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Introducing an agricultural app to rice farmers: A pilot study in Can Tho, Vietnam

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Summary

Plantix is an agricultural app developed by a private company based in Germany which offers a diagnosis and advice for more than 30 crops. It has great potential as a new form of extension service complementing a traditional face-to-face extension service. The CGIAR Plant Health Initiative seeks to introduce the app as part of a package of innovations available for integrated pest and disease management to facilitate behavioral change among farmers. Plantix has been widely used in India but has not yet become very common in Vietnam.

The aim of this pilot study was to test the usability of Plantix app for progressive rural rice growers in Vinh Thanh District, Can Tho City, Vietnam. A group of 15 farmers (5 woman and 11 men) participated in the training on use of the app and provided feedback after a two-week trial.

The results show that the farmers seem to have some trust issues with the app's diagnosis, as it reportedly failed to identify or distinguish early signs of certain pests and diseases on young rice. Nevertheless, the farmers showed interest in using Plantix app and considered it a useful tool once its early detection capacity is improved. The participants were experienced large-scaled rice farmers who were already quite familiar with the symptoms of regular pests and diseases. They agreed with the knowledge provided by Plantix. The farmers appeared to be conscious of the recommended dosage of chemical pesticides as written on product labels, however, the current local practice still involves overusing. This suggests that additional measures might be needed along with the introduction and dissemination of Plantix for a stronger impact on farmers' behaviors. The app can be very useful for farmers when they start growing new crops, when there are new pests and diseases, and when they have difficulties distinguishing one disease from others with similar symptoms. Some of the farmers suggested the need for information about new generation pesticides. They also expressed the need for recommendations of specific "top-ranked" pesticide products, to help them navigate the large number of products and brands currently on the market.

Considering the gender division of labor and decision-making, the results show that men are usually responsible for pest and disease management, but women are also involved in decision-making to some extent. It will be interesting to observe how women's improved knowledge on pest and disease management obtained through Plantix will lead to change in household decisions on pesticide use.

The participating farmers use various sources such as TV, Internet, extension workers, input suppliers and peer farmers as means of accessing information and exchanging knowledge. Male farmers tend to learn new agricultural technologies through social networks within their villages and the Internet more often, while the women do that through the Internet and TV. However, both groups trusted their own experience the most. Therefore, introducing the community's key farmers to new technologies though demonstration and success stories could work as a strategy to ignite behavior change among peer farmers. In addition, communication via the Internet and TV could quickly reach a large number of farmers. Involving input suppliers and extension workers in the introduction of the Plantix app could also be helpful.

While this pilot study focused on large-scaled farmers, there are smallholder farmers from poor households in some remote areas in the Mekong Delta. Their needs and knowledge may be significantly different from those of progressive farmers. Introducing the app to different types of farmers can help us understand the diverse needs and priorities of farmers in the process of digitalization.

Contents

List of abbreviations

1M5R	One Must Do, Five Reductions
3R3G	Three Reductions, Three Gains
CTU	Can Tho University
DET	Digital Extension Tool
FGD	Focus Group Discussion
GoV	Government of Vietnam
GSO	General Statistical Office of Vietnam
ICT	Information and Communication Technology
IPDM	Integrated Pest and Disease Management
MARD	Ministry of Agriculture and Rural Development
PPD	Plant Protection Department
SRI	System of Rice Intensification
VAAS	Vietnam Academy of Agricultural Sciences
WHO	World Health Organization

1. Introduction

The Mekong Delta is the most important rice producing region of Vietnam. The total rice planting area of the 13 provinces in this region in 2021 is estimated to be around 3.9 million hectares, accounting for 54% of that of the whole country (GSO, 2021). Traditionally, rice production relied on a single rain-fed crop in the winter. Taking the advantages of the fertile soil, water abundance and favorable weather conditions, since 1996, the Vietnamese Government has invested heavily in irrigation systems and production infrastructure to encourage rice intensification in the area. As a result, the 1995-2015 period saw a rapid expansion of double and triple-rice cropping systems throughout the whole region, with the total production doubling over the course of 10 years, from 12.8 million tons in 1995 to 25.6 million tons in 2015 (GSO, 2000, 2018). However, since 2015, due to climate change, the aftermath of extensive chemical fertilizer and pesticide use and other problems, rice production has been dropping (Van Kien et al., 2020; Vu et al., 2022). Rice intensification is being gradually replaced by diversification (Van Kien et al., 2020). Nevertheless, the Mekong Delta is still the most productive rice growing area in Vietnam, with an average yield of 62.4 quintals/hectare and total output of 24.3 million tons in 2021 (GSO, 2021).

Figure 1. Photos of rice production in the Mekong Delta

In recent years, driven by the intensive rice monoculture practices and climate change, outbreaks of pathogens have become more frequent and severe, threatening the livelihoods of rice farmers in the region (Nguyen et al., 2022; Norton et al., 2010; Tran et al., 2022; Yuen et al., 2021). Major pests and diseases include rice blast disease, bacterial leaf blight, sheath blight, brown plant hoppers, rice stem gall midges, small leaf folders, golden apple snails, rats, stem borers, etc. (Braun et al., 2019; Matsumura et al., 2018; Nguyen et al., 2021; PPD, 2022; Yuen et al., 2021). In 2022, the Plant Protection Department (PPD) reported 24 thousand hectares of rice infested with blast diseases nationally (February), 15 thousand hectares infested with plant hoppers, 15.4 thousand hectares infested with small leaf folders, 8.8 thousand hectares infected with leaf blight (September), 10.3 thousand ha infested with golden apple snails and 4.8 thousand ha affected by rats (May), etc., the majority of which occur in the Mekong Delta provinces. Throughout the years, these pests and diseases have been causing significant damage to rice farmers, sometimes affecting more than 50% of the cultivated areas (Berg & Tam, 2018), causing yield losses up to 50% (Heong et al., 2015), or even 64.57% in the case of neck blast disease (Hai et al., 2007).

Chemical overuse has become a serious problem in the Mekong Delta as an aftermath of the decades-long agricultural intensification in the region. The consequences include serious environmental pollution, loss of biodiversity, effects on aquaculture, reduced soil heath and impacts on human health. Various studies have found ubiquitous pesticide contamination in soil and water sources, including drinking water such as harvested rainwater or even purchased bottled water (Chau et al., 2015; Toan et al., 2013). High use of pesticide is also likely to cause negative effects on fish and other aquatic organisms (Stadlinger et al., 2018), resulting in decreased aquaculture yields as reported by the farmers in a study by Berg and Tam (2018). 85% of these farmers (n=80) also experienced health effects due to exposure to pesticide.

According to a household survey of rice growers (n=155) in Can Tho in 2013-2014, the average frequency of pesticide application is 11–13 times per season, equivalent to a mean cost of USD 190 per ha (Stuart et al., 2018). This is significantly higher than the numbers found by some previous studies, for example 4-8 times (amounting to 1.13-3.36 kg/ha) according to Chau et al. (2015), and 6-8 times (amounting to 1.9-3.7 kg/ha) according to Toan et al. (2013). Farmers use various types of pesticides including moderately toxic pesticides (WHO class II) (Braun et al., 2019; Chau et al., 2015; Galli et al., 2022). Some studies highlight farmers' inappropriate dosage and handling of pesticides. In one survey, 60-80% of the farmers (N=72) used higher amounts than recommended on the label (Chau et al., 2015). Access to and use of personal protective equipment is generally quite limited, except for face masks and gloves, whereas unsafe pesticide storage and waste disposal were widespread (Chau et al., 2015; Galli et al., 2022). Only a few farmers are concerned about the potential negative effects of pesticide on their health (Chau et al., 2015; Dang & Pham, 2022).

However, the aforementioned studies either do not have gender-disaggregated data, or only involve small numbers of female participants (7% of 400 farmers in Galli et al. (2022) and 10% of 194 farmers in Dang and Pham (2022)), which poses a limitation on gender investigation.

The Government of Vietnam (GoV) and Ministry of Agriculture and Rural Development (MARD) address the overuse of pesticides and chemical fertilizers in rice production by promoting alternative approaches such as the 'Three Reductions, Three Gains' (3R3G)[1] practice launched in 2003-2007. This practice formed the basis for the 'One Must Do, Five Reductions' (1M5R)[2], System of Rice Intensification (SRI), and Integrated Pest and Disease Management (IPDM) programs. Other approaches are for examples, establishing a certification system such as GlobalGap and VietGap certification, promoting the use of biocontrol through the 'Small Farmer, Large Field' model and extension programs, and enabling organic farming (Connor et al., 2021; GoV, 2018; Horgan et al., 2022; Nguyen, 2018; Stuart et al., 2018). The government also regulates agricultural chemicals through promulgating annual lists of permitted and banned agrochemicals in Vietnam (Hoi et al., 2016), regular inspection, training and guidance, as well as imposing penalties on violations (GoV, 2016; MARD, 2015).

However, the adoption of alternative approaches remains very low, with only a small number of innovative farmers trying them. Several studies highlight the lack of awareness and training opportunities for farmers (Galli et al., 2022). On the other hand, farmers choose chemicals or

[1] 'Three Reductions': reduce seed rates, nitrogen fertilizer and insecticides; 'Three Gains': improve yield, farmers' health and protect the environment. Developed by Vietnamese scientists in the early 2000s, this approach was officially recognized as a "technological advancement" for high-yield rice production in the Mekong Delta (MARD's Decision No. 1579 QĐ/BNN-KHCN) in 2005.

[2] 'One Must Do': use good-quality seeds; 'Five Reductions': reduce seed rates, pesticide use, fertilizer inputs, water use, and post-harvest losses.

application techniques based on their own and their peers' experience and habits rather than on information from experts, retailers and chemical pesticide labels (Berg & Tam, 2018; Chau et al., 2015). It is not clear if providing more information through traditional extension services can change farmers' behaviors.

Recently, information and communication technologies (ICT) such as mobile apps are becoming more and more popular as an alternative or complement to traditional face-to-face approaches to circulating new knowledge and practices. The use of ICT in Vietnam is facilitated by the country's well established digital infrastructure, as well as the MARD's support for smart agriculture (Sakata, 2019).

With its collective learning systems, ICT has a great potential in reaching populations that might be excluded in traditional extension services. However, in terms of the cost, ease of use, information contents and proposed solutions, the design of agricultural digital tools might not be best suited for low income, less educated and/or women farmers (Coggins et al., 2022; Krell et al., 2021). In Vietnam, according to Hoang and Drysdale (2021), male farmers are more likely to benefit from mobile phone information for their agricultural production and marketing compared to female farmers, despite their more or less equal involvement in both activities.

In fact, traditional extension services in Vietnam have the same limitations, as their approaches are more suitable to better-off male farmers (Lovell et al., 2021). Therefore, to be transformative in the aspects of equity and inclusiveness, ICT should not simply follow traditional extension approaches, which otherwise might reinforce existing gaps by disadvantaging marginalized social groups especially women who are in fact the majority of smallholders in the global South (Hargittai, 2018; O'Donnell & Sweetman, 2018; Schelenz & Pawelec, 2022). ICT interventions for women need to consider women's specific needs, interests and capacity.

Plantix is a mobile crop doctor app developed by PEAT, an agricultural technology company based in Germany. It offers six services to users: 1) diagnosis and treatment advice; 2) fertilizer calculation; 3) farming tips; 4) disease warnings and prevention; 5) a farmer community and 6) agricultural weather forecasts. Currently, Plantix offers instant diagnosis and treatment advice for 30 major crops, vegetables and fruits. Plantix has been widely used by male farmers in India.

In this study, we explore the potential for using Plantix to reduce pesticide use among rural rice farmers in the Mekong Delta. We also use Plantix as a case to study the impact of gender on the perception and adoption of new technologies by farmers. Can Tho City was selected as the study site as it shares many characteristics of the typical rice production in the region. This is the third pilot study in Vietnam, following the first pilot conducted in Gia Lam, Hanoi with small-scale urban vegetable growers (Bui, Nguyen, et al., 2022) and the second pilot in Don Duong, Lam Dong with larger scale vegetable farmers (Bui, Pham, et al., 2022).

We test the app in the context of Vietnam with both male and female rice growers. In particular, we aim to establish gender-responsive participatory learning approaches targeting both women and men. This study follows the scaling readiness approach (Sartas et al., 2020). In this first stage, we test the core innovation, seek possible complementary innovations appropriate to a given gender and social context, and identify stakeholders who can potentially facilitate scaling up of the app.

2. Methods

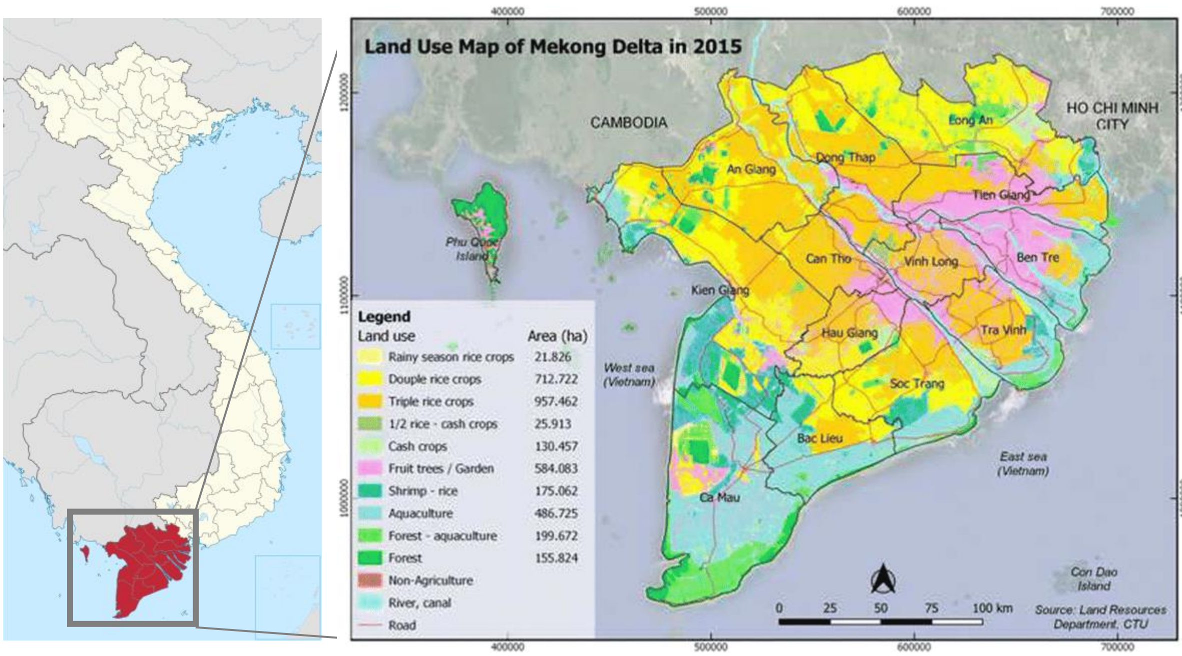
2.1. Study area

The Mekong Delta

In the Mekong Delta, rice production is most concentrated in the Alluvial Floodplain and surrounding broad depressions (Van Kien et al., 2020). The rice cropping systems here include mostly double- or triple-crop rice of modern high-yield, short-duration varieties (85-105 days) (Minh et al., 2019; Nguyen & Yen, 2021). The triple rice system includes Winter-Spring, Summer-Autumn and Autumn-Winter, located in well-irrigated areas with abundance of fresh water (Diem et al., 2021). Away from the big rivers, within semi-dike systems, farmers may grow 2 rice crops per year, including the main Winter-Spring crop and either of the autumn crops (Minh et al., 2019; Triet et al., 2018). The distribution of rice production in the Mekong Delta is illustrated at Figure 2. Of the three seasons, the Winter-Spring is generally the major crop, making up 40% of the annual rice growing area and contributing 45% of the annual production of the region (GSO, 2021).

Single short or medium-term rice combined with other crops such maize, sweet potatoes and vegetables is practiced in some areas where conditions are less favorable. Besides, a small number of farmer communities still keep the tradition of growing one crop of indigenous rice a year, where long-duration varieties (200-240 days, some 270 days (VAAS, 2005)) are grown in the wet season. This accounts for only 4% of the total rice farming area, scattered along the coast in Ca Mau, Kien Giang, Bac Lieu and Soc Trang provinces (Diem et al., 2021; GSO, 2021; Hoang-Phi et al., 2020; Minh et al., 2019).

Figure 2. Land use map of the Mekong Delta in 2015



Vietnam — Mekong Delta region

Source: Land Resources Department, Can Tho University (CTU)

The crop calendar in the Mekong Delta is heavily influenced by geographic, soil, irrigation and weather conditions, thus varies every year across different provinces, as well as areas within each province (Kontgis et al., 2019; Triet et al., 2018). Typically, the traditional single rice crop starts around June/July until December-January (Minh et al., 2019; Nguyen et al., 2016). Regarding intensive systems, the

Winter-Spring crop is planted in the dry season, from November-December to February-March. In the wet months, farmers can grow one or two crops – from March-April to June-July, and from July-August to October-November (Ferrer et al., 2022; Kontgis et al., 2019). The sowing time can differ greatly between shallow- and deep-inundation areas, up to 1-1.5 months earlier in the former (Triet et al., 2018). In addition, farmers can adjust the calendar, especially for the Winter-Spring season, depending on environmental conditions and how well protected the farmlands are against flooding (Ferrer et al., 2022; Triet et al., 2018). For example, in 2016 and 2020 when severe salinity intrusion occurred, a shift of 10-30 days earlier than normal planting was observed in the Mekong Delta (Hoang-Phi et al., 2020). In fact, since 2019, the Plant Protection Department has been recommending early planting of the Winter-Spring crop in coastal areas, including Long An, Kien Giang, and Soc Trang provinces, in response to changes in the climate (Ferrer et al., 2022). In some areas prone to salinity intrusion, due to reduced yield, farmers might, or are advised not to grow the Winter-Spring crop in the following year (Hoang-Phi et al., 2020). An overall rice crop calendar of the Mekong Delta, together with the PPD's 2022 recommendations are shown in Table 1.

Table 1. The Mekong Delta rice crop calendar and PPD recommended planting time

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					Traditional single rice						
										Winter-Spring	
		Summer-Autumn									
						Autumn-Winter					
Recommended planting time by PPD (2022)											
		Summer-Autumn			Autumn-Winter				Winter-Spring		

Source: Ferrer et al. (2022); Kontgis et al. (2019); Minh et al. (2019); Nguyen et al. (2016); Vietnam PPD (2022).

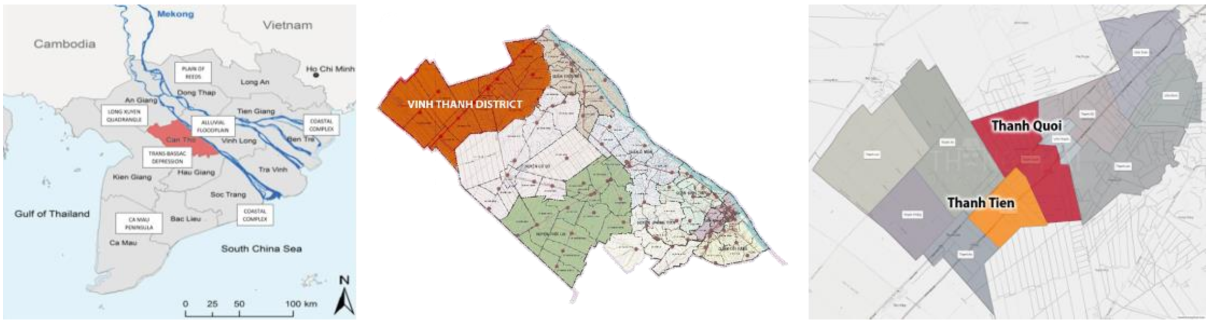
In recent years, triple rice monoculture is gradually being replaced by diversified rice-based cropping systems, such as rice in combination of upland crops, livestock, and especially aquaculture (Van Kien et al., 2020). The total production of aquaculture of the Mekong Delta increased by 170% between 2010 and 2021, largely contributed by a tremendous increase of 2.4 times in shrimp production, from 347 million tons to 836 million tons (GSO, 2015, 2021).

Can Tho City

Can Tho City lies in the central part of the Mekong Delta and is one of the major rice producing areas in the region. The city is subdivided into five urban districts and four rural districts. Located entirely within the Alluvial Floodplain, supplied by the rich sediments of the Hau River, a Mekong distributary, Can Tho possesses fertile soil and ample fresh water sources, while buffered against the harsh conditions of the coast. As of 2022, the city has 111,400 hectares of agricultural land (77.4% of the total area), of which 78,000 ha is devoted to rice production. Rice is mostly grown three times a year, producing 1.3-1.4 million tons annually (GSO, 2021; Trung, 2022).

The pilot study was conducted in Thanh Quoi commune, Vinh Thanh district in Can Tho City in December 2022. Vinh Thanh District (Figure 3) was selected as it is well-known for rice production. The district consists of 2 townships and 9 communes. Thanh Quoi commune has 7 villages, and we invited farmers from 2 villages from within this commune, and 1 additional female farmer from a nearby village of Thanh Tien commune. Apart from rice, farmers in the study communes also grow chili, mung beans, white radish, cucumber, squash, coconut, guava, yellow Mai flowers and raise livestock.

Figure 3. **Thanh Quoi & Thanh Tien Communes, Vinh Thanh District, Can Tho, Vietnam**



The Mekong Delta | Can Tho City | Vinh Thanh District

Source: Van Kien et al. (2020)

2.2. The selection of participants

According to our observations, as well as information from the literature (Chi et al., 2015; Gallina & Farnworth, 2016; Nhat Lam Duyen et al., 2021), although both men and women are involved in farm activities, rice production in the Mekong Delta is generally considered men's domain, especially in larger scales and in relation to "heavier" tasks such as pesticide application. There is a small number of women-managed farms, and women may also, to some extent, be involved in crop protection on male-managed farms. We, therefore, intentionally tried to include women farmers in this pilot study. As in the pilot study in Don Duong, Lam Dong in September 2022, many farmers in the study area use iPhones. This could be a major challenge for introducing Plantix in Vietnam.

The research team consulted with the local authority to select participants based on three criteria: 1) farmers who grow rice for sale; 2) farmers who have Android smart phones and access to internet; and 3) farmers who are interested in learning improved methods on pest and disease treatment. We also requested to have a gender balance among the participants and to include young farmers, if available.

A total of 15 farmers who were Android users (four woman and eleven men) participated in the training. The small number of female farmers reflect the overall more limited role of women in rice production in the study area. The majority of participants (75%) were middle-aged farmers between 40 and 49. Only four participants were aged between 27-36. Most of the participants had large-scale farms of 3 hectares or more, with the smallest at 1.9 hectares and the largest at 11 hectares.

Figure 4. Photo of rice fields in Vinh Thanh District

Several additional stakeholders were invited to the training session as they could provide technical input in intervention designs and/or facilitate scaling. These invitees joining the session were two female officers of Vinh Thanh District PPD, and a male extension officer of Thanh Quoi commune.

2.3. Training methods

The Plantix training was conducted on 13 December 2022. The training included an introduction to Plantix, downloading the app, a field trial, an initial feedback session and focus group discussions (FGDs) with the men and women to collect background information and household data.
These FGDs consisted of four topics: 1) the local crop calendar and seasonal differences in pests and diseases; 2) gender roles in pest and disease management; 3) information sources; and 4) perceptions of pesticide overuse.

During the two-week trial on their own farms, we made phone calls to some farmers twice to assist them with solving technical issues, and to monitor their progress with Plantix. In addition, the training participants were connected with a communication message app called "Zalo" to facilitate their collective learning and exchange information during the trial. The research team also joined this group to monitor and facilitate the group's communication.

Figure 5. Photos taken during the training and FGDs

2.4. Feedback methods

After the two-week trial period, focus group discussions were conducted to collect feedback from the participants. Ten male farmers participated, but only two female farmers could attend the feedback session, together with the two female PPD officers.

These focus group discussions consisted of three topics: 1) feedback on the content of the Plantix app; 2) behavioral change and information sharing; and 3) potential constraints for some farmers in using this app.

Figure 6. Photos taken during the feedback session

Photo credit: Trinh Thanh Thao, Van-Schepler Luu, Nozomi Kawarazuka

2.5. Data analysis method

A digital extension tool (DET) assessment framework was developed by Coggins et al. (2022), who identified major constraints to using DETs in the global south. They divided the constraints into three categories: 1) access to digital information; 2) the technical content of the tool; and 3) behavioral change. We applied these categories in our analysis with specific consideration of gender- and age-based constraints in this assessment framework (Table 2).

Table 2. Plantix Assessment Framework

	Constraint	Questions to consider
Access interface	Unaware of the usefulness of the digital extension app	How will the Plantix app be marketed?
		Can users easily share the app information?
	Device inaccessible	Who can/cannot access the required devices?
		Are the accessible devices of sufficient quality to use the DET (including operating software, durability, screen size, processing speed)?
	Electricity inaccessible	Can farmers access electricity with limited monetary and travel costs?
	Mobile network inaccessible	Is the Plantix app appropriate for the mobile network reliability, speed and affordability?
	Insensitive to digital illiteracy	Do farmers already use various apps in their mobile phones?
Access content	Insensitive to illiteracy	Is reading or typing required to use the DET?
	Unfamiliar language	Can the Plantix app offer local terms and metrics?
	Slow to access	How long does it take for users to access benefits?
	Hard to interpret	Is the content visual (or at least visualizable)?
	Unengaging	Can the Plantix app incorporate games, stories, humor, visuals or human interaction?
Change behavior	Insensitive to knowledge	Does the Plantix app information include (or at least adapt to) users' preexisting knowledge?
	Insensitive to priorities	Are the Plantix app priorities (e.g., increased yield, reduced risk) set by users or others?
	Insensitive to socio-economic constraints	Does the Plantix app provide users with options?
	Irrelevant to farm	Can Plantix be adapted to local soils, climates, agronomic practices and crop calendars?
	Distrust	Is the Plantix branding familiar and trusted?

Source: Coggins et al. (2022)

3. Results

3.1 Access to smart phones, mobile networks and digital literacy

In Vietnam in general, and in the study area in particular, smart phones are very common among both women and men. The pilot study confirms that the farmers are familiar with smartphone technologies, and although none of the farmer participants have 3G/4G data plans on their phones, everyone has access to wifi internet at home. Except for two farmers whose Android versions were too old, the rest of the participants successfully installed Plantix on their phones, and quickly learned and enjoyed using the app.

Plantix does not provide a service to iPhone users, which is the most significant constraint to disseminating the app.

3.2 Contents (languages, local terms and metrics)

Plantix's website and some illustrations in the app use images of male farmers, mostly from India. We need to request Plantix to include images of women farmers from Southeast Asia that female users in Vietnam can identify with.

There are six functions in the app: 1) diagnosis and treatment advice; 2) fertilizer calculation; 3) farming tips; 4) disease warnings and prevention; 5) a farmer community and 6) agricultural weather forecasts. All the participants who could install Plantix on their phones used the diagnosis and treatment advice function. Except for one district PPD officer who looked at the Community Q&A section, none of the other participants used the other functions.

Regarding metrics, the participants were comfortable with using "hectare" as they all have large farms. However, the local unit of "công" is more commonly used in Southern provinces (a small "công" equals $1000m^2$, and a large "công" equals $1296m^2$), so it could be helpful to include this local unit in the app.

3.3 Crop relevance

Rice is the main commodity crop in the study areas. Farmers here grow three crops of rice per year, Winter-Spring (November-February), Summer-Autumn (March – late May/early June) and Autumn-Winter (late June/early July – late September/early October). The current rice varieties are mostly short-term and high-yield, including OM18, Dai Thom 8, OM5451, and RVT, a high quality variety.
Apart from rice, four of the male farmers also grow yellow Mai flowers, two female farmers grow chili, and one male farmer grows coconut and guava. In addition, other vegetables including beans, white radish, cucumber and different types of squash are also grown in the area by other villagers. Four out of these nine crops are available in the app for diagnosis and treatment advice (Table 3).

Table 3. Seasonal crop calendar with major crops grown in the study area

Men's group												
Crop	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Rice	Winter-Spring		Summer-Autumn				Autumn-Winter				Winter-Spring	
	Pest& diseases			Pest& diseases				Pest& diseases				Pest& diseases
Others	Yellow mai flower (perennial crop)					Pests & diseases (rainy season)						
	Coconut, guava (perennial crops)											

Women's group												
Crop	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Rice	Winter-Spring		Summer-Autumn				Autumn-Winter					Winter-Spring
	Pest& diseases			Pest& diseases				Pest& diseases				
Others	**Beans**											
			Chili	Diseases (Anthracnose of pepper)								
	White radish (1.5 months/crop – flea beetle & tuber rot disease after 15 days)											
	Squash & Cucumber year-round (3 months/crop – withering disease at 2nd month due to soil-borne virus)											

**Bold*: farmers already used the app or intend to use the app in the coming season*
Source: FGDs with Vinh Thanh District farmers on 13 & 27 December 2022

As shown in Table 3 above, pests and diseases are prevalent in the middle growth stages of most crops, including rice. April-early May, August-early September and late December-January are periods when rice fields are threatened by pathogens, favored by hot and/or rainy weather. As reported by the farmers, the major problems on rice in the area include blast, bacterial blight, midge galls, leafrollers etc. Some of the pests/diseases are called different locally, therefore, the farmers suggested including the local names alongside the scientific names. A more detailed list of pests and diseases can be found at Appendix 2. The farmers practiced taking photos of rice plants during the trial period but did not try it with other vegetables because they themselves hardly grow any crops other than rice. However, a few farmers said they would try Plantix with beans and bananas in the next season, and some requested to include squash in the app.

Apart from rice and vegetables, farmers also requested a diagnosis and advice service for yellow Mai flower, which is an important income source.

3.4 Knowledge and priority relevance towards behavioral change

December-January is usually a rice pest and disease season in Can Tho. However, the rice plants are still at a relatively young growth stage during the trial period, and some farmers reported that there had been fewer pests and diseases in the past year. Therefore, although participant farmers took many photos with Plantix during the two-week trial, the rice plants did not show clear symptoms of pathogen infection.

One male farmer reported that after the app diagnosed his rice plants with Nitrogen deficiency, he followed the app's recommendation to address the problem. However, none of the remaining farmers took further actions following Plantix advice. There are a number of reasons why they did not change their practice immediately.

First, there seems to be some trust issues among both the male and female participants with the app's diagnosis results. Although some male farmers agreed with the app's diagnosis of rice leaf rollers, both the men and women thought that the app's identification of pests/diseases needed to be more accurate. The men reported that the app did not recognize or confused the following problems: damage due to weather, blast, and rice gall midge. One of the female district PPD officers felt that the app's interpretation of dark spots on rice leaves due to alum poisoning or excess phosphorus fertilizers as Zinc deficiency was incorrect, as was the diagnosis of Nitrogen deficiency which was actually due to the natural color change of rice leaves or cold weather. One potential reason for this could be that the rice plants as well as the pest/disease problems were at early stages, therefore did not show symptoms clearly enough to be correctly identified by the app.

Second, the targeted farmers are experienced and large-scale farmers who have a high level of knowledge about pests and diseases. Farmers' knowledge agrees with what the app says. However, some male farmers expressed that the descriptions should be more concise, and both the men and women group suggested shortening the names of the recommended products (keeping only the names of active ingredients, e.g., Tricyclazole, and removing the associated concentration and type of products (e.g., 75 WP). Some male farmers also expressed the wish for the app to recommend a list of "top ranked" pesticide products, or rank the pesticides by quality, to help them navigate the multitude of products, brands, and sometimes misleading advertising currently on the market. They also said that the inclusion of new generation chemicals would be helpful.

Third, the recommendation for the chemicals written in Plantix for the major pests/diseases are similar to what the farmers use in practice, for example, Tricyclazole 75.0 WP for rice blast, and Streptomycin Sulfate 90.0% SP, Tetracycline hydrochloride 10.0% SP for bacterial blight. However, the female district officer pointed out that some chemicals have recently been banned by the Vietnamese government, thus should be removed from the app (e.g., Carbendazim for blast disease). As for the dosage, the participants confirmed that Plantix's recommended dosage was the same as on product labels, which means they were aware of the "right" dosage. Nevertheless, the male participants admitted they still preferred to follow the current local practices, which usually involves overusing, sometimes doubling the recommended amounts. This could be explained by the fact that the farmers, both men and women, perceived prevention spraying as a quick and effective method to protect the rice fields from any potential outbreaks, thus economic damage. A male farmer said, "It helps prevent the spread of pests and diseases right from the beginning, which will minimize the damage later on, as well as reduce the amount of pesticide we have to spray again. If we spray when the problem just starts, it will be controlled right away, with smaller doses of pesticides. Otherwise, once the disease already breaks out, we would have to spray again and again and with higher doses; we will end up using even more pesticides, and it will also affect our health." Moreover, the farmers felt concerned over reducing pesticide use. "If I don't spray mine while other farmers spray their fields, the pests/diseases will come to my rice field," "Our rice production would be more dependent on weather," said the male farmers, while a female farmer expressed "We're afraid of facing more damage due to pests & diseases if we reduce pesticides." Regarding the application instructions provided by the app, the district officer commented "For some chemicals, the app advised to not apply the product if the farmer is harvesting in the next 30 days. However, the farmers won't follow this advice. I suggest shortening this period to 20 days only, so that the farmers will be more willing to comply." In the case of fertilizers, some farmers have been using their own formulars, which are adjusted to their own farm's conditions such as soil and rice varieties etc.

Fourth, the farmers appear to be quite resistant to change when it comes to chemical use. When asked whether they would follow Plantix recommendation if it was different from their current practice/knowledge, all the men and women preferred to follow their own knowledge and experience. This is related to the second point above – the selected participants are highly knowledgeable and experienced rice farmers, and many of them considered their own experience the most trusted source, as discussed later in Section 3.6 – Information sources. The farmers would only consider trying something new if their current measures were not effective. And this does happen from time to time, as both the men and women confirmed the issue of pesticide resistance. "We also must change pesticides from time to time when the pests/diseases become resistant. When we need to buy a new pesticide, first we will look up information of the company and the product to see if it's trustworthy or not, and then we will consult with the pesticide sellers when we buy it. We might test it on a small plot first, and if it's effective (usually we will know after 3-4 days), we will apply it on a bigger scale," said a male farmer.

In terms of attitudes towards technology and innovation in general, the men's group seemed to be more reluctant to change as they did not apply any new technologies in recent years, except for one man who hired drone services for spraying pesticide. The reason is explained by a male participant, "the current technologies are still good, and we will only adopt new technologies if we have seen someone else having done it successfully." Therefore, it may take sometimes to see outcomes of Plantix that some individual farmers change practices following the app's advice, and then other farmers see the success and follow them. Nevertheless, a few male farmers expressed their interest in having more training/experience exchange opportunities, which shows their willingness to learn.
Contrary to the men's group, the women seem to be much more open to new technologies. They reported having applied new rice varieties of ST24 and ST25, new fertilizer (Humix – an organic fertilizer) and pesticides (microbial and bio-pesticides), and new automation technologies such as drones for spraying, cluster rice planting machines, and transplanting machines. The female farmers show eagerness in learning new technologies as they are aware of the potential benefits, "we want to apply new technologies to reduce costs, improve product quality and economic efficiency."

Regarding the farmers' perception of pesticide overuse, the participants appear to be somewhat conscious of the negative effects of chemical fertilizers and pesticides on their own health, and said that emergency cases of pesticide poisoning happened once in a while. However, overall, it seems that they did not consider the effects to be serious. Some male farmers said, "Pesticides affect our health, we feel more tired, but only sometimes." Both the male and female farmers considered prevention spraying an effective strategy to control outbreaks quickly and reduce economic damage.

On the bright side, the farmers are also equipped with knowledge of alternative solutions such as biopesticides and biocontrol methods. The female district officer confirmed that the app provided good and detailed information, and highly appreciated the inclusion of bio-control measures. She said "The farmers here don't use much biocontrol on rice. It's good to include this option, so that the farmers can learn in the future." Two men said they were already using biopesticides (Abamectin) and/or natural enemies on their farms. The women said that they used biocontrol more on vegetables but less on rice. Both the male and female farmers agreed that this method was safe for human, crops and environment, but less effective against pests and diseases once they already spread. The women rated the efficacy of biopesticides at 60%, versus 80% of chemical ones. Their proposed solution was to use a mix of chemical and biopesticides to achieve better results, while reducing chemical amounts.

Some farmers introduced the apps to their family, friends and neighbors. Mr. Quang introduced Plantix to a female and two male farmer friends, and another male participant introduced the app to two male friends; these people have downloaded and tried it out. One man also shared general information about the app and the training with his wife, and another with 4 male farmer friends. One female participant shared it briefly with his father and younger brother, while the female district officer did during her training to local farmers, in which about 30 farmers attended. The participants thought that the app would be of interest to younger farmers between 30-55 years old (since many young people below 30 usually do not work in agriculture) who are directly involved in production, and who already have smartphones and are familiar with mobile apps. Both the men and women agreed that in the study sites, men are more involved in rice production than women. Nevertheless, the participants confirmed that women play certain roles and should also be targeted for training. Mr. Quang suggested that the dissemination could be facilitated by the Farmers Union, who has extensive local networks and good understanding of the local farmers.

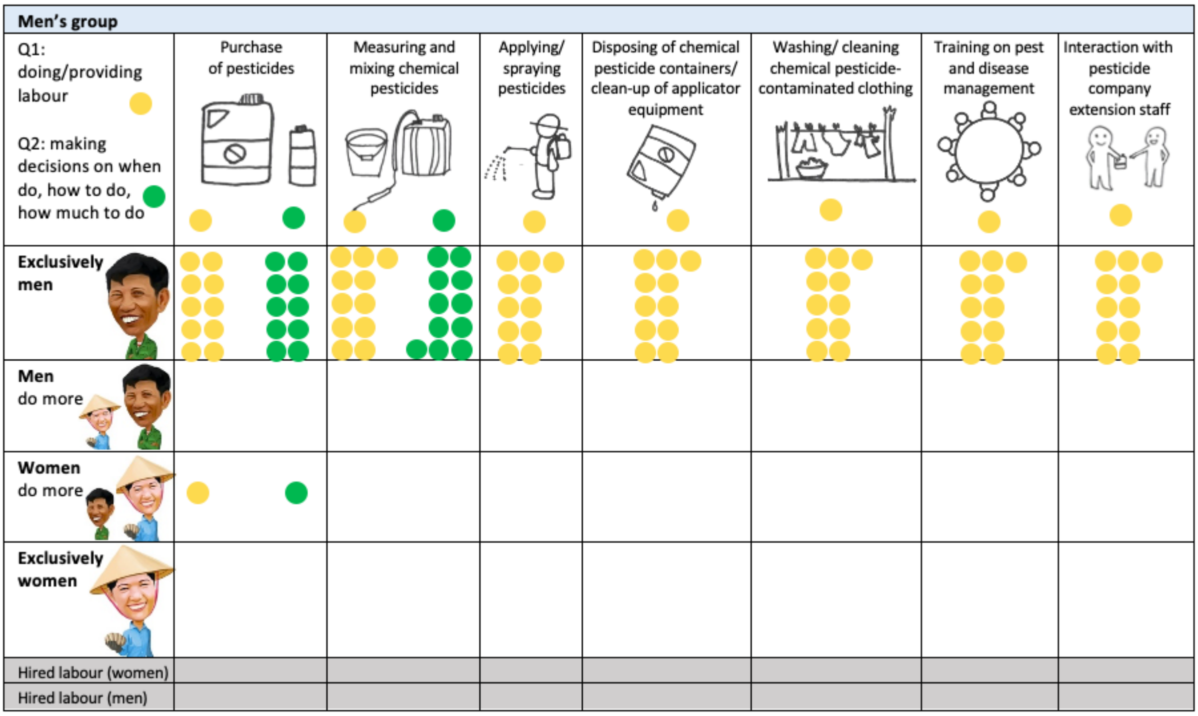
We formed a group with Zalo to facilitate communications, and the farmers used this tool to interact with one another. Some male participants joined the discussions by posting photos of the diseased plants and Plantix diagnoses to the Zalo group chat. However, overall, the group was not very active. This may be because participant farmers managed to use the app without further instructions or communications. In the study site, the app can work as an individual tool rather than a tool for facilitating collective learning for both women and men.

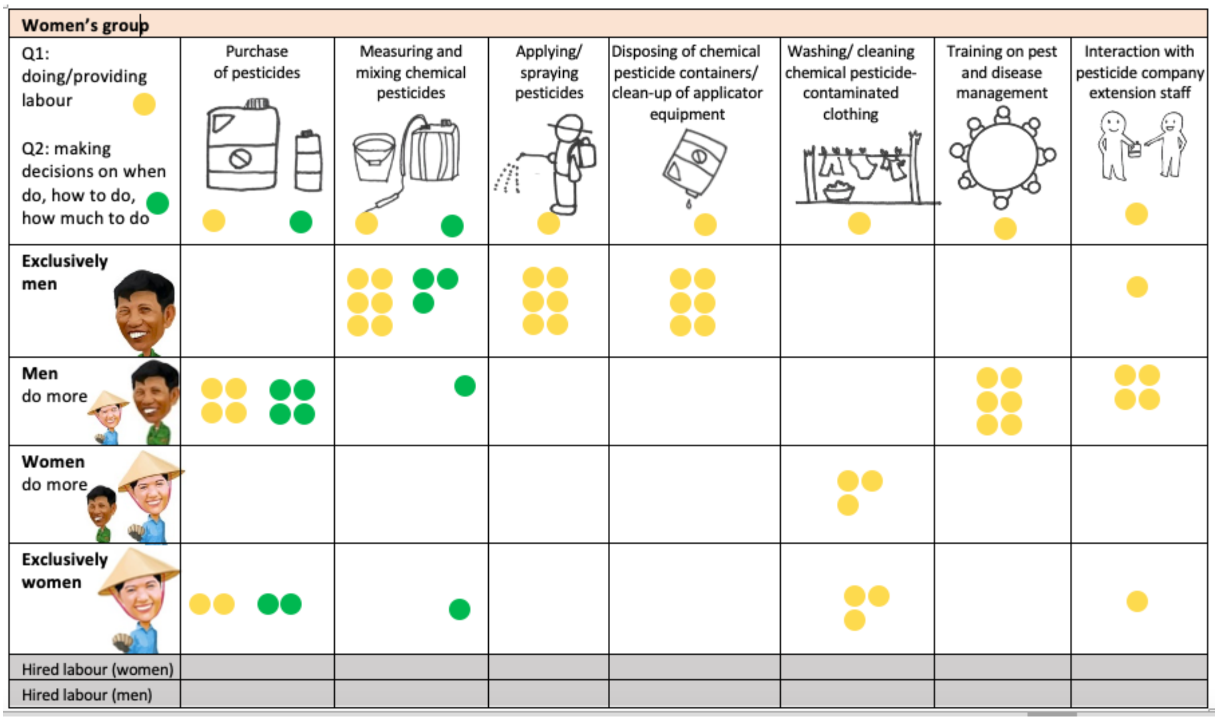
3.5 Gender roles and decision making

In this pilot study, we explored the gender roles and decision-making of the participants' own households. According to the focus group discussions, men are generally more involved in rice production as decision makers and laborers, while women do "lighter" work such as soaking seeds, planting, transplanting, weeding, fertilizing, managing money and arranging rice bags at the time of selling.

Regarding the work related to pest and disease management, we asked participants to nominate who in their household makes final decisions about and carries out each respective activity (Table 4).

Table 4. Gender roles and decision-making power





Source: FGDs with Vinh Thanh District male farmers (N=11) and female farmers (N=6) on 13 December 2022
Illustrations of a man and woman: © beelzebub2811@gmail.com
Other illustrations: ©n.kawarazuka@cgiar.org

There are some differences between the men and the women's opinions.

According to the male participants, all the pest and disease management activities are performed and decided exclusively by men, except for one household where the purchase of pesticide is done and decided more often by women.

In contrast, most of the female participants reported that they are also involved in the purchase of pesticides, attending training and interation with pesticide company/extension staff to some extent. In two households, the purchase of pesticides is solely decided by women, and one household where the decision of pesticide mixing is the women's exclusive responsibility.

The biggest difference can be seen in the task of washing/cleaning chemical pesticide-contaminated clothing. Contrary to what the men said, all the female participants agreed that this task is done more often, or exclusively, by women.

This shows that women play certain roles in rice pest and disease management and women's improved access to knowledge through Plantix may have some impact on household decisions on pesticide investment and use.

3.6 Information sources

Through the group discussions, we also identified the farmers' current major sources of information on agriculture (Table 5).

Table 5. Participants' use of information sources

Women's group									
Sources	TV	Radio	Internet (YouTube, Web)	Extension	Input supplier	Peer farmers (within village)	Peer farmers (outside village)	On my own experience	Others
Which one have you used?	●●●●●		●●●●●	●●●	●●●	●●	●●●	●●●●●	
About what crops?	All crops								
How often?	3 times a week		Daily	Once a month	1-2 times a week	Once a week	Twice a month	Daily	
Which is the most reliable?	●			●●				●●●●	
Gender				♂♀	♂♀	♂♀	♂♀		

Men's group									
Sources	TV	Radio	Internet (YouTube, Web)	Extension	Input supplier	Peer farmers (within village)	Peer farmers (outside village)	On my own experience	Others (specify)
Which one have you used?	●●●●●●		●●●●●●	●●●●●●●●	●●●●●	●●●●●	●●●● Soc Trang (1)	●●●●●●●	
About which crops?	All crops								
How often?	Once a week		Twice a week	Twice a month	Once a week	Daily	Once a month	Daily	
Which is the most reliable?						●●●●●		●●●●●●	
Gender				♂♀	♂♀	♂	♂		

Source: FGDs with Vinh Thanh District men farmers(N=11) and women farmers (N=6) on 13 December 2022

Both the men and women farmers use various information sources, including extension, TV, internet, input suppliers, peer farmers (from both outside and within the village), and their own experience. The men tend to gather information from peer farmers within their villages and the Internet more often (daily from the former, and twice a week from the latter), while the women do so from the Internet (daily) and TV (three times a week). Pesticide/input suppliers (both male and female) is also an important channel which is consulted twice a week by both male and female farmers during the crop seasons. Extension workers seem to be a less frequent source of information, and no participants mentioned radio.

When asked which sources of information they trusted the most, most participants (both men and women) selected “own experience”. It shows that the farmers have strong confidence in their own knowledge, experience and ability in farming. Interestingly, many of the male participants also place their trust on other male farmers within the same village, who they interact daily for information exchange. Meanwhile, the female participants discuss with both male and female peer farmers for information, but only once a week. Two out of 5 female farmers also said that they trusted extension workers the most, and one farmer considered TV the top source of information.
It is also important to note that, as mentioned earlier in section 3.4, the male farmers want to see successful stories before they decide to adopt a new technology.

Drawn on the above findings, one strategy to initiate behavior change could be to introduce Plantix or any digital apps to the community’s key farmers, both men and women, who are respected as advanced farmers. In addition, it might be useful to utilize media (such as internet and TV) to influence them as a first step. Involving input/pesticide suppliers together with extension workers in introducing Plantix could also work as a useful strategy, as some farmers consult pesticide sellers when they need to change chemical products.

4. Discussion and conclusions

This pilot study confirmed that the participating farmers are interested in using the Plantix app as a means to learning better practices to control pests and diseases, and improving the production and quality of their agricultural produce, once the trust issues are resolved.

Due to the limited number of female farmers during the feedback session, some opinions of the women might not have been fully captured. However, from our observations and the discussion with the male and female participants, it is important to involve women in the introduction of the Plantix app as joint farm managers and decision makers.

Among the 17 items of the assessment checklist, 7 items require adjustments to the local context (Table 6).

Table 6. Plantix Assessment Framework results

		Questions to consider
Access interface	Unaware of the usefulness of the digital extension app	How will the Plantix app be marketed? Training of community's key farmers can be the entry point to facilitate discussion, learning and behavior change among local peer farmers. TV and Internet can also be effective sources which can reach many farmers easily and quickly. Agricultural input suppliers and extension workers could also serve as important channels. The process of dissemination could be facilitated by the Farmers Union.
		Can users easily share the app information? Yes, the farmers confirmed the app information is easy to share for both men and women below 50-55 years of age.
	Device inaccessible	Who can/can't access required devices? iPhone users (this could be more than 50% of farmers), or users of old versions of Android.
		Are accessible devices of sufficient quality to use DET (including operating software, durability, screen size, processing speed)? Yes, the farmers confirmed that there are no problems.
	Electricity inaccessible	Can farmers access electricity with limited monetary and travel costs? Yes, electricity is 100% available in all households and affordable.
	Mobile network inaccessible	Is the Plantix app appropriate for the mobile network reliability, speed and affordability? Not many farmers have mobile data (4G), so they cannot receive diagnosis and advice on the farm but they can later have Internet access at home, which is common in the area.
	Insensitive to digital illiteracy	Do farmers already use various apps in their mobile phones? Yes, the farmers did not need much guidance in downloading and using the app.
Access content	Insensitive to illiteracy	Is reading or typing required to use the DET? Yes, some reading is required but both the men and women farmers confirmed that they have no problems.
	Unfamiliar language	Can the Plantix app offer local terms and metrics? Needs to be adjusted (see the results Section 3.2)
	Slow to access	How long does it take for users to access benefits? They receive some benefit instantly after taking a photo (obtaining new knowledge and information).

	Hard to interpret	Is the content visual (or at least visualizable)? Yes, farmers are more interested in functions with visual content than text-based content.
	Unengaging	Can the Plantix involve games, stories, humor, visuals or human interaction? No. However, the quick diagnosis and advice attracts farmers to keep using it. Plantix uses male farmers in images. Images of women farmers from various regions need to be included.
Change behavior	Insensitive to knowledge	Does the Plantix information include (or at least adapt to) users' preexisting knowledge? Some adjustments are required to update the list of permitted chemicals and recommended IPDM practices. Additional information such as top-ranked and locally available pesticide products and early warning messages may attract more progressive farmers to use the Plantix app.
	Insensitive to priorities	Are the Plantix app priorities (e.g., increased yield, reduced risk) set by users or others? Yes.
	Insensitive to socio-economic constraints	Does the Plantix provide users with options? Unclear. Plantix seems to be more useful for farmers with limited knowledge. We need to investigate further what options Plantix provides and if the options can cover the diverse needs and interests of farmers in different socio-economic situations.
	Irrelevant to farm	Can the Plantix be adapted to local soils, climates, agronomic practices and crop calendars? Some adjustments are required to include local crops and pests/diseases.
	Distrust	Is the Plantix branding familiar and trusted? Some farmers do not fully trust the app's diagnosis. However, regarding pest & disease knowledge such as symptoms, causes, prevention and treatment, the farmers trust most of the information provided by the app. Information on the accuracy rate of diagnosis should be shared with farmers to increase their trust.

Based on this pilot study, we request Plantix to make some adjustments for the Vietnam context as follows:

- Include female images of farmers from Southeast Asia;
- Add local names of pests/diseases;
- Include local area units (small "công" in Southern Vietnam, which equals 1000m^2, and large "công", which equals 1296m^2);
- Adapt pesticide recommendations to the Vietnamese market: Remove banned chemicals, and include new-generation active ingredients and chemical products and companies available in Vietnam;
- Provide a list of recommended pesticide products by quality ranking

This pilot study included limited assessment of some technical issues, such as comparing local practices and the app's advice. This was done for two major rice diseases of blast and bacterial blight, but a not in an exhaustive manner and still lacking other pests and diseases. Another limitation was the lack of assessment of the availability of and access to suggested chemicals in local agricultural input shops. Further research is required to obtain more detailed information on which to base requests to Plantix for technical adjustments.

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Appendix

1. List of participants

#	Name	Age	Gen-der	Village	HH size	Rice area (ha)	Other crops	Main person in charge of rice farming	Others in decision making	Train-ing	Feed-back	Notes
I. Farmers from Thanh Quoi and Thanh Tien communes, Vinh Thanh district, Can Tho city												
1	Nguyễn Văn Anh	35	M	Lân Quới 2	4	3	no	Husband	no	x	x	
2	Nguyễn Thanh Tùng	31	M	Lân Quới 2	2	3	yellow mai flower	Mother		x	x	
3	Phạm Thanh An	49	M	Lân Quới 2	5	3	yellow mai flower	Husband	Wife (small role)	x	absent	
4	Huỳnh Văn Bá	42	M	Lân Quới 2	4	5	no	Husband	no	x	x	
5	Phạm Giang	45	M	Lân Quới 2	5	7	no	Husband & wife		x	x	
6	Nguyễn Văn Bình	44	M	Lân Quới 2	5	11	no	Mostly husband	Wife supports	x	x	
7	Nguyễn Văn Đạt	49	M	Lân Quới 2	5	5	no	Husband	no	x	x	
8	Trần Văn Quốc	41	M	Lân Quới 2	5	2.6	no	Husband	no	x	x	
9	Nguyễn Anh Dương	45	M	Lân Quới 2	4	1.9	Coconut, guava	Husband	Wife (small role)	x	absent	
10	Nguyễn Văn Quang	49	M	Lân Quới 2	4	2	mai flower	Both husband & wife		x	x	
11	Nguyễn Thành Công	36	M	Lân Quới 2	5	4	mai flower, livestock	Husband	Wife supports	x	x	
12	Lê Văn Chương		M	Qui Lân 7	4	4	No	Husband	Wife	absent	x	Husband & wife
13	Nguyễn Kim Giang	40	F							x	absent	
14	Nguyễn Kim Hường	43	F	Phụng Thạnh - T.Tiến	7	3	Chili	Father, Brother	Herself	x	x	
15	Dư Thị Kim Chi	44	F	Lân Quới 2				Both husband & wife		x	absent	Quang's wife
16	Nguyễn Thị Bích Thảo	42	F	Lân Quới 2				Mostly husband	Wife supports	x	x	Bình's wife
II. Other stakeholders												
1	Lê Phương Tuyền		F	District PPD officers						x	x	
2	Bành Thị Cẩm Tú	27	F							x	x	
3	Mr. Đoàn	36	M	Commune extensionist						x	x	

** All names were changed*

2. List of common pests and diseases in the area

Men's group					
Crop	**Pests**	**Time of discovery** (days after planting)	**Diseases**	**Time of discovery** (days after planting)	**Notes**
Rice	Thrips	15	Rice blast	25	**Farmers usually apply prevention spraying*
	Leafrollers	25-30	Virus	55-60	
	Brown Planthoppers	40-45	Grain discoloration*	70	
	Stem borers*	40-45	Sheath blight	35-40	
	Rice gall midges	20-35			
Mai flower	Stem borers	In hot weather	Fungi	Year-round	
	Leaf miners	Year round			
	Mealybugs	Year round			
	Red mites	Year round			

Women's group					
Crop	**Pests**	**Time of discovery**	**Diseases**	**Time of discovery**	**Notes**
Rice	Rats Snails Thrips Rice gall midges Leafrollers Brown Planthoppers Whiteflies Stem borers Stinking rice bugs Rice leaf mites	Seedling stage Tillering stage Flowering stage Reproductive to Ripening periods	Leaf blast Bacterial leaf blight Brown spot Root-knot nematode Grain discoloration* False smuts ("than đen", "than vàng/hoa cúc") Sheath blight Panicle blast	Seedling stage Tillering stage Flowering stage Reproductive to Ripening periods	
Chili	Tobacco caterpillars Whiteflies Fruit borers	Seedling stage Early fruit bearing stage	Anthracnose of pepper Rot disease Wither disease	Early fruit bearing stage	
Squash/ Cucumber	Flea beetles Thrips Tobacco caterpillars	Before fruit bearing stage	Brown spot Rot disease Seedling killing disease	Throughout the cycle	
	Fruit borers Leaf miner				

Source: FGD with Vinh Thanh District farmers on 13 December 2022

3. Links to documents

Training materials (link)
Questionnaires for focus group discussions (link)
Original notes on focus group discussions (link)
Original notes on farmers' feedback during the two-week trial period (link)

4. Photos

Photos: ©Trinh Thanh Thao, Van Schepler-Luu and Nozomi Kawarazuka

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