Multi-disciplinary innovation response to extraordinary pandemic

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ABSTRACT Sabah's fruit and vegetable farmers were saddled with stockpiles of their fresh produce during the movement restriction orders enforced as part of control to contain the spread of infection during the COVID-19 pandemic. This resulted in loss of their livelihood because their produce could not reach consumers beyond their district and the land border closure stopped exports to Sarawak and Brunei. Calls for assistance were placed in local social media groups and word-of-mouth. Universiti Malaysia Sabah researchers, in consultation with the farmer community, responded by transferring knowledge on food product innovations and other technological innovations to the farmers. The Diffusion of Innovation Theory was used to explain the successes and challenges encountered. Cabbage floss and tomato sauce innovations that had reached different levels of market are used as examples.

KEYWORDS: Multi-disciplinary; Pandemic; COVID19; Livelihood; Innovation adoption
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INTRODUCTION

SARS-CoV-2 coronavirus was introduced into Sabah, East Malaysia from Peninsular Malaysia in early March 2020 (Balakrishnan *et al.*, 2023; NST, 2020). As a response to contain this airborne disease with no known vaccine and cure, the federal government of Malaysia used existing laws to enforce what would be the first of several 'movement control orders' from 18 March to 4 May 2020. All inter district non-essential travels were prohibited. Transportation and movement of food and local agricultural produce were exempt. However, the supply chain of food from farm to table was disrupted because many Malaysians' perishable food is produced by small farmers. The average size of such a small farm is 0.67 hectares for fruits and 1.01 hectares for vegetables (Hassan *et al.*, 2018). Small farmers may include people who produce food on land they do not own. During the movement restrictions, they could not reach their farms. Middlemen could not reach small farmers to convey their produce to the market, supermarkets and hypermarkets (Ooi & Dambul, 2020). In Malaysia, supermarkets and hypermarkets made up 43 percent of country wide retail food market, with the remaining 56 percent of the food retail sector shared by grocery shops, markets, weekly pop-up markets, roadside stalls and mobile vendors (Ngumbang, 2018). In Sabah, the *tamu* is a periodical pop-up market. Sellers gather at a designated area every week or every 10 days. Sellers are usually farmers. Each district has its own *tamu* ground, but most districts do not have urban areas and hypermarkets. The District Councils ordered *tamu* to be closed in March 2020. As a result, the income of small farmers was reduced.

In this paper, the focus is on imparting innovation knowledge from university researchers as part of agricultural extension to sustain livelihood of small farmers in the vegetable and fruit production areas of Sabah, namely Kundasang and Tamparuli during the various movement restriction orders, lessons learnt, successes and challenges. From the onset of the first movement control order on 18 March 2020, Kundasang vegetable farmers could no longer sell their vegetables because the

Sarawakians, Bruneians and middlemen stopped collecting their fresh produce from their farms due to logistical restrictions. Within ten days, farmers had discarded at least 800 tonnes of vegetables worth over MYR 1 million (approximately USD 237,603) (Chok, 2020). News of farmers' livelihood being affected also reached Universiti Malaysia Sabah researchers through local social media groups and personal communication. Tomatoes and vegetables were left unharvested in Kundasang. Pineapples were left to rot in the field in Tamparuli. These affected the farmers' livelihood as they had invested money, time and labour to cultivate them.

BACKGROUND THEORY

Diffusion of Innovation Theory in Agricultural Extension

The Diffusion of Innovation Theory was first proposed by Rogers (1962) and has been used extensively in agricultural extension albeit with criticisms of its limitations (Stephenson, 2003) which had also been acknowledged by Rogers (1995). However, the success and challenges observed in the multi-disciplinary response to the plea for help by small farmers in Kundasang and Tamparuli were indeed predicted by this model. The theory identifies five categories of adopters of innovation, i.e. Innovators, Early Adopters, Early Majority, Late Majority and Laggards and calls for identification of type of adopters so suitable strategies could be used to appeal to them. To the best of our knowledge, this is the first-time innovation adoption that focused on downstream food product development are examined using this theory. Earlier publications looked at innovations in new farming systems which lacked discussion on examples of those innovations (Jamsari *et al*., 2012), a specific farming practice like a new method of keeping bee hives (Sumin *et al*., 2024), or was focused on small and medium enterprises' supply chain technology (Faisal & Idris, 2020).

METHODOLOGY

Collection of Information on Problems Faced by Farmers

Between March and April 2020, various researchers in Universiti Malaysia Sabah were contacted by their village kinsfolk or community leaders or learned about problems faced by farmers through community social media groups and word of mouth. Often, this information was accompanied by pleas for help by the farmers to resolve their dwindling livelihoods due to inability to move their farm produce for sale.

Innovation Ideas by University Researchers

Brainstorming of ideas by groups of researchers

Various groups began to form, initially from within the same faculty, to offer to transfer innovative solutions to the farmers. For example, researchers from the Faculty of Food Science and Nutrition wanted to transfer various food product innovations that utilise surplus fruits and vegetables. Researchers from the Faculty of Social Sciences and Humanities wanted to utilise the local knowledge within the community to produce sellable food products. Colleagues from the Faculty of Sustainable Agriculture proposed a self-sustainable domestic farming system. Those from the Faculty of Business, Economics and Accounting wanted to develop innovative alternative supply chains that could complement the broken supply chain during the movement restrictions. Colleagues from Faculty of Computing and Informatics wanted to develop mobile applications utilising smartphone and the internet that could be used to connect agricultural producers directly with end purchasers. Those from the Faculty of Engineering wanted to offer to transfer expertise on mechanising food processing.

These initial online brainstorming efforts by researchers from within the same faculty led to groups reaching out to researchers from other faculties as innovations have a social acceptability component, a marketing component, and probably a digital component, thus forming multi-disciplinary teams.

By April 2020, various groups began exploring funding opportunities for their ideas. Most of the funding would eventually come from Universiti Malaysia Sabah's internal funds from the Research Management Centre's innovation grants. In total, 71 researchers from faculties and institutes across the university proposed 13 innovation projects that included agriculture, food technology, nutrition, digital technology, business and marketing, local wisdom and social science disciplines. Collectively, these researchers were loosely branded as UMS AgriSolutions with a mission to bring innovative solutions from farm to plate, and from university to community. Its vision was to strive to be an innovative group capable of quick action.

Discussions with entrepreneurs and community leaders

At various points of the brainstorming, individuals from the target community in Kundasang and Tamparuli were consulted either online or through one authorised field visit to meet in-person, which was coordinated between the university and the police. The participants comprised of individuals who contacted university researchers, and people known to these individuals.

Innovation technology transfer to farmers and villagers

Once the innovation technology proposed had been agreed with various farmer and village groups, information about training workshops were disseminated through community social media groups. Those who responded were included in the workshops. Researchers obtained permission to travel to the villages to conduct training workshops. Some workshops were conducted online. They were no participation fees. Raw materials were surplus fruits and vegetables from farms. Some community leaders and local entrepreneurs shared their own equipment and offered their premise for the workshops. Processing equipment and consumables were brought from the university. Small equipment was purchased via grants and corporate social responsibility (CSR) programmes and given to participants after the training workshops to enable them to adopt the diffused innovations.

Food product innovation projects included imparting knowledge on food safety, food processing, food labelling, sensory evaluation test and product storage. Mobile application projects included trial run of the developed apps. Farming system innovation projects included nurturing of vegetables or chicken livestock from seedling to harvest and sales of produce. At least three training workshops were conducted for each project. We will focus on cabbage floss and tomato sauce technology diffusion as examples. The Diffusion of Innovation Theory will be used to demonstrate the various categories of adopters of technology.

RESULT AND DISCUSSION

The agricultural extension used a multi-disciplinary approach to transfer knowledge of new food products that could extend the shelf-life of agriculture produce that would have otherwise perished, and it was hoped that farmers who were trained would be able to increase and/or sustain their livelihoods in the face of a total loss of the sale value of their entire harvest. Figure 1 shows a model on how stockpiles of agricultural produce which otherwise would have over-ripened and discarded as waste during the movement restrictions could be salvaged by food product innovation. At the same time, efforts to produce new food products were also informed by local tradition and knowledge. Imparting knowledge on storage and post-harvest handling, including ways to handle excess harvest was also useful. When innovation diffusion was successful, the knowledge acquired

by participants could be utilised to improve their livelihood after the pandemic. The cabbage floss innovation utilised local tradition and knowledge to produce new products. The tomato sauce innovation introduced innovation that allowed utilisation of over-ripe produce and excess harvest. Both innovations allowed extension of shelf life, which improved profit margins and increased time available to sell farm produce.

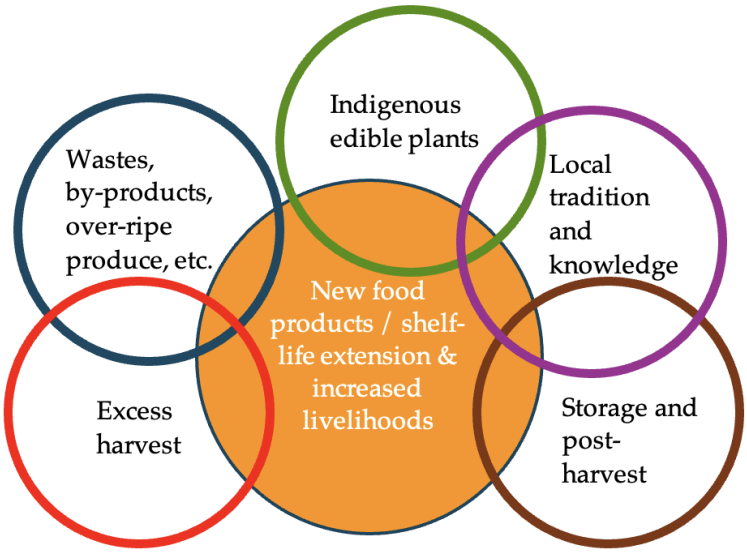

Figure 1. Multiple opportunities for innovation.

Among the success was cabbage floss which was initially produced at cottage scale using household utensils. The innovation was a combination of traditional knowledge of making deep-fried floss and stockpiles of cabbage in Kundasang which could not be delivered to the market. Diffusion of technology was conducted over three online sessions. News of the product from the initial training workshop and social media posts attracted new people who were not farmers but were keen to try producing this innovation. It is now produced by several entrepreneurs and are available in retail stores (Inus, 2021), online locally (Pasar Maya Serunding Kubis, 2024) and internationally on the Halal Street UK online platform. The technology adopters also received further product improvement advice from the Department of Agriculture and university food science and technology researchers.

Another example was the diffusion of tomato sauce bottling technology (Daily Express, 2020). The in-person training workshop was attended by 20 participants. A second meeting was attended by 13 participants to discuss with an engineering researcher on mechanisation of the bottling process. Bottled sauce has not reached the market because there were several problems beyond solving the initial issue of stockpiles of tomato during the movement restriction. When commercial logistics resumed, farmers preferred to sell fresh tomatoes to middlemen for a quick return of their investment. An idea to mechanise production was no longer feasible because all tomatoes either went to local retail markets or were exported to Sarawak and Brunei. Any access harvest was seasonal. Not all tomato varieties planted in Kundasang were suitable for optimum sauce processing. Competitively priced glassware for bottling tomato sauce had to be shipped from Peninsular Malaysia. That cost was prohibitive for farmers. Processing equipment for a small processing plant required a large capital investment and constant supply of tomato stockpiles. Instead, participants with guidance from the food technology researcher conducted further innovations and combined tomatoes with other farm harvests. Their products were packaged into plastic food-grade containers and marketed at a smaller scale compared to the cabbage floss. Figure 2 shows the cabbage and tomato products.

Figure 2. Retail cabbage floss (left) and tomato-based products (right).

Agricultural extension services in most developing countries post-World War II were organised under a national (or state, in the case of Sabah) ministry of agriculture without an effective connection to agricultural universities or relevant faculties. Rogers (1988) stated that the result was an agricultural extension system that did not have much to say to the farmer (Rogers, 1988). Despite the well-publicised story of innovation diffusion for tomato sauce described here, both in printed and online media (Daily Express, 2020), a government agricultural extension agency described research to produce bottled tomato sauce and canned puree based on an estimate of excess of 10 metric tonnes of lower grade Kundasang tomatoes which were often discarded (Daniel *et al*., 2024).

The Innovation Diffusion Theory's limitation was evident here. In the case of the tomato sauce bottling diffusion, the Innovators were present. They continued to work with the university researcher on diversifying their innovation despite inconsistent supply of surplus tomatoes. However, the momentum did not diffuse to other farmers of entrepreneurs because individual resources, ecosystem support and market opportunities to adopt the innovation were not present. There was no relative advantage for more farmers to adopt this innovation because sale of fresh tomatoes offered quicker profits. In terms of compatibility, the innovation was not consistent with the experiences and needs of most farmers. Unlike the cabbage innovation diffusion, there were no Early Adopters and Early Majority for the tomato innovation diffusion because the cost of production of tomato products was not competitive compared to retail price of the same product by established manufacturers.

In the cabbage innovation diffusion, the Innovators described by the Innovation Diffusion Theory were very keen to adopt the cabbage floss. Their willingness to take risks included using their own money to purchase small drying cabinets in the early stage of their adoption. This wave was followed by Early Adopters who heard about the innovation and needed no further convincing to start their venture. When demand outstripped the small-scale production ability, more people adopted the innovation. These Early Majority included non-farmers, for example, people who were out of employment because of the pandemic. The success stories of the Innovators and Early Adopters convinced them to adopt this new food production.

The lessons learned from these two UMS AgriSolutions innovation diffusion projects were: (1) moving from knowledge provider to listening to different perspectives, (2) navigating different aspired and perceived roles of university researchers, and (3) necessity to balance between attention toward knowledge and attention toward values and emotions. These lessons concur with the case study findings conducted on topics on gene editing technology and society, nature and inclusive agriculture, environmental aspects of food, and the role of science researchers in the public arena (de Roo *et al*., 2024). Although researchers conducted consultations with the community to understand the problems faced by farmers prior to the innovation diffusion workshops, more could be done to

appraise the different needs of farmers. For example, farmers might prefer assistance on selling their fresh produce compared to acquiring knowledge for downstream processing of their produce despite a possible higher profit return. Marketing and business skills might not be transferable in the same manner and pace as food processing knowledge. The focus should be equally balanced between imparting technological knowledge and learning about the values and emotions of the community.

CONCLUSION

We have described a multi-disciplinary innovation response to the once in a generation situation of the COVID-19 pandemic, and its effect on farmers' livelihood. The Innovation Diffusion Theory demonstrated the successes and challenges faced by researchers in transferring innovation knowledge to the community. The way forward is to have more university researcher involvement in transferring innovations, government agencies to work together with university researchers to avoid the same pitfalls that had been encountered, and finally but not less importantly, to listen to the community's emotions and values when attempting to transfer research-based innovations.

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