistically non-significant by F-test at $p < 0.05$.

Water use Efficiency (kg m^{-3})

Inside the nethouse, there was a bit rainfall and runoff while using the drip irrigation systems. Irrigation water use efficiency (IWUE) was the relation between yield and irrigation water, and was computed based on melon yield divided by irrigation amount. So, the irrigation water use efficiency (IWUE) is the same as the water use efficiency (WUE). The irrigation water use efficiency of different treatments is listed in Table 3 and Fig. 1. The analysis of variance showed significant differences between irrigation treatments. The highest WUE yield was obtained in T3 by 78.18 kg m^{-3} and the lowest at the T4 with 51.98 kg m^{-3} (Table 2). There were no significant differences in WUE between T1, T2 and T4 which are 55.60 kg m^{-3}, 64.10 kg m^{-3} and 51.98 kg m^{-3},

respectively. This result was not consistent with the former research (Kirnak et al., 2005; Sensoy et al., 2007) which considered that the lower the amount of irrigation water received the higher the irrigation water use efficiency achieved, but it is similar to the research by Fabeiro et al., (2002). From Table 2, it can be seen that the yield of T1 and T4 was obviously declined compared to T2 and T3, resulted in decrease with IWUE. Ortega and Kretchman (1982) found that in water-stressed plants the growth of large fruits continued, whereas the growth of small fruits was seriously inhibited. In this experiment, the low fruit yields of T1 and T4 maybe suffered from serious water stress due to over-irrigated water by drip irrigation which applied just one time, while the hand-watering applied irrigation twice per day could waste the irrigation water and caused surface runoff resulted in lack of soil water in the root zone of the melon plant.

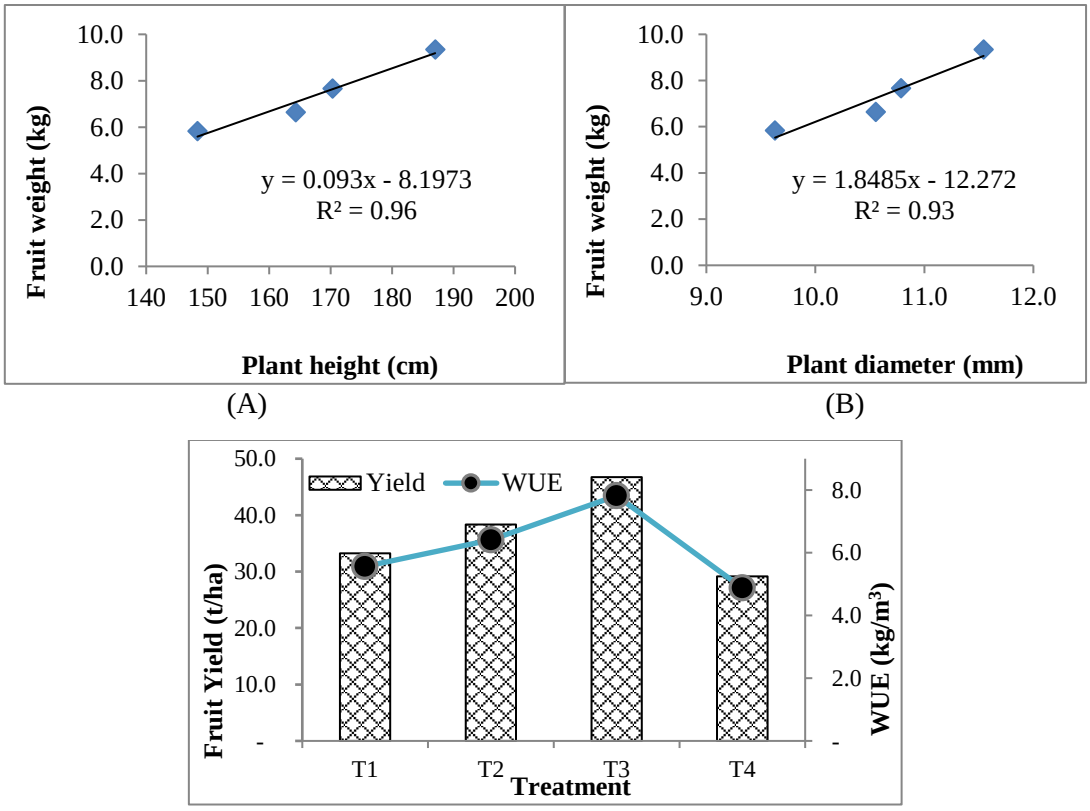

Fig. 1. The relationship between fruit weight with plant height (A) and plant diameter (B), and fruit yield and irrigation water use efficiency for different treatments (C)

Figure 1 shows the relationship between fruit weight with plant height (A) and plant diameter (B) and fruit yield and irrigation water use efficiency for different treatments (C). Through linear regression analysis, a mathematical function was obtained. From Fig. 1 (A) and (B), it can be found the relations of fruit weight and plant diameter and plant height that the fruit weight increased with the stem diameter and plant height which showed the vegetative growth is important for melon fruit. Fig. 1 (C) shows fruit yield and irrigation water use efficiency for different treatments which meant that irrigation water had significantly affected fruit production. Fruit production was the highest for treatment T3 as shown in Table 3 and Fig. 1.

CONCLUSION

The results of the study showed that irrigation frequency plays significant role in vegetative growth, fruit yield and quality of melon grown in nethouse conditions which may be affected by soil water content, especially the frequency of irrigation, which produced significant differences in yield and components in all treatments of the experiment as the irrigation level was applied at the same amount. In particular, the irrigation frequency increased yield not only by increasing the mean fruit

weight, but also by increasing fruit size which was performed in fruit diameter. Of the four irrigation treatments, the highest fruit yield (46.75 t/ha) and WUE (78.18 kg m^3) were obtained from the T3. This amount of production was achieved with maximum water use efficiency with irrigation intervals 3 times per day. Therefore, T3 would be the most appropriate thresholds for melon grower irrigating by drip-irrigation which could offer multiple benefits to reduce erosion and loss of nutrients in the soil, makes the ground slow density, reduce grass, use less water, save time, crops grow well and yield increased.

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Research article

Accuracy Verification of UAV-SfM Survey of Terrace Paddy Fields in a Hilly and Mountainous Area

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Abstract In order to facilitate environmental restoration and reconstruction following natural disasters, accumulation of detailed topography and land use information before the disaster is essential. Recently, the Geospatial Information Authority of Japan announced a survey manual using Unmanned Aerial Vehicles (UAV). The UAV-Structure from Motion (SfM) system has accumulated a great deal of accuracy verification information from the topographic survey, and it is expected that in the future UAV surveying and mapping will be expanded in scope. However, many research cases were performed in flat areas, and UAV surveying and mapping in hilly and mountainous areas are few. With the progress of depopulation and ageing, there is concern that regional disaster prevention capabilities will decline because of the devastation of agricultural land and the disappearance of communities in hilly and mountainous areas. It is necessary to clarify the method for UAV surveying and mapping with high accuracy even in the complex geographical conditions of hilly and mountainous areas. In the present paper, we attempted to create a Digital Elevation Model with UAV in the terrace paddy field of Shizuoka prefecture, Japan. We investigated the influence of flight conditions and the number and location pattern of Ground Control Positions (GCPs) on surveying accuracy by UAV. UAV surveying results are compared with the accuracy of the digital topographic map with scale in Japan specified by the public survey work regulations. We also surveyed the GCPs by RTK-GPS at 15 locations in the terrace paddy field. Comparing the results of UAV surveying without GCPs and RTK-GCP, the standard deviation in the horizontal direction and elevation was 2.44 m ± 1.59 m (SD) and 39.36 m ± 45.30 m (SD), respectively, and corresponds to the digital topographic map with scale in Japan 1:1,000 and 1:5,000, respectively. From these results, it is verified that correction by GCPs is necessary for UAV-SfM surveying in order to ensure high accuracy.

Keywords UAV-SfM, topographic survey, terrace paddy, resilience

INTRODUCTION

In recent years, natural disasters have increased in both number and degree of severity. The Great East Japan Earthquake that occurred on 11 March 2011, revealed that modern nations have serious and systematic vulnerabilities to natural disasters and that their responses to such disasters are concerned largely with infrastructure improvements, such as the reinforcement of levees and improving the resistance of buildings to earthquakes. However, successfully overcoming modern vulnerability to natural disasters will demand contributions from software and other research fields.

There is an urgent need to promptly deal with immediate damage in order to restore 'resilience'—even when normal operations are not drastically impaired, or in cases where some damage is unavoidable. A prompt response under all conditions strengthens our ability to reduce potential damage when disasters are most extreme (The World Bank, 2012; United Nations, 2013; Aitsi-Selmi et al., 2016). A multi-dimensional construct, 'resilience' is defined as the capacity of individuals, families, communities, systems and institutions to anticipate, withstand and/or judiciously engage with catastrophic events, actively making meaning out of them, with the goal of maintaining normal function without fundamental loss of identity (Almedom and Tumwine, 2008). According to the Hyogo Framework of Action (UNISDR, 2005), disaster resilience is the capacity of a system, community or society potentially exposed to hazards to adapt to conditions, by resisting or changing their approaches, and to achieve and maintain an acceptable level of functioning and structure.

The use of Unmanned Aerial Vehicles (UAV) in the field of disaster management is increasing. Lightweight, compact UAVs are highly mobile; self-sustaining flight is possible even in places where human responders cannot gain access; and, because they are inexpensive, they are being increasingly considered as an efficient means for information gathering in the event of a disaster (Erdelj and Enrico, 2016; Maza et al., 2011). In order to promote timely disaster response protocols, it is essential not only to understand the situation *after* a disaster but also to accumulate information *before* a disaster. In disasters that cause large topographical changes such as earthquakes and floods, it is necessary to quickly judge changes before and after a disaster, reduce the risk of secondary disasters and effectively restore the environment to its pre-disaster state. When it comes to the acquisition of topographical data, improvements in photogrammetry techniques, using images taken with UAV, have become an important field of research. As it is becoming possible to improve the functions of the cameras mounted on the UAV, highly accurate photogrammetry and topographic analysis should be carried out in such a way as to stay abreast of the progress of Structure from Motion and Multi–View-Stereo (SfM-MVS) technology, which is now widely used for the reconstruction of three-dimensional structures. In Japan, the Geographical Survey Institute released a public surveying manual using UAV in 2018 (U.S. Geographical Survey Institute, 2018), and further utilisation of UAV at the survey is expected. Kakiuchi et al. (2016) verified the accuracy of SfM photogrammetry, and the results of the mean square error of the verification point have been reported as follows: horizontal position X = 0.037 m, Y = 0.038 m and altitude H = 0.041 m. It is expected to be applied to numerical topographic maps with a map information level of 1:250. In SfM photogrammetry, characteristic features are extracted from each image as key points; images having the same key points are matched to each other; and the shooting position of each shot image is estimated. At this point, the geospatial coordinates of the synthesised image are not defined. Therefore, it is necessary to correct the latitude, longitude and altitude of the three-dimensional image restored by SfM-MVS using a known coordinate—in this instance, the Ground Control Posision (GCP). It is necessary to record not only image acquisition by UAV but also position information as a GCP, and it has been reported that the presence or absence of GCP greatly affects surveying accuracy. However, there are no clear guidelines on the number and arrangement of GCPs, and reports on precision verification are particularly limited, especially for areas having complex topographies.

In this study, the target area for photogrammetry was chosen to be a rice terrace located on a slope with a high specific height. The accuracy of our photogrammetry changed with the number of GCPs. Results were compared and verified.

METHODOLOGY

Study Site

The study area is the rice paddy terrace of Sengamachi tanada located in Kamikura Sawaji district, Kikugawa city, Shizuoka prefecture (Fig.1). Rice paddy production is carried out on slopes having a specific height of approximately 30 m. The coordinates of 15 points were measured by RTK-

GNSS (GRS-1, TOPCON) in the study site (Fig.2), and these were taken as GCP in order to correct photogrammetry. The RTK-GNSS was carried out on 25 May 2018.

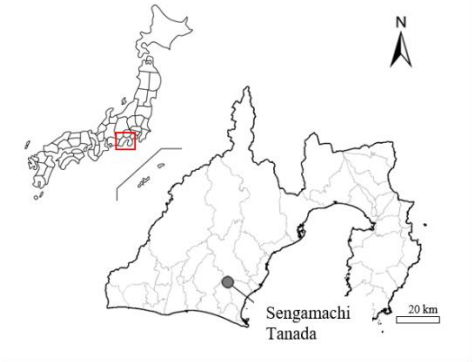

Fig.1 Location of the study site

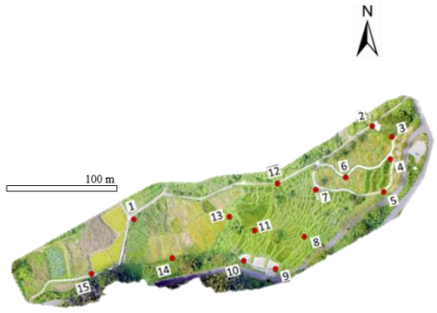

Fig.2 Location of 15 GCPs in Sengamachi Tanada

Shooting condition of UAV

The UAVs used in this study were a Phantom 3 advanced and a Mavic 3 pro (DJI). Shooting date and conditions are shown in Table 1. We designed the route using a Pix4D Capture (Pix4D) and photographed during an automated flight at a certain altitude. In the Public Surveying Institute of the Geospatial Information Authority of Japan, the overlap of adjacent photographs is described as being 80% or more in over and 60% or more in the side. However, in the case where the land use in the image is unified, and the feature points do not resemble the agricultural area under present consideration, synthesis of the image is often difficult. Here we set the overlap higher than the Public Surveying Institute. Also, since the object to be photographed is a slope, when photographing is performed at a certain altitude, the ground resolution in the image varies depending on the location. At the GCP point obtained by RTK-GNSS, a small-sized colour cone was set as an anti-aircraft sign.

Table 1 Shooting date and conditions

Date	height	Overlap		Camera angle	UAV
		Over	Side		
2017/12/15	100	80	75	90	Phantom 3
2018/2/15	100	80	75	90	Phantom 4
2018/5/25	100	80	75	90	Phantom 5
2018/7/27	100	80	75	90	Phantom 6
2018/8/30	70	80	80	90	Mavic pro

SfM-MVS

The obtained image was subjected to SfM-MVS processing using Pix 4 D Mapper (Pix 4 D) to restore the orthoimage and Digital Surface Model (DSM). In this process, the number of GCPs to be corrected was changed, and a plurality of images with different correction conditions was synthesised. The number of GCPs used for correction in each case was 14 points, 7 points, 6 points, 3 points and 0 points (no correction), respectively.

In the case of 6 points, two patterns with changed placement were prepared, and a total of six orthophotos and DSMs were synthesised.

Verification of Accuracy

We verified the accuracy of the image with the GCP correction number according to ArcGIS (Ver. 10.6). We imported orthophotos into ArcGIS and created point features on anti-aircraft signs reflected on each shooting date and each correction condition image, and we obtained latitude and longitude coordinates for each point. We also acquired elevation data from the corresponding DSM. The coordinates obtained by ArcGIS and the coordinates judged by RTK-GNSS as being the most probable values were compared, and the error was verified. The standard deviation was used for

accuracy evaluation and compared with the digital topographic map with scale in Japan (Table 2) which is the standard in public surveying. The standard deviation is defined as the mean error ± standard deviation, and it is assumed that this numerical value satisfies the digital topographic map with scale in Japan when the numerical value falls within the standard deviation as the standard of a public survey.

Table 2 The digital topographic map with scale in Japan

The digital topographic map with scale in Japan	SD of hirozontal	SD of elevation
1: 250	≦ 0.12 m	≦ 0.25 m
1: 500	≦ 0.25 m	≦ 0.25 m
1: 1,000	≦ 0.70 m	≦ 0.33 m
1: 2,500	≦ 1.75 m	≦ 0.66 m
1: 5,000	≦ 3.50 m	≦ 1.66 m
1: 10,000	≦ 7.00 m	≦ 3.33 m

RESULTS AND DISCUSSION

Comparison of Accuracy without GCP Correction

Figure 3 shows the error in horizontal direction and elevation, respectively. The vertical axis of the graph is the error from the coordinates measured by RTK-GNSS, and the horizontal axis is the GCP number. Since the GCP of no.13 was fixed during conditions of low visibility, it was excluded in this study. The data from 15 February 2018 were also excluded from consideration, since the standard deviation on the horizontal direction and elevation was extremely large compared with data from other photographing dates.

Standard deviation without correction by GCP resulted in a horizontal error of 2.44 m±1.59 m (SD) and an elevation error of 39.36 m±45.30m (SD) with mean error ± standard deviation (Table 3). As a result, it was shown that the accuracy in the horizontal direction corresponds to the digital topographic map with scale in Japan of 1:10,000, and the altitude direction shows an error that cannot be used for surveying.

Without GCP correction by the Pix4D mapper, three-dimensional data are generated, referring to the positioning information of photographed pictures. The coordinate information corresponding to each photographic image taken by the UAV is obtained by independent positioning from the GPS mounted on the UAV. It is particularly unsuccessful at taking observations of elevation, and it is greatly affected by the arrangement of the satellites: as a result, it was found that the measured values for altitude deviate in units of several dozens of metres.

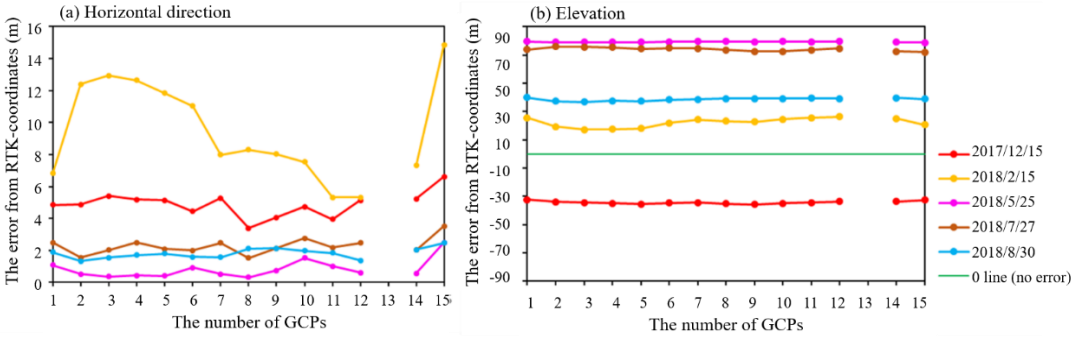

Fig.3 The error of horizontal direction and elevation

Table 2 Mean values and standard deviation of error

Date	Horizontal		Scale	Elevation		Scale
	mean (m)	SD (m)		mean (m)	SD (m)	
2017/12/15	4.88	±0.74	1: 10,000	-32.5	±0.97	-
2018/2/15	9.45	±2.97	-	22.3	±3.08	-
2018/5/25	0.82	±0.56	1: 2,500	79.2	±0.24	-
2018/7/27	2.27	±0.48	1: 5,000	74	±1.24	-
2018/8/30	1.81	±0.31	1: 5,000	38.6	±0.93	-

Comparison of Accuracy when Changing the Number of GCP Corrections

Fig.4 shows the six GCP patterns that changed according to the number of GDPs for correction. Fig.5 shows the error in horizontal direction and elevation, respectively. The vertical axis of the graph represents the error over against the coordinates measured by RTK-GNSS, and the horizontal axis represents the GCP number. Table 4 shows the mean error and standard deviation in the horizontal direction and elevation of each GCP pattern.

In the horizontal direction, patterns (1) through (3) demonstrated accuracy equivalent to the digital topographic map with scale in Japan 1:500; patterns (4) and (5) were equivalent to the digital topographic map with scale in Japan 1:1,000 and for pattern (6) the accuracy was equivalent to the digital topographic map with scale in Japan 1:5,000. For measurements in elevation, patterns (1) through (4) were accurate with reference to the digital topographic maps with scale in Japan 1:250 through 1:500; pattern (5) demonstrated accuracy equivalent to the digital topographic map

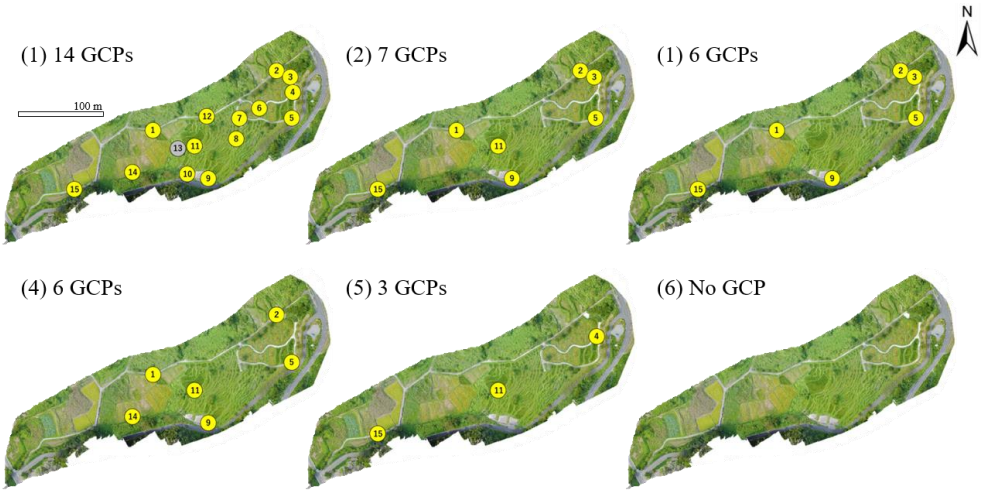

Fig.4 Six patterns of GCPs correction

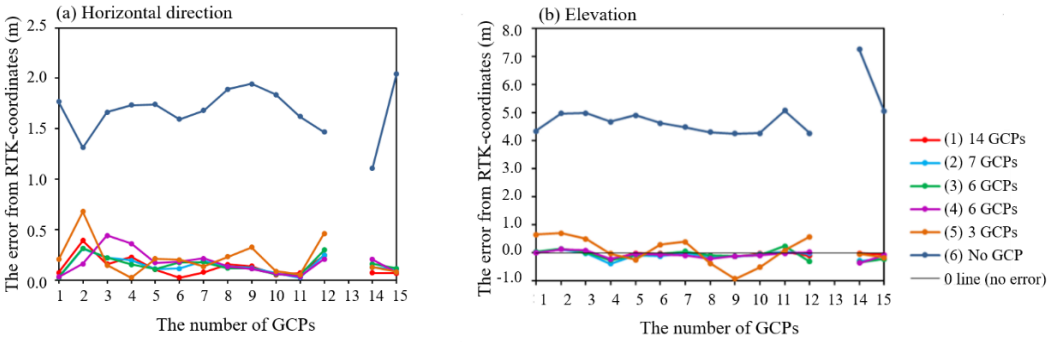

Fig.5 The error of horizontal direction and elevation

Table 3 Mean values and standard deviation of error

GCP pattern	Horizontal mean (m)	Horizontal SD (m)	Scale	Elevation mean (m)	Elevation SD (m)	Scale
(1) 14 GCPs	0.13	±0.10	1: 500	-0.03	±0.09	1: 250
(2) 7 GCPs	0.14	±0.08	1: 500	-0.09	±0.13	1: 250
(3) 6 GCPs	0.15	±0.09	1: 500	-0.07	±0.16	1: 250
(4) 6 GCPs	0.17	±0.12	1: 1,000	-0.08	±0.12	1: 250
(5) 3 GCPs	0.21	±0.17	1: 1,000	0.07	±0.47	1: 2,500
(6) No GCP	1.67	±0.24	1: 5,000	4.82	±0.74	1: 10,000

with scale in Japan 1:2,500; and pattern (6) demonstrated accuracy equivalent to the digital topographic map with scale in Japan 1:10,000. From the average error and standard deviation of patterns (1) through (3), when the GCP was set to 6 or more, thereby enclosing the outer circumference of the target site, it was shown that there is no difference in the map information between the generated 3D model and that generated by standard surveying techniques.

CONCLUSION

In this study, we performed SfM-VMS photogrammetry using UAV images and verified the accuracy according to the presence of GCP and the number of GCPs in topographies with a high specific height. From the accuracy verification of three-dimensional data without GCP correction, no special error was found. In particular, topographies with a high specific height were not found to introduce any special errors. From the accuracy verification based on the number and arrangement of GCPs, it was shown that highly precise SfM photogrammetry could be performed on rice paddy terraces by performing GCP correction. Also, it was confirmed that sufficient precision of the digital topographic map with scale in Japan of 1:500 could be obtained by setting the number of GCPs and arrangement of 6 points on the outer circumference and 1 point at the centre. From these results, it was suggested that the accuracy of UAV survey could be ensured by setting the GCPs for 6 points on the outer circumference and 1 point at the centre with minimum effort.

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Research article

Preliminary Assessment of Nature-Based Tourism Resources in the Buffer Zone of Bach Ma National Park, Vietnam

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Abstract The buffer zone plays a key role as an ecological barrier for protected areas. Socio-economic conditions of the residents relate not only to the development of provincial regions but also to the success of conservation strategies for the protected areas. Recent studies revealed that the local communities surrounding Bach Ma National Park, Vietnam, especially ethnic minority communities that utilize forest resources for their economic livelihoods, could contribute to biodiversity loss. Alternative livelihoods could be an effective solution to reducing their dependences on forest resources. In this study, we employed a GIS-based criteria approach to evaluate nature-based tourism resources. Forest management units in the buffer zone within Dong Giang district, Quang Nam province were chosen as study units. Twelve meetings with sixty local representatives were organized to identify potential destinations. This study proposed three criteria for the assessment of the suitability to tourism development. The first criterion is "attraction", which is scored by evaluating diversity of landscape, destination potential, and topographic characteristics. The second criterion is "accessibility", which evaluated the distance from main road to tourism resources, and the third is "adaptation", which is scored based on local legal scenarios pertaining to land use management and usage. These criteria led to the identification of eleven potential destinations and eight forest management units, which have a high potential for nature-based tourism development. The results of this study show that there are bright prospects for improving local livelihood by the tourism development in the buffer zone.

Keywords nature-based tourism resource assessment, livelihood, forest, Bach Ma

INTRODUCTION

Bach Ma National Park in Vietnam contains significant biodiversity (7% and 17% of all fauna and flora, respectively). However, the park and its buffer zones have faced many threats leading to biodiversity loss and forest degradation (Huynh et al., 2016). The buffer zones are defined as areas contiguous to protected areas and established to prevent or reduce negative impacts upon the areas (Decision No. 186, 2006). The buffer zones of Bach Ma National Park are located inside the transition zone of northern (Sino-Himalayan, Indo-Burmese) and southern (Malesian) floras, which has been assessed as an important "Floristic Biodiversity Centre" for the Indochina region (Tran and Ziegler, 2001). It is within three districts in two provinces and covers an area of 58,676 hectares. This area contains two mountainous districts, which include communities of ethnic minorities (Van et al., 2016), who have been classified into a poor socio-economic group by the government during many successive generations (Decision No. 73, 2016). Thanh and Sikor (2006), and Nguyen et al. (2016) indicated that the ethnic minorities have historically inhabited the nearby forests and utilized the forest resources for their livelihoods. Considering the dependence of the local communities, it is difficult for forest management organizations to achieve sustainable management without negatively affecting the livelihoods of those communities (Hong and Saizen,

2019). Therefore, the investments in local livelihood development should strive to reduce forest dependence and facilitate sustainable forest conservation.

Investments in agriculture or agroforestry are often encouraged to enhance rural areas and reduce forest dependence; however, the effects of the investment are limited due to local conditions. Chung et al. (2015) revealed that agricultural activities on household-scale farmlands relied entirely on weather conditions and the lack of irrigation water in the dry season was a significant challenge in the highland areas of central Vietnam. Meanwhile, Masud et al. (2017) reported that regional resources, such as natural landscapes and local culture were key components for developing tourism. The concept of ecotourism emerged in the early 1980s and was evaluated as an effective tool to create funds for nature conservation, improve local economy and raise awareness on nature conservation for local communities (Toko, 2016). Therefore, the evaluation of regional resources for ecotourism may contribute to the development of new livelihoods, which could in turn reduce forest dependency in the study area.

OBJECTIVE

The specific objectives of this study were to 1) investigate nature-based tourism resources through a community-based approach, and 2) determine appropriate areas for nature-based tourism development based on resource assessment.

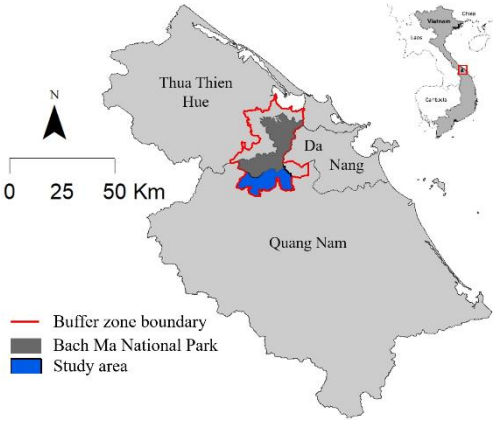


Fig. 1 Study area

METHODOLOGY

Interview and Community Mapping

Field surveys were conducted from May to June 2017 and July 2018 in the part of buffer zone, which belongs to Dong Giang district, Quang Nam province (Fig.1). We organized twelve meetings with sixty local representatives who are collecting forest resources for their livelihoods. Participatory mapping exercises and semi-structured questionnaires were undertaken to determine outstanding natural collection sites. General nature-based tourism resources, such as hot water springs, waterfalls, hills, and natural lakes were proposed in the meetings. A base map of local topographic characteristics was used for a mapping exercise in which the participants were asked to place colored beans on the map to indicate the locations of potential tourism sites. Descriptions of the surrounding landscape and preliminary assessment of the mentioned sites were also discussed in the meetings. Many kinds of waterfalls were mentioned so that classifications of waterfalls proposed by Bantinas (2010) was shown to participants in order to hear their description of the sites. The mapped information from the mapping exercise was subsequently digitized using ArcGIS 10.5.

Criteria of Nature-based Tourism Resource Assessment

Evaluation of nature-based tourism resources is often based on landscape quality and conditions relating to the enjoyment of visitors (Priskin, 2001). Boniface et al. (2016) stated that a tourist destination should consist of following main elements: 1) presence of attractions; 2) accessibility, facilities and services related to tourism activities; 3) political stability for tourism development; and 4) support of destination products by tourism stakeholders. In this study, three criteria were considered: *attraction*, *accessibility*, and *adaptation*.

Tourists often expect to have access to diverse, rare or unique destinations (Deng et al., 2002). In this study, the diversity of landscape, the potential to be a destination, and topographic characteristics are taken into account in the *attraction* criterion, as illuminated in previous studies (Aiping et al., 2015; Rahayuningsih et al., 2016). Rahayuningsih et al. (2016) defined a list of elements and sub-elements in *attraction* criterion of nature-based tourism assessment. We applied the list and assigned scores from 0 to 5 for forest management units based on the number of sub-

elements they contain, the units are designated by the government for forest management (Decree No 23, 2006). Three types of datasets consisting of a land use map, ***digital elevation model (***DEM) data, and the information from meetings with local representatives, were utilized for counting the number of sub-elements and scoring (Table 1).

Table 1 Criteria of attraction

Elements	Sub-elements	Score of study unit Number of sub-elements					
		5	4	3	2	1	None
Landscape *(based on land use map and participant opinions in meetings)*	1. Forest scenery/view 2. Rice field scenery/view 3. Plantation scenery/view 4. Garden/field scenery/view 5. Waterbody (lake, river, etc.)	5	4	3	2	1	0
Tourism objective distribution *(based on land use map and participant opinions in meetings)*	1. Natural beauty (forest, plantation, etc.) 2. Natural phenomenon (Cave, crater, etc.) 3. Waterbody (lake, waterfall, river, etc.) 4. Cultural attraction 5. Historical heritage	5	4	3	2	1	0
Uniqueness of resources *(based on land use map and participant opinions in meetings)*	1. Forest ecosystem 2. Karst ecosystem 3. Landscape scenery/view 4. Hot water spring/waterfall/lake/river 5. Cultural and historical heritage	5	4	3	2	1	0
Value *(based on participant opinions in meetings)*	1. Ecological value 2. Knowledge value 3. Medicinal value 4. Economic value 5. Belief, cultural, and historical value	5	4	3	2	1	0
Possible tourism activities *(based on participant's opinion in meetings)*	1. Research/education 2. Hiking/tracking/climbing 3. Photography 4. Enjoying scenery 5. Viewing cultural /historical heritage attraction	5	4	3	2	1	0
Altitude *(based on DEM)*	1. > 2.000 meter (high mountain) 2. 1.000 - 2.000 meter (mountain) 3. 500 - 1.000 meter (high hills) 4. 100 - 500 meter (hills) 5. 15 – 100 meter (lowland)	5	4	3	2	1	0
Slope *(based on a transformation of DEM)*	1. >45 (very steep) 2. 25-45 (steep) 3. 15-25 (wavy/undulating) 4. 8-15 (rather flat) 5. 0-8 (flat/level)	5	4	3	2	1	0

Rahayuningsih et al. (2016) cited the elements and sub-elements

Accessibility refers to the ease of being able to physically access destinations (Priskin, 2001). The criterion was divided into five distance ranges from a main road to the mentioned destination. The destination is assigned a score from 0 to 4 depending on the distance. The study unit's score is calculated by averaging the scores of all destinations distributing within the unit (Table 2).

The criterion of *adaptation to local legal condition* was considered with respect to the local legal documents on forest management and usage. This criterion was scored from 0 to 3 based on the regulations mentioned in these documents regarding the community's access to different forest types (Table 2). Generally, the access was determined by the function of forests. For instance, the special-use forest is designed to conserve the natural forest ecosystem and genetic sources; thus local community's access here is limited completely (Decree No. 117, 2010). The access in the protection forest has more flexibility, but still can be restricted in some cases to prevent erosion,

desertification and to maintain its function of regulating climate. While access in the production forest is limited for environmental protection, residents have limited access because its main function is to produce and trade timber and non-timber resources (Decision No. 49, 2016).

Finally, the suitability of study units to nature-based tourism development was delineated by a sum of scores from *attraction*, *accessibility*, and *adaptation to local legal condition*. Five classifications of suitability were used, as shown in Table 3.

Table 2 Criteria of accessibility and adaptation to local legal condition

Criteria	Distances to main road (km)					Land use			
Element	0-5	5-10	10-15	15-20	>20	Farmland and others	Production forest	Protection forest	Special-use forest
Score	4	3	2	1	0	3	2	1	0

Table 3 Assessment of nature-based tourism resource by criteria

Criteria	Classification				
	Very low	Low	Moderate	High	Very high
Attraction	0-7.0	7.0-14.0	14.0-21.0	21.0-28.0	28.0-35.0
Accessibility	0-0.8	0.8-1.6	1.6-2.4	2.4-3.2	3.2-4.0
Adaptation to local legal condition	0-0.6	0.6-1.2	1.2-1.8	1.8-2.4	2.4-3.0
Suitability	0-8.4	8.4-16.8	16.8-25.2	25.2-33.6	33.6-42.0

RESULTS AND DISCUSSION

Spatial Distribution and Description of Nature-based Tourism Resource

Eleven potential sites were identified and mapped in the meetings. These sites were digitized and a map was generated to show the locations of nature-based tourism resources (Fig. 2). We identified 2 types of tourism resources, waterfalls and hot water springs, which have been deemed significant by tourism planners and managers because of their high attraction to visitors (Prasetyo et al., 2017). In this study area, there are 7 types of waterfalls, and *slide* and *tiered* waterfalls are common (Table 4).

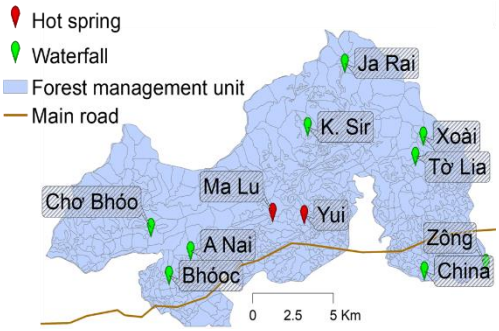


Fig. 2 Location of potential sites

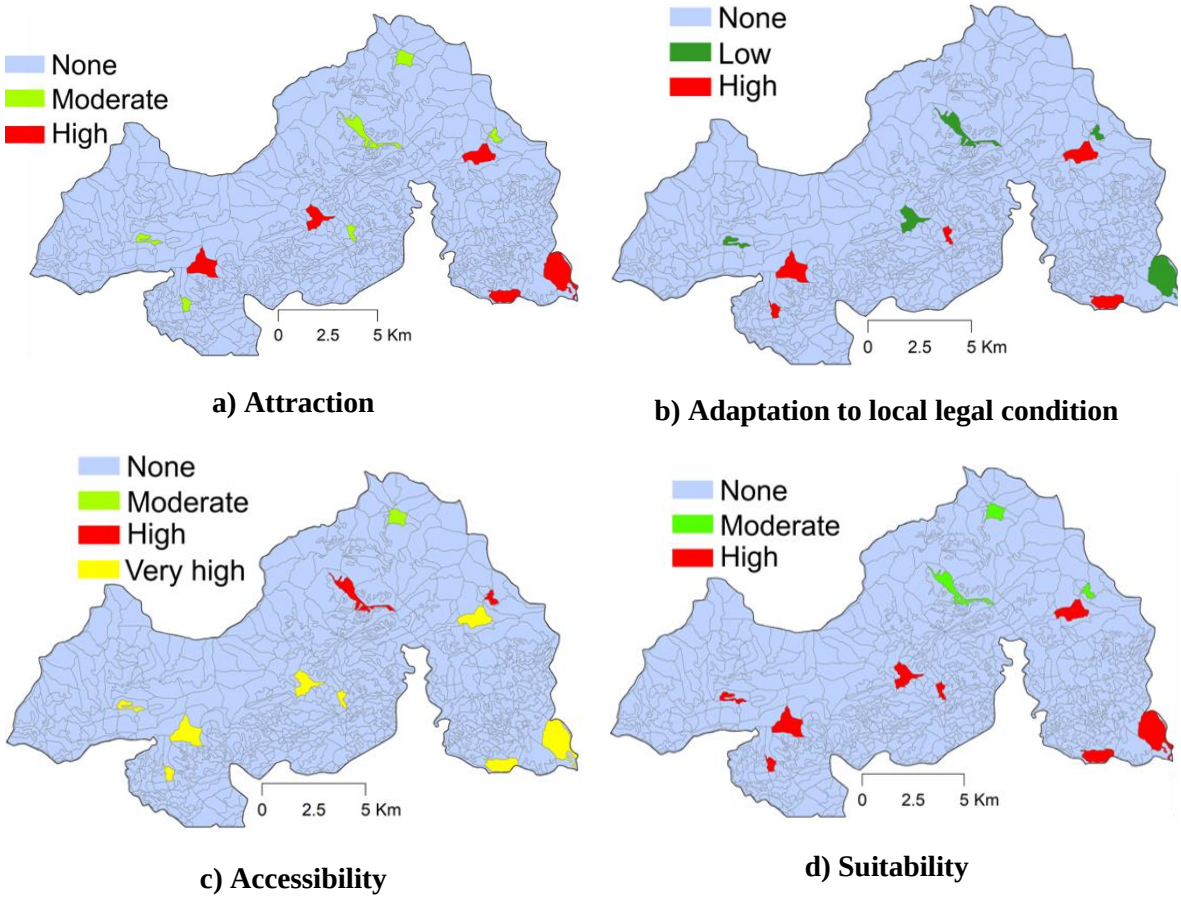
Table 4 Description of nature-based tourism resource

Type		Local name	Description
Waterfall	Fan	Thác Chơ Bhóo	The fall looks like a fan, its the base is much wider than the top.
	Curtain	Thác Bhóoc	Wide breadth, thin flow, and its height is taller than the width.
	Cascade	Thác Tơ Lia	The fall descends gradually on sloping rocks, a series of small steps in quick succession is observed.
	Slide	Thác Chơ Run Thác A Nai	The fall is thin and descends on a smooth, inclined surface.
	Horsetail	Thác China	The fall is very high, looks like a horsetail, with a spreading tail.
	Tiered	Thác Zông Thác K.Sir	The height of flow decreases with the stratification of rock.
	Punchbowl	Thác Ja Rai	The fall is short, small, and spreads out in a vast basin.
Spring	Hot water	Suối nước nóng Yui	Since the spring links to a freshwater spring, water's temperature is safe for bathing.
		Suối nước nóng Malu	Since the spring links to a freshwater spring, water's temperature is safe for bathing. It stems from a high mountain where *Cotu* people believe that the mountain gods are dwelling.

The summary is derived from the opinions of the participants in the meetings

Assessment of Nature-based Tourism Resource

Among five classifications for the *attraction* criterion, only classes of moderate and high were observed, with six and five units, respectively (Fig. 3a). While some of the sites exhibited low *adaptation to local legal condition* on forest management and usage (Fig. 3b), tourism activities are still planned in the forests. Article 17 in Decision No. 17 (2015) shows that ecotourism in the protection forest can be started if the ecotourism activities meet some requirements for forest conservation. Meanwhile, it is much easier to launch ecotourism in the production forest when the planned ecotourism activities are not having negative impacts to timber and non-timber production and the soil environment (Article 19 in Decision No. 49, 2016). Accordingly, it would be better to prepare specific plans for tourism development in different forests. Furthermore, most identified sites are within a distance of 5 km to the road connecting to a neighboring city and district with high evaluation scores for *accessibility* (Fig. 3c). A suitability map built by overlaying all assessed scores shows that a significant percentage, approximately 73% (8/11), of forest management units was classified as high suitability for nature-based tourism development (Fig. 3d). Their distribution is spread widely throughout the study area, which could boost the local economy of multiple villages by tourism development.



a) Attraction

b) Adaptation to local legal condition

c) Accessibility

d) Suitability

Fig. 3 Classification of forest management units based on criteria

CONCLUSION

The study proposed a GIS-based criteria approach for assessing the potential of ecotourism through investigating nature-based tourism resource and knowledge of the indigenous residents. While we did not integrate weights into the criteria in the assessment, this was to allow for flexibility for applying the criteria among various stakeholders in the future. The sites with high suitability to nature-based tourism development were identified by the proposed criteria, and they were observed

in various forest types. A comprehensive plan covering all forest types for nature-based tourism development should be prepared through future work.

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