Introducing an agricultural app to vegetable farmers: A pilot study in Lam Dong, 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 vegetable growers in Don Duong District, Lam Dong Province, Vietnam. A group of 8 farmers (1 woman and 7 men) participated in the training on use of the app and provided feedback after a two-week trial.

The results show that the farmers are very interested in using Plantix. Some of the male participants were already familiar with the symptoms of regular pests and diseases. The app can be very useful for them 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 additional information concerning the prediction of pests and diseases at a very early stage before spread in the community. They also suggested the need for information about new generation pesticides.

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 frequently use the Internet and mobile phones as a means of accessing information and exchanging knowledge. Male farmers learn new agricultural technologies through social networks within and outside their villages. However, the most trusted information source is input suppliers. Involving input suppliers in the introduction of the Plantix app could be the key to changing farmers' behaviors. The participants actively exchanged information from Plantix using another message app, Zalo, which can be used as a platform for facilitating communication among farming peers, researchers and other stakeholders.

While this pilot study focused on progressive farmers, there are small-holder farmers from poor households in some remote areas in Lam Dong. 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.

1 Introduction

Lam Dong Province is well known for horticultural produce, in particular, vegetables, roots, tubers, flowers, fruits, coffee and tea. The outskirts of Da Lat City offer a panoramic view of greenhouses covering hundreds of hectares of irrigated farmlands (Figure 1).

Figure 1. Photos of the horticultural industry in Lam Dong province

The view of greenhouses from the outskirts of Da Lat City (left) and women and men harvesting leaf vegetable in Lam Dong Province (Photo credit: Pham Thi Hoa)

The overuse of pesticides and chemical fertilizers has become a serious issue in Lam Dong Province (Houbraken et al., 2016; Nguyen et al., 2018; Nguyen et al., 2017). During the wet season, farmers spray as often as once every three days for prevention purposes (Houbraken et al., 2016). Each year, over 3,700 tons of plant protection products are used within the province, of which chemical products account for a staggering 92%, as opposed to 7.9% of bio-products. More than 280 companies produce, import and/or distribute 1,500 plant protection products in Lam Dong (Viet, 2022).

Vegetable production is concentrated in particular parts of the province, such as Da Lat City, Don Duong District and Duc Trong District, which is one of the largest tomato production areas in Vietnam. The major vegetable crops include cabbage, tomato, chili, carrot, chayote, onion, potato and brassicas, and most of the vegetables are sold in Ho Chi Minh City (Lam Dong Crop Production and Plant Protection Department, 2021a-d; Nguyen et al., 2017).

Several studies have reported overuse of pesticides in the horticultural sector in Lam Dong Province. According to a household survey of vegetable growers (n=150) in Lam Dong (Nguyen et al., 2017), various types of pesticides including highly toxic pesticides (WHO class II) are used. The majority of farmers (78%) spray more than seven times per cropping season during the rainy season. There is no statistically significant difference by gender in spraying practices. Some farmers (28%) stop spraying only 3–7 days before harvesting. Similar evidence was found in a household survey (n=40–60) conducted by the Lam Dong Crop Production and Plant Protection Department (2021a-d). For example, the majority of farmers spray cabbages and potatoes more than 10 times per cropping season, which amounts to over 30 ha/season. Some studies highlight farmers'

inappropriate mixing of pesticides and disposal methods and ill-timed applications (Loveniers, 2019; Nguyen et al., 2018; Tran & Do, 2019).

Farmers in Lam Dong use basic protective equipment such as gloves and face masks (Nguyen et al., 2018). However, around one third of farmers reported health symptoms such as dizziness, eye and nose irritation, headache or nausea. Almost all farmers are concerned about the effects of pesticides on their health (Nguyen et al., 2017).

The provincial government and local organizations address the overuse of pesticides and chemical fertilizers by promoting alternative approaches such as Integrated Pest and Disease Management (IPDM), VietGap certification and biocontrol through extension programs (Hoi & An, 2015). The government also regulates agricultural chemicals through regular inspection and guidance (Lam Dong Crop Production and Plant Protection Department, 2021a-d).

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 (Hoi & An, 2015). On the other hand, farmers choose chemicals based on their own and their peers' experience in terms of effectiveness rather than on information from experts, retailers and chemical pesticide labels (Houbraken et al., 2016; Loveniers, 2019). It is not clear if providing more information through traditional extension services can change farmers' behaviors.

The objective of this pilot study is to explore the potential for using the agricultural app Plantix to reduce pesticide use among rural vegetable farmers, both women and men, in Lam Dong. This is the second pilot study in Vietnam, following the first pilot conducted in Gia Lam, Hanoi with small-scale urban vegetable growers (Bui et al., 2022).

Plantix 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, it offers instant diagnosis and treatment advice for 30 crops, vegetables and fruits.

Plantix has been widely used by male vegetable growers in India. In this study, we test the app in the context of Vietnam with both male and female vegetable growers. In particular, we aim to establish gender-responsive participatory collective learning approaches targeting both women and men.

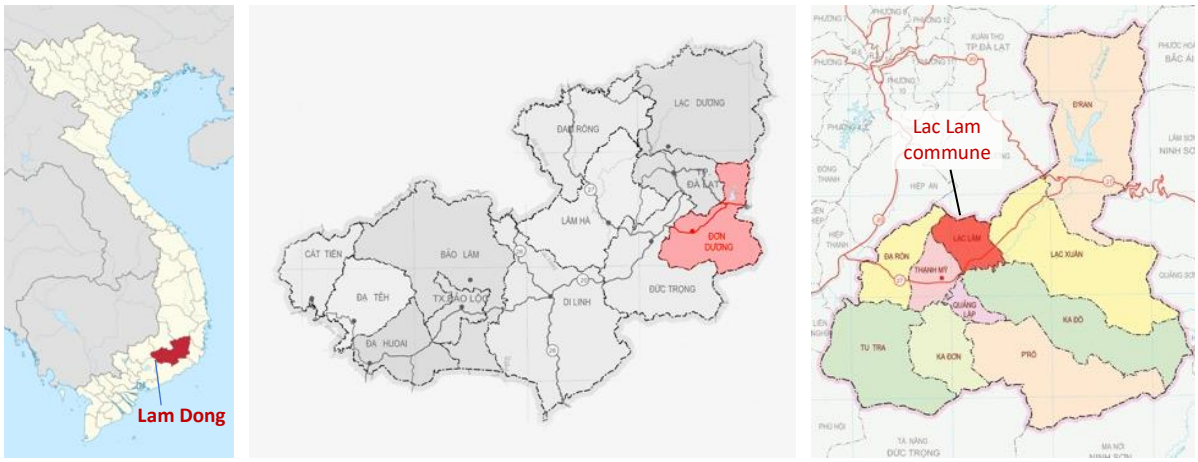
This study also attempts to scale up Plantix following the scaling readiness approach (Sartas et al., 2020). In this first stage, we test the core innovation, seek possible complementary innovations appropriate to a given gender and social context, and identify stakeholders who can potentially facilitate scaling up of the app.

2 Methods

2.1 Selection of study area

The pilot study was conducted in Lac Lam Commune, Don Duong District in Lam Dong Province in August 2022. Lam Dong Province consists of 2 cities and 10 rural districts. Don Duong District (Figure 1) was selected as it is well-known for vegetable production. Don Duong District consists of 2 townships and 8 communes. Lac Lam Commune has ten villages, and we invited farmers from 3 villages from within this commune. The major vegetables grown in the study commune are capsicums and chilis, lettuces, tomatoes, onions, and leafy greens. Apart from vegetables, farmers also grow flowers. There is no rice production in the study area.

Figure 2. Lac Lam Commune, Don Duong District, Lam Dong, Vietnam



2.2 The selection of participants

According to our observations as well as information from the literature (Loveniers, 2019; Nguyen et al., 2017), the majority of farms in Lam Dong are managed by men. 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 Gia Lam, Hanoi, 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 vegetables for sale; 2) farmers who have android smart phones and data plans; 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 eight farmers who were android users (one woman and seven men) participated in the training. The majority of participants were young farmers with the youngest being 27 years old. However, only one woman attended the training, and she could not join the feedback session as she was caring for a sick family member. Most of the participants had large-scale farms of 1 hectare or more, with the smallest at 0.4 hectares and the largest at 5 hectares.

Figure 2. Photos of farms in Don Duong District

Some 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 the vice director and an officer of the Don Duong District Agriculture Center, the director of a farmer cooperative, two university lecturers and one female student, as well as three employees from a food processing company (see Appendices 1 and 2 for lists of participants and stakeholders).

2.3 Training methods

The Plantix training was conducted on 20 August 2022. The training included an introduction to Plantix, downloading the app, a field trial and an initial feedback session. 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 4: Photos taken during the training

2.4 Feedback methods

After the two-week trial period, a focus group discussion was conducted to collect feedback from the participants. Only five men participated in the focus group discussion as two men and the female farmer could not attend this feedback session due to family matters. Two young women farmers who had heard about Plantix from one of the participants joined the feedback session. Although they had not used Plantix, we listened to their views and incorporated them in some general sections to represent the perspectives of women farmers.

The focus group discussion consisted of seven topics: 1) the local crop calendar and seasonal differences in pests and diseases; 2) feedback on the content of the Plantix app; 3) behavioral change and information sharing; 4) potential constraints for some farmers in using this app; 5) gender roles in pest and disease management; 6) information sources; and 7) perceptions on pesticide overuse.

Figure 5: Photos taken during the feedback session

2.5 Data analysis method

A digital extension tool assessment framework was developed drawing on Coggins et al. (2022), who identified major constraints to using digital extension tools 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 1).

Table 1: 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 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 have good access to mobile networks, and all the participants quickly learned and enjoyed using the app. Some farmers had even installed the app and tested it before the training session.

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. Six of the eight participants used the diagnosis and treatment advice function. Only one male farmer used the agricultural weather forecasts, and none of the participants used the other functions.

The participating farmers agreed that the app is very easy to use and that the recommendations are in line with their previous training and knowledge. Some farmers pointed out that the diagnosis was not 100% correct—the misdiagnosis was due to a photo angle—but this indicates the importance of training for farmers to build their trust and confidence in the app.

Many male farmers have confidence in their pesticide and fertilizer use and their knowledge on how to grow crops. Mr Hoang (27) commented, "The app is good for farmers who just established their farms and have little experience of cultivation… We are experienced, so when the symptoms are clear, we can recognize which pests/diseases are on our plants, and how to treat them. It will be much more helpful if the app can identify problems even when the disease is still at the early stage, before the damage becomes serious."

Mr Dung (61) also commented "It would be helpful to include local names, in addition to the scientific names of the diseases or problems, so that it will be more familiar to farmers."

Most of the participants own large-scale farms, so "hectare" was comfortably used as the unit of area for the calculation of fertilizers or pesticides. However, when asked about their farm size, one smaller-scale farmer did describe it using the local term "sao" (equivalent to 1000 m^2 in the central highlands and southern Vietnam), so there might be benefits to including local Vietnamese metric units to better suit smaller producers.

Mr Long (27) also suggested that "The fertilizer calculation should be according to the growth stage of plants because small and grown plants have different needs for nutrients."

3.3 Crop relevance

Among the 12 vegetables which many farmers grow in the study area, only 7 vegetables are available in the app for diagnosis and treatment advice (Table 2).

Table 2: Seasonal crop calendar with major crops grown in the study area

<table>
<tr><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Onion, garlic, potato</td></tr>
<tr><td colspan="12">Cabbage, spring onion, tomato, chili, capsicum, cucumber, eggplant, lettuce, kohlrabi, other leafy greens</td></tr>
<tr><td colspan="12">Flower**</td></tr>
<tr><td></td><td></td><td colspan="5">Pests (on leafy greens)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="7">Diseases (rainy season)</td></tr>
</table>

*__Bold__: farmers already used the app or intend to use the app in the coming season
**Only a few farmers grow flowers.

Source: FGD with Don Duong District farmers on 06 September 2022

As shown in Table 2 above, pests and diseases are prevalent in August to September during the rainy season. Therefore, farmers had many opportunities for using the app during the pilot test.

The farmers requested that the following crops also be included in the app: celery, spring onion, lettuce, beetroot, kohlrabi (popular in the area), and cauliflower, broccoli, carrot, spinach, sweetpotato, mustard green and asparagus (fewer growers).

Apart from vegetables, farmers also requested a diagnosis and advice service for flowers, which are important income sources.

3.4 Knowledge and priority relevance towards behavioral change

August to September is pest and disease season in Lam Dong. Many photos were taken with the Plantix app by the participating farmers. They actively exchanged information obtained through Plantix among themselves during the two-week trial.

However, they did not take further actions following the Plantix advice. There are a number of reasons on why they did not change their practice immediately.

First, the targeted farmers are progressive farmers who have a high level of knowledge about pests and diseases. The farmers' knowledge was in agreement with the recommendations of the app. The farmers expressed a willingness to take action if the app provided new information that filled a gap in their knowledge. Mr Hoang remarked, "The app provides useful advice and information on chemicals that I didn't know before. It would be very useful if the app also updates us on new generation chemical products and active ingredients on the market, because pests have become more resistant to old pesticides. Also, specific detailed instructions for each crop should be provided."

Second, the recommended quantities of pesticides and fertilizers provided in Plantix are different from those they actually use, but the farmers still prefer to follow their own formulas which usually involves overuse. In the case of fertilizers, some farmers have been using more complex formulas than those advised by the app. Mr Dat explained, "I am using my own formula of fertilizers, consisting of single fertilizers mixed at certain ratios depending on the age and health of crops. I have not yet used the fertilizers advice from Plantix." The

participants reported that farmers still typically spray pesticides 2–3 times per week, sometimes even daily when it rains a lot, or during periods of serious pests or diseases. One farmer commented, “The farmers here still use more than the recommended amount. The reason is that we want to see immediate results.” Mr Hoang also commented on the overuse of pesticides: “We would prefer to kill all the pests including natural enemies than miss some of the pests. But even doing that is sometimes not effective enough to control pests and diseases.” Other farmers added that they have to spray more to compensate for a certain amount of chemical which is absorbed into the soil instead of plants due to the operation of high-pressure pump sprayers. The farmers also reported increasing the dose to reduce the number of times they need to spray and the associated labor.

Third, farmers follow the example of their peers, as mentioned by a male farmer: “Here, we often follow what other farmers are doing.” Therefore, it may take some time before the hoped for outcomes that some individual farmers change practices following the Plantix recommendations, and then other farmers observe their success and follow them.

Forth, farmers are closely connected with pesticide companies who offer gifts such as caps, raincoats, and pullovers with their logos as well as small bottles of pesticides. Strong incentives may be required for farmers to change to pesticides with unfamiliar brands.

The farmers appear to be conscious of the negative effects of chemical fertilizers and pesticides on their own health and the environment. Mr. Hoang shared, “When spraying, I have to wear a raincoat and cover myself the whole time, which is very uncomfortable and hot. After spraying, I am very tired. I feel like I have pesticide poisoning. I am nauseous the whole day, my appetite is gone and I don’t want to eat anything.” Other farmers also mentioned their concerns over the chemical contamination of water sources and soil.

On the positive side, the farmers are also equipped with knowledge of alternative solutions such as biopesticides and biocontrol methods. Some of them are already using biopesticides and/or natural predators on their farms. Mr Dat reported, “On my farms, we’re using natural enemies, so we must follow the recommended dosage of pesticides, because excessive concentration of chemicals will kill beneficial organisms.”

When asked about other crops they would like to be added to the app, the farmers were enthusiastic and raised a great number of ideas, which indicates their eagerness to learn from the app. Some farmers said that they were willing to try Plantix’s advice even if it goes against their experience. The farmers are also very open to new technologies, and they have been adopting various new technologies over the past years. This is a great indicator of potential behavioral change in the future, when the app can fill the knowledge gaps and address the farmers’ specific needs.

Some farmers introduced the apps to their friends and neighbors. Mr Dung introduced the app to a male farmer friend and a pesticide seller who downloaded it and tried it out. Another male participant introduced the app to two female friends. The participants thought that the app would be of interest to young farmers (less than 50 years old), vegetable dealers, pesticide sellers, as well as new farmers who need more farming experience. The participants confirmed that women can also be interested as they are also involved in agriculture. Two of the participants’ wives work in vegetable production but the participants did not share the app with their wives.

We formed a group with Zalo to facilitate communications, and the farmers used this tool to interact with one another. Some participants, both male and female, were actively participating in discussions by posting photos of the diseased plants and Plantix diagnoses to the Zalo group chat and asking questions. Other farmers also responded by sharing their knowledge on certain pests and diseases and how to treat them. These observations suggest that the app can work as an individual and a collective learning tool 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 discussion, men are generally more involved in vegetable production as decision makers and laborers, while women do lighter work such as planting, weeding, monitoring, harvesting and selling. Women are more involved than men in harvesting.

Regarding the work related to pest and disease management, we asked participants to nominate who in their household makes decisions about and carries out each respective activity (Table 3).

Table 3: Gender roles and decision-making power

Q1: doing/providing labour ● Q2: Making decisions on when and how to carry out tasks ●	Purchase of pesticides	Measuring and mixing chemical pesticides	Applying/ spraying pesticides	Disposing of chemical pesticide containers/ clean up of applicator equipment	Washing/ cleaning chemical pesticide-contaminated clothing	Training on pest and disease management	Interaction with pesticide company extension staff
Exclusively men 	●● ●●	●● ●● ●●	●● ●●	●● ●●		●	●●
Men do more 	●● ●● ●●	●● ●●			●●	●● ●●	●● ●●
Women do more 					●● ●●		
Exclusively women 							
Hired labor (Men)			●●●	●●●			
Hired labor (women)							

● Providing labor ● Decision-making

Source: FGD with Don Duong District farmers on 06 September 2022 (N=7)

Among the participants' households, the actual tasks of applying pesticides, disposing of containers and cleaning equipment are performed exclusively by men (either male participants themselves or hired male labor). Other activities such as buying and mixing pesticides, attending training and interacting with extension staff or pesticide company staff are also either performed and/or decided by men only in some households, or mostly by men in others. The only activity which is performed more often by women than men is washing pesticide contaminated clothing. However, these results also imply that women do play some, albeit smaller, roles in pest and disease management.

Women are also involved in decision-making on purchasing pesticides and how much to use. This shows that women's improved access to knowledge through Plantix may have some impact on household decisions on pesticide investment and use.

3.6 Information sources

We identified the farmers' current major sources of information on agriculture (Table 4).

Table 4: Participants' use of information 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 been used?			●●●●	●	●●●●●	●●●●● (More men)	●●●●●● (More men)	●●●●●	
About what crops?			All crops						
How often?			Almost daily (FB posts) or when having a problem/ question	Once a month, when they visit	Every week, when purchasing	Regularly (weekly)		All the time	
Which is the most reliable?			●		●●● (incl.2 female voters)		●	●●●	

Source: FGD with Don Duong District farmers on 06 September 2022 (N=7)

The most commonly used information sources include peer farmers (from both outside and within the village, and more often men) and pesticide/input sellers. These information sources are consulted on a weekly basis. Internet sources and using their own experience are also common. Extension workers seem to be a minor source of information, and no participants mentioned TV or radio.

When asked which sources of information they trusted the most, most participants selected "pesticide/input sellers" and "own experience". Interestingly, the female participants seem to place more trust on the former.

Involving input suppliers in introducing the Plantix app could be a key strategy for changing male farmers' behaviors. Further studies are required to understand how women obtain information and which sources they trust.

4 Discussion and conclusions

This pilot study confirmed that the participating farmers are greatly 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.

Due to the limited number of female farmers, the gender aspects were not well explored. However, from our observations and the discussion with male participants and two young women who joined the feedback session, it is important to involve women in the introduction of the Plantix app as joint farm managers and decision makers.

The information needs and the potential utilization of Plantix for progressive male farmers in Lam Dong are different from those of small-holder men and women farmers in Gia Lam, Hanoi whose knowledge on pests and diseases is relatively limited. If the Plantix app can meet different needs by offering different levels of information, it can attract diverse users in Vietnam.

Among the 17 items of the assessment checklist, 7 items require adjustments to the local context (Table 5).

Table 5: 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? The farmer cooperative plays a key role in facilitating the introduction of the app. Agricultural input suppliers may need to be involved in the introduction of Plantix as they are the most trusted source of information for farmers.
		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 years of age.
	Device inaccessible	Who can/can't access required devices? iPhone users (this could be more than 50% of farmers).
		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? Mobile networks work well on farms. Those who do not have mobile data (4G), cannot receive diagnosis and advice on the farm but they can later when they have Internet access.
	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 2.2)
	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 include locally available pesticides and locally recommended IPM practices. Additional information such as new generation 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? Although this is the first time using it, the farmers trust most of the information from the app. Some farmers do not fully trust 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 adjustments for the Vietnam context as follows:

- Include female images of farmers from Southeast Asia;
- Add a local unit "sao" (1 sao is 360m^2 in the north, 500m^2 in the central region, and 1000m^2 in the south);
- Add local names of the pests/diseases;
- Guides with diagnosis and advice for the following vegetables: lettuce, celery, spring onion; beetroot, kohlrabi, broccoli, cauliflower, carrot, spinach, sweet potato, asparagus, and mustard greens;
- Provide fertilizer recommendations specific to each crop and stage of growth;
- Include new-generation active ingredients and chemical products and companies available in Vietnam;
- Include market information on agricultural inputs.

This pilot study included limited assessment of some technical issues, such as comparing local practices and the app's advice. 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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7 Appendix

1. List of farmer participants

	Name*	Age	Gender	Village	HH size	Area (ha)	Types of crops	Main person in charge	Others in decision making
1	Bùi Văn Đạt	27	M	Hải Dương	4	2.5	Capsicum, lettuce, spring onion	self	father
2	Nguyễn Huy Hoàng	35	M	Hải Hưng	4	1.1	Capsicum, lettuce, tomato, spring onion	self	wife
3	Nguyễn Minh Quân	28	M	Hải Hưng	4	1.0	Kohlrabi, spring onion, lettuce	mother & self	wife
4	Nguyễn Quốc Anh	27	M	Hải Hưng	4	0.4	Lettuce, spring onion	self	No (wife has a non-farm job)
5	Nguyễn Văn Dũng	61	M	Lạc Lâm	4	5	Sweet potato, Capsicum	self	no
6	Nguyễn Mạnh Trung	30s	M	Quỳnh Châu Đông	Absent from the feedback session				
7	Nguyễn Thành Châu	50s	M	Hải Hưng	Absent from the feedback session				
8	Nguyễn Thị Mỹ Hạnh	30s	F	Quỳnh Châu Đông	Absent from the feedback session				

* All names were changed

2. List of stakeholders

	Affiliation	Title	Age	Gender
1	Lac Lam Co-operative	Co-op Director	61	M
2	Don Duong District Agriculture Center	Vice Director	50s	M
3	District Agriculture Center	Officer	40s	M
4	Yersin University	Lecturer	38	F
5	Yersin University	Lecturer	30	F
6	Dalat University	Student	21	F
7	Asuzac Foods Company	Employees	30s	M
8			30s	F
9			30s	F

3. Summaries of Lam Dong Crop Production and Plant Protection Department 2021 reports

Report	Cabbage	Carrot	Potato	Tomato
Planted area (2020)	7,611ha (Da Lat 969ha, Lac Duong district 1,462ha, Don Duong 4,481ha and Duc Trong 534ha)	3,477 ha, (Da Lat 1,068 ha, Lac Duong 43 ha, Don Duong 481 ha and Duc Trong 1,885 ha)	1,353 ha, of which Da Lat 484 ha, Lac Duong 68 ha, Don Duong 597 ha and Duc Trong 204 ha	7,254.8 ha (10.6% of the province's vegetable area), mostly in Don Duong and Duc Trong, and scattered in Dalat, Lac Duong etc.
Yield	531.5 quintals/ha	338.4 quintals/ha	261.7 quintals/ha	46.6 tons/ha
Production	404,524 tons	117,672 tons	35,409 tons	347,767 tons
Markets	Ho Chi Minh City, some Southwestern, central and Central Highlands provinces, also exported to Taiwan, Singapore, and Malaysia.	Mainly in Ho Chi Minh and southern provinces.	Sold as frozen and fresh, mainly in Ho Chi Minh City, central provinces and the southwestern region.	
Pests and diseases	leaf blight, root rot, ring spot, mildew, anthracnose, worms, jumping beetles, aphids etc.	nematodes, ring spot disease, rot, black spot, root collar disease. Grey worm, cavity worm, aphids.	powdery mildew, leaf flies, peach aphid, thrips, grey worm, borer. Ring spot disease, soft rot, late blight, root collar disease, green wilt bacteria.	fruit borers, leaf borers, and whiteflies; green wilt, powdery mildew, leaf spot, virus, yellow wilt
Estimated amount of drugs used in 2020 (incl. insecticides, herbicides, growth stimulants)	249.13 tons (biological drugs 12%).	40.89 tons (biological drugs 6%).	48.07 tons, (biological drugs 13%)	Projected 2021: 390.8 tons/year (biological drugs 11.5%)
Survey sample (2021)	60 cabbage growing households	50 carrot growing households	40 potato growing households	50 tomato farming households
Sites	Da Lat city, Lac Duong, Don Duong, and Duc Trong districts	Da Lat city, Don Duong district, Duc Trong district	Da Lat city & Don Duong district	Don Duong and Duc Trong districts
Survey Results				
No. of spray times/season	Most farmers spray more than 10 times/season (68%).	64% of farmers sprayed 8 times/season.	Most farmers sprayed more than 10 times (57.5%), 27.5% sprayed 10 times	58.6% of farmers sprayed >8 times/season
Average amount used	32.73 *kg (liter)/ha/ season*	11.76 *kg (liter)/ha/ season*	35.53 *kg (liter)/ha/ season*	53.9 *kg (liter)/ha/ season*

Report	Cabbage	Carrot	Potato	Tomato
Selection of pesticides	85% choose pesticides based on their own experience; 8.3% as suggested by pesticide dealers; 1.7% read the instructions on the label, 3.3% follow the advice of acquaintances and 1.7% follow the instructions of plant protection officers;	78% choose based on their own experience; 4% based on the recommendation of pesticide dealers; 6% read the instructions on the label, 8% based on their habits and 4% based on instructions of plant protection officers;	80% of farmers choose pesticides based on their own experience; 7.5% as suggested by pesticide dealers; 2.5% read the instructions written on the label, 5% follow the advice of acquaintances and 5% follow the instructions of plant protection officers;	72% based on their own experience; 30% based on the guidance of plant protection officers; 28% rely on the recommendation of pesticide dealers; 22% based on instructions on the label and 18% based on the advice of acquaintances.
Decision on time to spray	11.7% chose the time to spray when seeing pests and diseases, 3.3% according to the surrounding households, 5% based on the recommendations of plant protection officers, 80% sprayed periodically. No farmers listened to announcements on the radio and results of field surveys.	12% chose the time to spray when seeing pests and diseases, 6% followed the surrounding households, 4% followed the recommendations of plant protection officers, 78% sprayed periodically; no farmers listen to radio announcements and field survey results.	12.5% chose the time to spray when seeing pests and diseases, 5% followed the surrounding households, 5% based on the recommendations of plant protection officers, 77.5% spraying periodically, no farmers listen to announcements on radio and field survey results.	68% chose the time to spray when seeing pests and diseases, 66% periodically based on experience, 30% based on recommendations of plant protection officers, 24% based on field survey results and 4% followed surrounding households.
When buying	61.7% care about whether pesticides are biological or chemical, 38.3% do not care	76% care about whether the drug is biological or chemical, 24% do not care.	82.5% were interested in whether pesticides are biological or chemical, 12.5% replied that they did not care.	66% are interested in whether pesticides are biological or chemical, 34 % answered that they do not care.
When applying	10% followed instructions of technical staff, 16.7% followed instructions on the labels, 10% followed instructions of the seller, 63.3% used higher concentration than indicated on the label.	4% followed instructions of technical staff, 8% according to the labels, 12% according to the instructions of the seller, 76% used higher concentration than stated on label.	5% followed the instructions of the technical staff, 12.5% according to the labels, 7.5% according to the instructions of the seller, 75% used higher concentration than indicated on the label.	42% follow instructions labels, 40% follow the instructions of pesticide sellers, 36 % follow instructions of technical staff, 2% used higher and 2% used lower concentration than stated on the label.

Report	Cabbage	Carrot	Potato	Tomato
Concern about toxicity	100% are concerned about the toxicity of drugs to users and the environment, 8.3% of farmers get information from vendors, 6.7% learn from labels, 3.3% from technical staff	100% are concerned about the toxicity of drugs to users and the environment. 14% get information from sellers, 10% learn from the labels, 4% from technical staff and 72% from personal experience.	100% were concerned (5% of farmers sought information from vendors, 7.5% learn from labels, 5% from technical staff).	58% concerned, while 42 % did not care. Tomato farmers get information on the toxicity of pesticides from labels (54 %), vendors (5%), and technicians (24%).
Isolation time before harvesting	93.3% applied isolation time, of which 8.9% followed instructions of pesticide sellers; 32.4% based on drug packaging, 3.6% according to technical staff's instructions.	90% did not apply isolation time; only 10% complied with the isolation time, of which 100% follow the isolation time as recommended on packaging.	90% applied isolation time, of which 100% complied with the isolation time at the request of the buyer	100% applied isolation period, 46% follow the isolation period based on the drug packaging, 42% follow the instructions of pesticide sellers, and 32% according to the guidance of plant protection officer
Wear full protection when spraying	73.3%	80%	87.50%	98%
Recommendations	Training, IPM models, manage residues, inspect pesticide traders	Training, communication, inspect pesticide traders.	Training, communication, inspect pesticide traders.	Training, IPM models, inspect pesticide traders

4. Links to documents

Training materials (link)

A questionnaire for focus group discussions (link)

Original notes on focus group discussions (link)

Original notes on farmers' feedback during the two-week trial period (link)

Photos







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