広島大学ホームカミングデー　生物生産学部・生物圏科学研究科企画

第 5 回 生物圏科学研究科 食料・環境問題国際シンポジウム
「東アジアの持続可能な農業を目指した研究の進歩」

The 5th International Symposium on Food and Environment
"Current Research Progress on Sustainable Agriculture in East Asia"

日　時：平成２４年１１月３日（土）　13:00 － 16:00
場　所：広島大学生物生産学部 C206 講義室

Date: 3 November, 2012 (Sat)　13:00 – 16:00
Venue: Room C206, Faculty of Applied Biological Science, Hiroshima University

研究科長からのご挨拶

食料・環境問題は世界共通の大切な課題であり、また本学部と研究科がとくに力を入れている教育研究のテーマでもあります。このシンポジウムでは「持続可能な農業」の構築を目指して、東アジアの農業現場における環境循環の形成、有用な生物資源の開発と生産、食品の流通などについての最近の研究を紹介していただきます。環境破壊と温暖化が進む中で持続可能な農業についての各国のアイデアから、安定的な食料供給を担う農学と農業の在り方について活発に意見交換してくださるようにお願いいたします。

研究科長　谷口 幸三

Greetings from the Dean

Sustainable food production is an essential issue for human beings, while the problems of global warming and environmental conservation are becoming more serious. Developing advanced research and technology on production systems in agricultural fields is a very important priority. In this Symposium, we would like to share the recent research results and to discuss the necessity of collaborative work for the establishment of sustainable agriculture in East Asia.

Dean, Prof. Kohzo Taniguchi

Program プログラム

General Chairman 総合司会: Yukinori Yoshimura 吉村 幸則

13:00 Welcome message from the Dean 研究科長からの歓迎のご挨拶
Dean, Kohzo Taniguchi 谷口 幸三 研究科長

= Part 1 第 1 部 =

13:05 Sustainable Management of Banana Fusarium Wilt Disease Through Generating of Soil Suppressivenes
（土壌の病害抑止力の向上によるバナナ萎凋病の持続可能な管理）
Dr. Arif Wibowo （Gadjah Mada University, Indonesia）
Chair 司会: Toshinori Nagaoka 長岡 俊徳 ---Page 3

13:35 Sustaining the Agricultural Production System and Environment by Integrative Sciences: A Case Study from Thai Cassava Production
（持続可能な農業生産と環境を構築するための科学の連携：
タイのキャッサバ生産を例として）
Dr. Sutkhet Nakasathien （Kasetsart University, Thailand）
Chair 司会: Jun Wasaki 和崎 淳 ---Page 5

14:05 Coffee break 休憩
Poster presentation of the research supported by the 2011 Grant-in-aid from Dean
（2011 年度研究科長裁量経費助成研究成果のポスター発表）

= Part 2 第 2 部 =

14:30 Implement of centralized recycle system for hog excreta and sludge in Taiwan
（台湾における養豚場の排泄物と汚泥の集中リサイクルシステム）
Dr. Ryogen Oh （Tunghai University, Taiwan）
Chair 司会: Shinichi Kawakami 河上 眞一 ---Page 8

15:00 Present Conditions and Issues of the Food Recycling Loop in Japan
（日本における食品リサイクルループの現状と課題）
Dr. Izumi Yano （広島大学大学院生物圏科学研究科）
Chair 司会: Masahiro Yamao 山尾 政博 ---Page 11

15:30 General Discussion 総合討論 Chair 司会: Masahiro Yamao 山尾 政博

16:00 Closing remarks 閉会の辞 Yukinori Yoshimura 吉村 幸則

Sustainable Management of Banana Fusarium Wilt Disease Through Generating of Soil Suppressivenes

Arif Wibowo[1)], Medina Uli Alba Somala[1)], Aulia Rahman Alboneh[1)], Rahma Kusbandari[1)], Sudarmono[1)], Sri Nuryani Hidayah Utami[1)], Siti Subandiyah[1)], Tonny Pattison[2)], Leanne Forsyth[2)], Agustin Molina[3)]

[1)]Faulty of Agriculture, University of Gadjah Mada, Indonesia
[2)]DEEDI, Australia
[3)]Bioversity International, Phillipines

Fusarium wilt posed serious threat to Indonesian banana industry. Recent epidemics of banana fusarium wilt in Indonesia was caused by the tropical race 4 (TR4) of *Fusarium oxysporum* f.sp. *cubense* (Foc). Many efforts have been developed to control the disease. However, no single method has been proven to be effective to control the disease. Our collaborative research in Gadjah Mada University was addressed to conduct research on soil health, biological control and suppressive soil for managing fusarium wilt of banana. Surveys were conducted in 5 banana plantations in 3 provinces in Indonesia, i.e., Lampung-Sumatra, West Java and Central Java. Of 5 locations, 2 locations (Salaman-Central Java and NTF Lampung-Sumatra) were heavily infected by Foc while 3 other locations (Sarapad-West Java, Talaga-West Java and GGP Lampung-Sumatra) were healthy banana plantations without Foc infection. Our results showed that soil suppressiveness against banana fusarium wilt did not relate with soil physical and chemical properties. However, it related with great soil microbial activities. Microbial community analysis showed that the diversity of bacteria in the suppressive soil was greater than those of the conducive soil. More than 100 bacterial isolates were collected from both suppressive and conducive soil and 10 of them were antagonistic against Foc *in vitro*. Labile carbon analysis showed that the suppressive soil brought against Foc had greater total carbon content than the condusive soil. The analysis of fluorescin diacetate hydrolase (FDA) and β-glucosidase also showed that the total microbial activity in suppressive soil was higher than the conducive soil.

One alternative control to fusarium wilt of banana is using a cultivation technique by manipulating nutrient status. The study to determine the influence of soil application with silica and manure on the incidence of fusarium wilt of banana was conducted by observing the incidence of necrotic rhizome of Foc susceptible Ambon Kuning (AAA) banana cultivar. The result showed that the application of silica into suppressive soil taken from Sarapad-West Java and inoculated with Foc did not effect on the incidence of fusarium wilt disease, while application of manure could suppress disease development. However, for the conducive soil taken from Salaman-Central Java, silica or manure applications were not able to suppress the incidence of fusarium wilt of banana. The result of this study indicated that application of organic matter in suppressive soil can increase soil microbial activity, so it is able to suppress Foc development in soil.

Studies on disease suppression have shown that many different mechanisms contribute to disease control. Involvement of cultural practices may play an important role in the establishment of soil suppressiveness to soilborne plant pathogens. Our ongoing research was focused on generating suppressive soil for managing fusarium wilt banana by manipulating banana cultural practices. The objectives of the present study were to determine the effect of (i) *Allium* spp. multiple cropping and (ii) biofertilizer on banana fusarium wilt suppression. Preeliminary data indicated that after 1 year planting, *Allium tubersosum* and *A. cepa* multiple cropping could suppress the development of fusarium wilt of banana. We suspect that *Allium* spp. produces chemicals that affect the activity soil microorganisms and had indirect effect on the development of Foc in soil. Therefore our future study is to rotate banana with *Allium tuberosum* or *A. cepa* to suppress the Foc population in soil. Two types of strategies are involved when using suppressive soil to control soilborne plant pathogens. One strategy is based on enhancement of the level of suppressiveness that exists in any soil and the other strategy consists of the selection of efficient strains of antagonistic microorganisms as biological control agents. Biofertilizer contained many beneficial microorganisms which may contribute for promoting plant growht and suppressing plant disease when applied in soil. Our preliminary data showed that banana treated with biofertilizer had a better growth compare to control treatment and may induced plant resistance against fusarium wilt disease.

Key words: Banana, fusarium wilt, soil suppressiveness

.

Sustaining the Agricultural Production System and Environment by Integrative Sciences: A Case Study from Thai Cassava Production

Sutkhet Nakasathien, Vichan Vichukit, Ed Sarobol, Piya Kittipadakul, Chalermphol Phumichai, Pasajee Kongsil and Chariensak Rojanaridpiched

Department of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand

The demand for cassava (*Manihot esculenta* Crantz) tubers; starchy tuberous roots, as raw material for both domestic industry and export such as cassava chips, cassava pellets and modified starch, and for supplying for the newly developed industry of bioethanol, has continuously increased over the past decade. As the world first exporter of cassava and the increase local demand, the planting areas has reached 1.2 Mha with the average root yield of 21.8 Tons/ha and average starch content of approximately 25% based on fresh weight (OAE, 2011). Thai cassava researchers have put tremendous effort on numbers of strategies imposing on the improvement programs covering the breeding, and crop physiology and production, and pest management. The integration of basic and applied sciences are then required for sustainable production of cassava.

One of the most important factors influencing on the cassava root yield is derived from the exotic traits in germplasm collection. To accomplish on the increment of root yield, all good genetic resources are targeted, i.e., drought tolerance, wide adaptability, disease resistance and excellent agronomic characteristics of effective plant architecture, good emergence rate and vigor, resistance to disease and insect pests, shorter harvest cycle, longer storagability of tuberous roots and stem cuttings for propagation. However, it is unlikely to achieve in cassava breeding program to have a pool of all referred traits in one variety or “all in one”. Thus, the current exotic cassava lines still need the good agricultural practices to pave their ways to success for the high final root yield.

Since Thailand has adopted cassava to be one of the economic crops for nearly 50 years, the average total fresh root yield has increased by more than 100% and average total root dry matter content has increased by more than 20% as the result of cassava breeding programs, mainly from the collaboration of Centro International Agricultural Tropical; CIAT and Kasetsart University (KU), and Department of Agriculture (DOA) under the Ministry of Agriculture and Cooperatives (Kawano, 2003). From 1992 up to now, one of the successes, a cassava variety of Kasetsart University 50 (KU50) has been adopted and grown more than 50% of cassava planting areas in Thailand and, as well, is one of the most well-known and well adopted in southeastern Asian countries and other regions of the world.

Continuously, KU with a cooperation with the Thai Tapioca Research Development Institute (TTDI) has developed new cassava varieties with higher root yield and starch content, such as Huay Bong 60 (HB60) and Huay Bong 80 (HB80) and have been used as elite varieties in Thailand, along with the varieties of Rayong (R) series such as R5, R7, and R9 developed by the DOA.

Together with the cassava improvement programs, good agricultural practices have been conducted to accommodate the wide range of planting areas and different groups of cassava producers, ranging from the small farm holders to the industrial scale production. As the responsive species to the limiting factors of water and fertilizer, cassava physiologists have tried to come up with the best practice for improving the root yield while maintaining the excellent plant health throughout the crop cycle. It usually requires 8 to 12 months after planting before cassava can be harvested. Since it was firstly adopted as a poor farmer crop, thus the input factors of fertilizer, water are practiced at minimum to none for small farm holders. In contrast, with a limitation of cassava planting area expansion while the fresh root demand has increased, the problem should be sustainably solved by integration of crop physiology, emphasizing on the aspects of water and fertilizer application aiming for increasing the yield while improving the green and environmentally friendly agricultural production systems.

The cassava production areas are mainly rainfed and minimum agricultural practices resulted on the relatively low average root yields (Tongglum *et al*., 2000). So, focusing on the management of water and fertilizer could shape a new crop production strategy with a double increment of root yield from the country average. If this practice can be adopted for only just 25% of cassava planting areas, it would minimize the competition over the planting areas with other economic crops, such as sugarcane, para rubber and oil palm. However, the requirement of water resource and investment on applying the irrigated and fertilizer system have to be taken into accounts with a consideration of a period to break an even of over production costs. With this promising practice, there are needs to be further developed the cassava production to support the year-round need of cassava raw materials.

Some success of the cassava improvement program and crop physiology production could have been hindered as well. Starting from late 2008, the new phenomena of invasion of cassava mealy bug (pink mealy bug; *Phenacoccus manihoti*) damaged the plantation areas of more than 30%, consequently caused a country root yield reduction of nearly 20% (DOA, 2011). This unexpected widespread of pink mealy bugs in cassava led the different field of researchers to the battleground. Entomologists, cassava physiologists and breeders extended to commercial partners focused on the abruptly emerged problem. To troubleshoot this impediment, the soaking of stem cutting before planting and the integration of biocontrol using the pink mealy bug native predator (*Anagyrus lopezi*) obtained from Benin, Africa were the key success factors, and the problems have been reduced since rainy season of 2011 up to now.

From some of the cases in the production of cassava in Thailand, they encompass all dimensions a wide range of agricultural science, basic science, economics and social science. Thailand, as an agricultural country, all stakeholders have to step forward to work on, to facilitate, to troubleshoot all the current and foreseen situation to accommodate and fulfill the well being of Thai farmers and, as well, maintaining the balance on socio-economics of the country.

References

Department of Agriculture, Kasetsart University, and Department of Agricultural Extension. 2011. Management of pink mealy bug. The agricultural co-operative federation of Thailand., Limited. Nonthaburi. 60pp (in Thai)

Kawano K. 2003. Thirty years of cassava breeding for productivity- biological and social factors for success. Crop Sci. 43: 1325-1335

Office of Agricultural Economics. 2011. Fundamental information of Agricultural Economics. Cassava Production. Source: http://www.oae.go.th/main.php?filename=agri_production. 15 July 2011

Tongglum A., Suriyapan P., Howeler R.H. 2000. Cassava agronomy research and adoption of improved practice in Thailand- major achievements during the past 35 years. *In* Proceedings of the sixth regional workshop. Feb 21-25, 2000. Ho Chi Minh City. Vietnam.

Implement of centralized recycle system for hog excreta and sludge in Taiwan

OH, RYOGEN

College of Agriculture, Tunghai University, Taiwan

Hog farming is an important agricultural industry in Taiwan, especially in 1980s, it became the biggest item of livestock products of the nation and farmers started exporting frozen pork to Japan. Additionally, dispose of waste materials of hog farms has turned into a hard hurdle to the government and the farmers. How to reduce, reuse and recycle waste materials of hog farms has been a nationwide issue. It is said that hog farming will give three problems to environment including waste water, solid wastes and offensive odor. As pork is the most important and popular meat for Taiwanese, how to overcome these three problems, and reduce, reuse and recycle the hog excreta or sludge will be the key point for seeking a better way of sustainable hog farming for Taiwan.

Most of researchers in Taiwan tended to suggest hog farmers should separate solid wastes from liquid and then ferment solid wastes to be compost, as well as sanitize liquid wastes to be qualified sewer water. Unfortunately, for the sake of contributing a clean feeding yard for hog raising, many farmers in Taiwan drew a great quantity of groundwater to wash the yard and sluiced waste water into irrigation ditches or sewers. This kind of trouble caused by over-use of groundwater, not only had lead ground had been sinking in rural areas for several years, but also had made more waste water be flushed with hog excreta illegally. In this age, researchers presented many ideas to help farmers saving usage of water in feeding yard. In order to improve the water pollution about waste materials from hog farms, the government requested farmers to build up their own purification equipment for waste water as an essential obligation to operate the farms.

The farmers know they have to find a better and sustainable way to make waste materials be useful , but disposal of solid wastes as useful material is limited by several factors, including shipping cost, spoilage during storage and transport, and the presence of undesirable components such as salt or alkaline. Water content is a major factor to decide shipping cost and spoilage speed. Composting is a popular option for disposal, but odor and leaching of soluble constituents are limiting factors. Composted solid wastes of hog excreta is valued as a soil amendment or potting soil, but widespread use and market ability are limited by shipping cost. Composition of the composting materials needs to be modified to obtain the correct physical mix to allow the natural composting aerobic bioprocesses to proceed. Disposal of solid wastes from hog farms to domestic sewers is becoming less favorable because of increased sewer rates and the hesitation of municipal sewage treatment plants to accept these waste streams that have high biological oxygen demand (BOD) and high salt content. Since the cost and the quality of composting solid wastes of hog excreta not always benefit farmers, some of them no longer compost but only separate free liquids from the solids, then collect solids as sludge and fill to the land. The practice of land-filling is becoming less favorable too due to the generation of foul odor as communities expand and reside next to hog farms. Leaching of undesirable constituents such as salt, soluble organics into the soil and groundwater is also an important concern where the groundwater is used by citizens or it interflows into nearby water resources of living water.

Under technical and financial support of government, hog farmers purchase dewatering screens, centrifugal screens or strainers to separate liquids from the solid wastes currently. They are trying to sanitize the liquids from hog excreta and find more efficient ways of utilizing the liquids, and get solid wastes with lower moisture. Moreover, in an effort to reduce the volume of solid wastes of hog farms and also transform the usable parts of solid wastes into compost or fuel, some researchers tried to use bacteria to speed up fermentation of solid wastes and gather methane gas as fuel, but many later surveys showed that is not an efficient way. The main factors that methane gas gathering system did not work well due to the scale of hog farms was too small, the methane gas gathering machine was hard to be maintained. Besides, to recycle solid wastes of hog farms as compost is a good concept for enriching soil, but there are some tough problems still left to be deal about how to control the concentration of metal, antibiotic, salt and residual chemicals what will be input from hog feed or animal medicines. Thus if we want to recycle solid wastes of hog farms into compost, it should be figured out a standard tolerance value for certain critical materials.

On the contrary, how to lower the cost of hog feeding was still a main issue, so hog farmers in Taiwan were not quite positive to set up sewage purification equipment. A lot of hog farmers sluiced liquid and solid wastes into river directly without sanitization until government started severe penalty. For the reason, hog farming once considered as a pollution source to the home environment and caused pollution trouble of groundwater.

As stated above, researchers and government officials of Taiwan have made efforts to help farmers can reduce and reuse the waste material from hog excreta, but it seems didn’t work well. In 1997, foot-and-mouth Disease (FMD) spread again in Taiwan since last hit in 1924, and caused meat packers to stop exporting fresh meat to Japan. In irony, after FMD had killed tremendous amount of pigs, many hog farmers decided to close down their business, and also involved the quantity of emissions and excretion of waste materials to be decreased remarkably.

New treatments for hog excreta are carried out nowadays in Taiwan. A group of NTU plans to evaluate a centralized wastewater treatment plant in a river area of south Taiwan. The evaluation results for planning a centralized wastewater treatment plant showed that the plan using liquid transporters to collect wastewater is feasible and cost effectively under using a good recycle system of solid wastes at the same time. By the way, the pay back periods could be shortened if composting house and bio-methane plant were owned and run by farmers. However, gather bio-methane from fermentation of hog waste materials doesn't seem to be a fine way as mentioned, another approach is launching evaluate microbial ecology and performance of nitrification of active sludge in hog waste materials by using ammonia oxidizing bacteria(AOB) and nitrite oxidizing bacteria(NOB) what are selected through cloning.

Though excellent skills of fermentation are available for converting solid wastes into compost fast, offensive odor is another problem what exists in liquid wastes of hog farms. Therefore, how to solve the problem and recycle the liquid wastes as useful matters will be a hot theme for the next stage of Taiwan's livestock products. A group of THU is simulating an operation model of centralized recycle system in Yulin where is located in middle Taiwan but taking the second place of quantity of hog raising output, and the group is planning to conduct the model as a commercial business under adopting an recyclable sewer disposal system. This system consists of centralized recycle plant for composting solid wastes, distribution network for shipping solid wastes by trucks and sanitization machine for each hog farm to dispose of liquid wastes. In this research, the group will try to establish a distribution network of trucks for gathering solid wastes of hog farms. Operators of the plant will ship solid wastes to centralized recycle plant by trucks, and will make it to be composted and deliver compost products to vegetable farmers of Yulin prior. The group will also supply selected microorganism to each farmer to remove the offensive odor of liquid wastes but will keep the nutritional molecule for soil remaining in the sanitized liquid because the group expects every hog farmer who participate this project can supply sanitized liquid to irrigation system of paddy fields as functional liquid fertilizer.

Present Conditions and Issues of the Food Recycling Loop in Japan

Izumi YANO

Graduate School of Biosphere Science, Hiroshima University, Higashi-Hiroshima, Japan

Situation of the Current Food Waste

About 1/3 of the foods produced all over the world for human consumption is abandoned, which makes approximately 1.3 billion tons of food waste per year, according to the United Nations. The way how food wastes are generated is different between developed and developing countries. In developed countries, 40% of the food wastes come from the retail level (including restaurants) and the household kitchens and tables while 40% of the food wastes in developing countries are produced during post-harvest and food processing.

All over the world, the concern for food waste and its recycling is increasing and it has become a big social issue in Japan. The statistics in 2009 shows that 30.6 million tons of food that constitute 36% of all food supplied to the consumers in Japan have ended up as waste. Among these, 12.7 million tons are by-products (soybean meal, wheat bran, etc.) which are generated during food manufacturing and processing, and have been historically reintroduced to the market as the valued new products. Therefore, these are not strictly called "waste". So, we can say that the 'pure' food waste in Japan is the remaining 17.9 million tons. Commercial wastes from supermarkets, groceries, wholesalers and restaurants generate 7.6 million tons. About half of them are unsold food at the stores and leftovers at the restaurants, which were originally supplied as edible food. The other 10.3 million tons are from domestic households. Among the food wastes from the households, 2-4 million tons are leftovers at the table and discarded fresh food that have rotted or gone beyond their expiration dates during storage without being consumed.

This means that true "food loss" today can be estimated at 5-8 million tons in Japan. The definition of "food loss" in Japan is "food that has been abandoned although it is edible or was once edible". The available statistical data of the Ministry of Agriculture and Forestry refer to the sum of the leftover food from the food service industry and the home, the food discarded directly (e.g., food that has expired) and excessive removal (e.g., edible part of food excessively removed on cooking).

Background of Food Loss in Japan

Why is such food loss produced in Japan? Similar to other developed countries as mentioned above, the big factors are the consumers' behavior and the food distribution system.

The first consideration is the detailed perishable foods standardization system. The main distribution channel of fresh food in Japan is an extensive nationwide distribution system through the public wholesale markets. The public wholesale market links the sellers and the purchasers of large amount of fresh food promptly, and it can be a place which provides a fair price with the open auctions. In order to execute many and prompt dealings at the wholesale market, the standardization of food is required. Standardization can improve the efficiency of distribution. However, the foods which are sub-standard (e.g., too large or too small a size, a small blemish on the surface and so on) cannot be accommodated on this large and efficient delivery channel, and in the worst case, they are abandoned at the farm. Those discards are not included in our statistics so that we can say that actual food loss is more than what statistics will show.

The conventional way of the food trade in recent years can be the second factor. The producers and manufacturers used to influence the marketing channels of food, but now the retailers and consumers exert more impact on the channels. In food marketing, the idea of "ECR (Efficient Consumer Response)" has become most important. The retailers have to supply appropriate food to the consumers at a good price at the right time. They can never be allowed to deplete their stocks in the shop and the wholesalers have to keep a large stock in their storage.

Thirdly, the consumers' behavior and food purchase preference are contributors to food loss. The consumers' confidence survey conducted by the Agriculture, Forestry and Fishery Finance Corporation in 2008 showed that more than half of respondents value freshness in food purchases regardless of the kind of food. This tendency appears strongly in fish (76.5%), vegetables (71.6%) and dairy products (66.3%). This factor also affects the second factor mentioned above.

National System of Food Recycle and its Limit

"The Promotion of Utilization of Recyclable Food Waste Act (Food Recycling Law)" was enacted in 2001 to build a pro-active society based on reduced food waste and food recycling. It requires the food industry including food manufacturers, processors, traders and restaurants to reduce their food waste and to promote recycling. To further promote recycling, the law was amended in 2007 and the recent action plan based on the new Food Recycling Law requires for the food industry to raise recycling targets by year 2012, i.e., 85% for the food manufacturers, 70% for food wholesalers, 45% for food retailers, and 40% for food service industries.

The Food Recycling Law only targets food industries and does not address waste from households which produce the bulk of food waste today. Moreover, the Food Recycling Law did not cause remarkable waste reduction although the recycling ratio increased. In addition, the law provided for an obligatory recycling ratio which caused the expansion of the reproduced food waste commodity market and the increase of food recycling entrepreneurs. For these entrepreneurs, a certain amount of food waste is needed so they can maintain their business.

Consequently, the amount of animal feeds and fertilizers made from food waste is increasing every year. However, there are not enough organic or general farms which use organic fertilizer partly to accept those recycled from food waste in Japan. The demand for organic fertilizer of food waste origin is not so high. This might cause a situation wherein recycled resources themselves can become waste.

Food Recycle Loop and its Issues

In actuality, the food industry is mainly carrying the burden of food recycling costs. They cannot receive any profit by recycling as they don’t sell most of their discards. The industry can recover recycling costs only when there is a need to identify other clients to accept, buy and use those recycled resources then finally the industry utilize the products as value-added commodities grown with those recycled resources. In other words, the loop is indispensable for food recycling. Retail stores are expected to sell the vegetable and meat produced from using the regenerated manure fodder from food waste, and the restaurants are also expected to use these meat and vegetables. In that case, our research has found that the biggest problem lies in the consumers’ awareness about recycled food waste resources.