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Are Vietnamese coffee farmers willing to pay for weather index insurance?☆

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A R T I C L E I N F O

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A B S T R A C T

Global coffee production experiences detrimental impacts of climate change. Weather index insurance (WII) offers an opportunity for coffee farmers to mitigate the climate risks in production and motivate them to adopt sustainable farming practices. This study explores Vietnamese farmers' willingness to participate and pay for WII schemes for coffee. A contingent valuation survey was employed on a sample of 151 farmers from the two largest coffee production areas: Lam Dong and Dak Lak provinces. The findings revealed that farmers are willing to pay, on average, US$92.30 per policy for a premium on insurance products. We also found that farmers in Lam Dong are willing to pay more than those in Dak Lak despite fewer Lam Dong farmers being willing to participate in the insurance schemes. The majority of farmers prefer drought to be insured within 3 months of coffee blossom, from February to April. Factors influencing farmers' decision to join the insurance schemes include education, farm size, climate change perception and experiences, and insurance knowledge. The study suggests that the current coffee industry co-contribution to insurance premiums could potentially be reduced by up to 90 %. However, caution must be taken when adjusting co-contribution, as farmers' willingness to pay is heterogeneous. In addition, raising awareness of the impact of climate change on crop production and insurance knowledge training is critical to ensure an increased number of participants in the schemes. The recommendations from this study will contribute to improving the design of coffee insurance products that are tailored to local needs and preferences and will assist in upscaling the products' outreach in the Coffee Climate Protection Insurance Program.

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1. Introduction

Globally, coffee production is suffering a severe loss as a result of climate change and increased weather variability [1–3].[1] As coffee susceptible to increased temperature and inclement weather patterns, the coffee yield is projected to reduce significantly [9,10]. A research report shows that climate change might reduce the global production of Arabica coffee and Robusta by 45.2 % and 23.5 %, respectively.[2] In addition, the global area suitable for coffee may experience an overall loss of 50 % [11,12]. This situation could be detrimental to the livelihood of more than 25 million smallholder coffee growers across 60 tropical countries [2,13] as well as large multinational coffee corporations [14]. In light of this, governments, development agencies, and private industries in the coffee sector are urgently promoting climate change adaptation and mitigation practices for coffee farming.

Agriculture insurance has been well known as a risk transfer mechanism that helps households manage disaster risks and extreme weather events [15]. In agriculture, various forms and types of insurance products exist but they can be grouped into two categories: indemnity-based insurance products and index-based products. Indemnity-based insurance products have a long history of existence since its first product appeared in the market in 1920s [16]. Indemnity insurance products cover production risks for farmers when actual loss is assessed and certified by a professional loss adjuster. The process of verifying the loss is often costly and time consuming. In addition, indemnity insurance has been characterized with asymmetric information problems, strong covariate risk exposure, and high transaction cost [17,18]. This results in market failure of indemnity insurance products in many developing countries [19].

Index-based insurance products were developed in the latter years as a promising alternative that could address the drawbacks of indemnity insurance. Among different types of index-based products (e.g., area-yield index, soil quality index), weather index insurance (WII) has been increasingly explored as a potential tool for farmers to address weather-related production risks by improving their financial capacity to adopt climate change adaptation practices [20–22]. Instead of linking payouts with actual loss like in the indemnity insurance, WII is based on pre-defined thresholds and trigger points of weather parameters (e.g., rainfall, temperature) to compensate policyholders. The payout of WII is triggered if the weather parameter moves beyond the pre-specified threshold and trigger points, regardless of losses. This reduces transaction cost and guarantees a quick process for claim settlement. Moreover, the payout of WII is based on observable, exogenous events such as weather data, thus, leaving no room for adverse selection and moral hazard [23–25]. Further advantages of WII over indemnity crop insurance schemes include simplified contracts, transparent, and symmetric information for both insurance companies and policyholders [17,26,27].

Worldwide, WII has been offered for a variety of crops in developing countries and positive impacts have been documented. For example, drought index insurance has been shown to help Kenyan pastoralists to cope with livestock mortality due to drought, as is evidenced by the reduction in food aid aftershocks [25]. In India, over 6 million farmers received compensation for crop losses due to rainfall insurance. Payouts from WII have been used to diversify investments in more profitable crops for better risk management in the case of India [28], tobacco in China [29], and cotton in Mali [30].

Despite these potential benefits, the actual uptake of WII has not met its theoretical expectation. Literature has emphasized fundamental factors influencing the widespread adoption of the WII products such as: basis risk [17,18]; premium cost [25,31,32]; contracts design [33–35]; and individual's socio-economic characteristics, experience and attitude towards risk, insurance and climate change [21,36–38]. The adoption of an innovation relies on the characteristics of the targeted population, as well as the technical and financial suitability of the innovation for the population [39–41]. As a market-based innovation, WII requires a thorough demand analysis of local market to determine which products would be suitable for local context, and at what cost clients would be willing to purchase the products.

The main objective of this paper is to explore whether coffee farmers in Vietnam would be willing to participate in, and their willingness to pay for WII schemes to cope with climate risks for coffee production. Specifically, this study seeks to: (i) assess factors affecting farmers' willingness to join a WII scheme; (ii) estimate the average amount that farmers would be willing to pay for the WII scheme; and (iii) explore farmers' preferences for different WII designs that are specifically subjected to the characteristics of coffee horticulture. To address these objectives, a contingent valuation survey is conducted for 151 coffee farmers in the two most popular coffee-growing provinces in Vietnam: Dak Lak and Lam Dong where coffee production is highly affected by climate change. Currently, two WII products, extreme rainfall and drought, have been designed and piloted at a small scale under a project, called DeRISK SE Asia, funded by the International Climate Initiative of the German Government. A global coffee trading company, ECOM, and a global re/insurance broker, Willis Towers Watson (WTW), are partnered in this project to pilot the WII products. One hundred farmers who have a coffee sustainable farming program with ECOM have been selected to participate in the insurance schemes, with 100 % premium cost initially contributed by the company.

This paper sets itself apart from previous works by empirically examining the potential of WII as a climate change adaptation strategy for coffee, the most important cash crops for farmers in the Central Highlands of Vietnam. The context of this research is also different from previous studies. While other studies in developing countries focused on investigating farmers' WTP for hypothetical WII products with government subsidy, this research focuses on a private insurance scheme where the target clients are farmers who have supplying contract with a company, among which some of them have experienced WII products with 100 % support on premium from the company. The contribution and involvement of private sector play a critical role in sustaining the insurance scheme by reducing burden on government resources and ensuring a rapid expansion of insurance program [42,43]. This has been witnessed in

[1] More studies regarding the impact of climate change on the coffee production can be found in Refs. [4–7]; among others. [8] also reports that both the worldwide average yield and the land suitable for coffee reduces by 2050 due to climate change.

[2] https://www.sei.org/wp-content/uploads/2021/09/climate-trade-global-food-security-sei-report.pdf.

the case of PepsiCo in India where 95 % of potato contracted farmers with the company choose to buy the index insurance [44]. The percentage is considered significantly high compared to the uptake of agricultural insurance in national programs.

Although coffee is one of the most globally traded commodities, only few studies assessed insurance demand and markets for coffee. [45]; using lab-in-the field experiment, has investigated willingness to pay for coffee insurance of Guatemalan farmers and found that their WTP increases with the severity and variability of perils covered by the index. The authors also found that risk-averse farmers do not prefer risk pooling ideas where payouts can be distributed through cooperative. Using a similar method [46], reveal that bundling loans with insurance increases Costa Rican coffee farmers' uptake rate regardless of their certainty in liability.

Despite lack of studies on coffee insurance demand, WII products have continued being piloted by international organizations and trading companies in large coffee producing countries, for example: café Seguro by Nespresso (rainfall index) in Colombia,[3] DeRISK SE Asia WII for coffee in Vietnam,[4] World Bank funded coffee WII in Jamaica,[5] etc. The growing number of pilots for coffee insurance is due to the significant loss of coffee harvest in recent years that put this multi-billion-dollar industry at risk. It should also be noted that farmers' demand and WTP for commercial crops might differ from subsistence crops. Empirical evidence suggests that there is a positive relationship between the level of insurance demand and commercialization. For example, it was reported a higher percentage of commercialized farms (farms with annual sales higher than USD250,000) participated in a crop insurance package relative to intermediate farms (farms with annual sales lower than USD250,000) [47]. [47] show a positive correlation between the amount of WTP for the insurance scheme and the output of crops quantity sold in the market. In addition, coffee is a perennial crop with planting regimes different from annual crops. Exploring farmers' preferences and demand for weather perils and coverage periods that are subject to coffee plantation would help design insurance contracts more locally attractive to coffee producers. Our results not only contribute to expand the scarce literature on WTP for coffee insurance in developing countries but are also valuable for improving and refining WII product design in the specific Vietnam context.

The remainder of this study is organized as follows. Section 2 describes the context of the study region before outlining the methodology and data sampling process in Section 3. Section 4 presents the empirical results. Section 5 provides discussions and conclusions are in Section 6.

2. Context of the study region

Coffee production in Vietnam contributes to about 21 % of the total gross domestic product (GDP) for agriculture in 2019, represents 10 % of total exports, with more than 700 thousand hectare and more than 1.4 million smallholder farmers.[6] Globally, Vietnam is the second largest coffee producer after Brazil, and is the largest Robusta growing origin.[7] With such a significant share of the global coffee market, any change in Vietnamese coffee production would have a serious impact on the global price, and subsequently affects coffee producers around the world.

About 95 % of coffee production in Vietnam is grown in the Central Highlands area including five provinces: Dak Lak, Lam Dong, Gia Lai, Dak Nong, and Kontum[8] [48]. The area has a warm tropical climate with one wet and one dry season, which are favourable for coffee plantation, particularly Robusta. However, changing trends in climate has been observed in the area, with the increase in temperature of about 0.4 °C compared to the last decade, unpredictable rainfall patterns, and longer-lasting drought [49].

Coffee production in Vietnam is highly vulnerable to climate change. According to Ref. [50]; the suitable areas for Robusta coffee in the Central Highlands would be reduced by up to 36 % under the low climate impact scenario and 83 % under the high impact scenario. [51]; using data of coffee production and climate data in Central Highlands of Vietnam and Indonesia, revealed that every 1 °C increase in the temperature above 24.1 °C would lead to a decline in the yield of Robusta coffee by 14 %.

The government of Vietnam and other coffee industrial sectors have been trying to promote sustainable farming practices for coffee production in the Central Highlands to adapt to changing climate. However, recent literature reports unsustainable farming such as excessive use of chemical inputs and irrigation water by Vietnamese coffee farmers [52,53]. This contributes to worsen the situation particularly when climate shocks occur. Previous drought events during 1997–1998 and 2010–2011 have led to the reduction of up to 25 % of the total production of coffee beans in the region. In 2015–2016, all the provinces in the Central Highlands were affected severely by drought, resulting in 152,000 ha of agricultural land areas impacted, with direct economic losses of VND 6004 billion (approx. US$ 269 million) [54]. Coffee growers in the region, with about 85 % are smallholder farmers [54,55] who are barely equipped to cope with shocks, have been hardest hit by this event. Following the 2016 drought event, the communities in Central Highlands received various forms of assistance, such as the provision of rice and food supplies, water tanks, access to low-interest credit, cash support, seed and agricultural inputs to restore crop production [56]. However, no support for crop insurance was made available.

As a response to the increasing climate risks faced by coffee farmers, the DeRISK SE Asia project has designed and piloted the Coffee Climate Protection Insurance (CCPI) scheme. The CCPI aims to enhance the financial capacity of farmers to manage climate risks effectively by providing WII to address drought and extreme rainfall risks. The program is being trialed in three phases over five years,

[3] https://www.sustainability.nespresso.com/crop-insurance-coffee-smallholders.

[4] https://ikinews.climatechange.vn/innovative-insurance-solutions-to-help-manage-climate-risk-in-vietnam/.

[5] https://www.worldbank.org/en/news/press-release/2010/01/26/jamaica-agriculture-ministry-and-world-bank-to-assess-weather-risk-insurance-model-for-coffee-industry.

[6] Vietnam's General Statistic Office, 2023 (https://www.gso.gov.vn/en/homepage/).

[7] https://www.fao.org/markets-and-trade/commodities/coffee/en/.

[8] https://www.ico.org/documents/cy2018-19/icc-124-9e-profile-vietnam.pdf.

from 2021 to 2025 (Fig. 1).

The CCPI scheme is designed to introduce the benefits of WII for farmers to mitigate climate risks and increase their participation by gradually reducing financial support for a premium over time. In the first phase (2021), WII products were designed and piloted for 100 coffee producers (about 200 ha of coffee) with premium cost fully supported by ECOM. In the second phase (2022–2023), WII products will be offered to 500–600 coffee producers covering about 750 ha, and in the last phase (2024–2025), it is expected that more than 1000 coffee producers will participate in the WII scheme with financial co-contribution from all the stakeholders including farmers, coffee traders and roasters.

The CCPI scheme covers the risks related to drought and extreme rainfall perils for coffee farmers in Vietnam. The two WII products were designed including a low cumulative rainfall index (drought) and high cumulative rainfall index. The drought index covered April to May period and was piloted to 50 farmers in Dak Lak province while the rainfall index, covering the period from July and August, was trialed to 50 farmers in Lam Dong province. These two provinces were selected based on the area of coffee, and the extent of impacts on coffee caused by extreme weather events. According to the official government's portal of Vietnam,[9] Dak Lak and Lam Dong have the largest coffee area and the highest coffee production among the five provinces. Lam Dong has the highest coffee yield, about 17 % higher than the average yield of other provinces. During the drought event in 2016, Dak Lak had the largest impacted coffee area (56,000 ha impacted), followed by Lam Dong with more than 30,000 ha[10]. For Lam Dong, another climate threat that was reported is excessive rainfall. According to Lam Dong's agricultural extension department, excessive rainfall has led to early drop of fruits in many hectares of coffee in the province.[11]

The coverage period was designed based on the results of focus group discussion and experts' interview within the initial assessment phase of the project. The index thresholds were developed based on the ERA5 dataset which covers Earth on a 30 km grid and resolve the atmosphere using 137 levels from the surface up to a height of 80 km. Research of quality-assured month updates of ERA5 (1959 to present) are published within 3 months in real-time. Preliminary daily updates of the dataset are available to users within 5 days in real-time. Actuarial analysis was also conducted to determine premiums, payouts, and the probability of payout. In the drought index, participants would have a chance to receive payout from US$222 to US$432 per policy, while participants in the rainfall index could receive payout from US$630 to US$1200. Given that the products were developed for a small commercial pilot scheme at the explorative phase, the designs were simplified regarding thresholds, coverage period, premium, and payout.

The two WII products were jointly developed by the University of Southern Queensland (USQ) and WTW in conjunction with ECOM. Under DeRISK SE Asia project, WTW had an agreement with ECOM to offer the pilot WII products and reinsure in the next phases. ECOM is committed to pay on average $100 for premium support for each farmer participating in the WII schemes.

The main aim of this phase is to explore market demand and to create awareness for WII, introduce the concept of WII and how it works through a trial phase to local community. This study was conducted after the first phase of the project focusing on the early participants of CCPI and a portion of non-participants (about 34 %). The results of this study are closely linked to the improvement and refinement of CCPI scheme. Additionally, the study results will aid in determining the appropriate balance of premium co-contribution from industry stakeholders and coffee farmers, which is vital for the sustainability of the program.

3. Methodology and data

3.1. *Contingent valuation methodology*

The contingent valuation method (CVM) and Choice Experiment (CE) are the most commonly used stated preference approaches to elicit the monetary values of non-market goods and services by measuring the willingness to pay of respondents [57]. In the context of studying the demand for agricultural crop insurance, both CVM and CE have been employed.

A CE involves asking individuals a series of choice scenario from which to choose the most preferred alternative among several alternatives defined by their attributes and attributes' levels [58–60]. The choice scenarios in a CE are constructed by a statistical experimental design so that each scenario varies with its alternatives and attributes' levels. This allows to generate a large amount of preferences data and thus produce a robust statistical analysis without requiring a large sample size. CE can also reveal respondents' preferences and WTP for changes in each attribute and for the whole program with changes more than one attribute simultaneously [59–61].

Compared to the CE method, a CVM is less complex as it offers respondents a single binary choice of two scenarios: the status quo and the hypothetical scenario [61]. In addition, the scenario in CVM is described as a whole program without separately varying attributes or attributes' levels. This means that using CVM generates less information on preference data than using CE given the same sample size, and CVM is not able to explore individuals' preferences and WTP for simultaneous changes in attributes and their levels [59]. However, CVM would be more suitable than CE in evaluating the whole scenarios in several settings [62]. An example is that the total value of wetland may be greater than the sum of each attribute's value [60] and such the wetland value may be assessed as a whole.

Depending on purposes of the research and the context of projects, researchers may choose either CE or CVM to address their

[9] Vietnam's Government Communication Portal, 2023: https://baochinhphu.vn/xay-dung-chuoi-nganh-hang-ca-phe-viet-nam-chat-luong-cao-102230312155540856.htm.

[10] Dak Lak Development Investment Fund, 2016: http://dldif.vn/tay-nguyen-hon-7500ha-cay-trong-bi-thiet-hai-do-han-han-104.html.

[11] Lam Dong's agricultural extension department, Department of Agriculture and Rural Development. http://khuyennong.lamdong.gov.vn/thong-tin-nong-nghiep/trong-trot/2605-th%E1%BB%B1c-tr%E1%BA%A1ng,-nguy%C3%AAn-nh%C3%A2n-r%E1%BB%A5ng-tr%C3%A1i-c%C3%A0-ph%C3%AA-v%C3%A0o-m%C3%B9a-m%C6%B0a-v%C3%A0-gi%E1%BA%A3i-ph%C3%A1p-kh%E1%BA%AFc-ph%E1%BB%A5c.

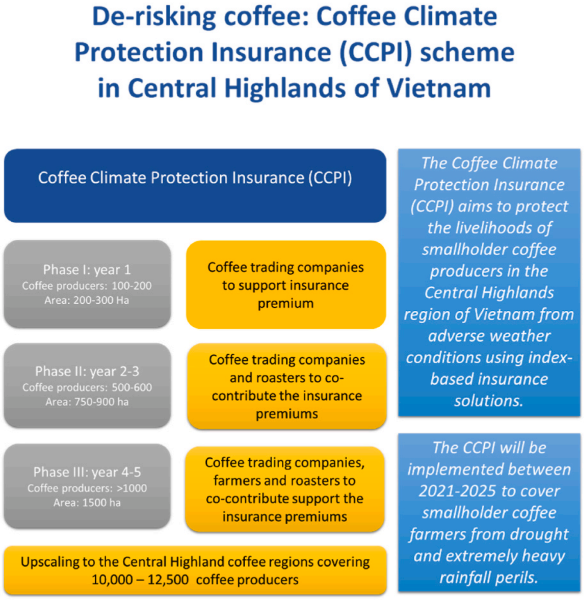

Fig. 1. Schematic details of the Coffee Climate Protection Insurance (CCPI) scheme in Central Highlands of Vietnam.

objectives. With the purpose of investigating whether farmers are willing to pay for crop insurance scheme (or weather-indexed scheme), several studies have employed CVM. For example [47], used CVM to explore farmers' WTP for crop insurance for flood and disaster risk coverage in Pakistan [63]; studied Nepalese farmers' preferences for weather-indexed microinsurance for paddy and livestock; and [64] assessed maize farmers' WTP for drought-index insurance in Ghana. With a more specific focus on different designs of WII, CE has been used to explore farmers' preferences and WTP for different designs of a WII such as: types of disaster to be covered, coverage rate, and annual premium insurance rate [65]; duration of insurance contract, indemnity versus weather-indexed assessment methods [34]; amount of insurance capital, insurance deductibles, and contract terms [35].

In this study, we employed CVM for several reasons. Firstly, this study is follow-up research of DeRISK SE Asia project which has designed and piloted two weather-indexed insurance schemes in the study area during the first phase. One of the purposes of this project is to upscale the two piloted schemes while gradually reducing the premium cost contribution from coffee trading industry. The focus, therefore, relies on the WTP of farmers for the two schemes as a whole, not the designs of each scheme. Secondly, compared to a CVM, designing a CE is more complex and requires rigorous information to determine types and number of attributes and their levels, as well as how to describe them in an understandable way for respondents [59,60]. This study serves as exploratory research to obtain farmers' preferences for different designs of WII scheme in a simple surveyed question. Results from this study will contribute to further research on other WII schemes where a CE can be designed and implemented.

In a CVM survey, individuals are asked to specify the amount of money that they would pay for a product or service in a hypothetical scenario. While several question formats exist to elicit such monetary value from individuals, the most commonly used formats include single-bounded dichotomous choice (SB-DC) and double-bounded dichotomous choice (DB-DC) [66]. The SB-DC elicitation format is well-known for its simplicity and convenience in implementation; however, it has been criticized for being less statistically efficient than the DB-DC format, particularly when the sample size is small [67]. Respondents are presented with two dichotomous choice questions in the DB-DC format, while in the SB-DC format, only one is provided. The second question in the DB-DC format is aimed at following up the respondents' answers to the first one. This follow-up yes-no question helps to provide a clearer picture of the WTP estimates, increase the number of responses, and thus, reduce the variance of the WTP [67–69]. The DB-DC is known as one of the elicitation formats that help enhance the amount of preference data in CVM [61].

This study applies the DB-DC format to elicit farmers' WTP for climate insurance products. Consider that farmer i is initially presented with a dichotomous choice of a yes-no question on whether or not farmer i is willing to pay a specified amount, B_i^1, to purchase a WII product. Depending on the farmer's response to this question, another follow-up question with a different amount of money, B_i^2, is presented. If the farmer answers 'yes' to the first question, B_i^2 is higher than B_i^1, and if the farmer answers 'no', B_i^2 is lower than B_i^1. Thus, four possible outcomes are generated including: (i) 'yes-yes', denoted as *yy*, indicating both answers to the first and the second questions are 'yes'; (ii) 'no-no', denoted as *nn*, if both answers are 'no'; (iii) 'yes-no', denoted as *yn*, if the first answer is 'yes' and the second is 'no'; and (iv) 'no-yes', denoted as *ny*, if the first answer is 'no' and the second is 'yes'.

Let us assume that the true WTP of farmer i, WTP_i, can take the form of a linear function written as follows:

$$WTP_i(x_i, \varepsilon_i) = \beta x_i + \varepsilon_i, \quad (1)$$

where x_i represents the vector of explanatory variables, β is the vector of parameter coefficients, and ε_i is an error term. The error term

ε_i is assumed to be normally distributed with zero mean and variance of σ^2, $\varepsilon_i \sim N(0, \sigma^2)$. The probability, P, of farmer i choosing a yes or no answer for each of the four cases aforementioned cases can be written as follows:

$$P_i^{yy} = P\left(WTP_i \geq B_i^2\right) = \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right), \text{where } B_i^2 > B_i^1,$$

$$P_i^{nn} = P\left(WTP_i < B_i^1, WTP_i < B_i^2\right) = 1 - \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right), \text{where } B_i^2 < B_i^1,$$

$$P_i^{yn} = P\left(B_i^1 \leq WTP_i < B_i^2\right) = \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^1}{\sigma}\right) - \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right),$$

$$P_i^{ny} = P\left(B_i^1 > WTP_i \geq B_i^2\right) = \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right) - \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^1}{\sigma}\right),$$

where Φ is the standard cumulative normal. The parameters β and σ are estimated by maximizing the following likelihood function of N farmers:

$$\sum_{i=1}^{N} \left[z_i^{yy} \ln\left(\Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right)\right) + z_i^{nn} \ln\left(1 - \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right)\right) + z_i^{yn} \ln\left(\Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^1}{\sigma}\right) - \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right)\right) + z_i^{ny} \ln\left(\Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^2}{\sigma}\right) - \Phi\left(x_i' \frac{\beta}{\sigma} - \frac{B_i^1}{\sigma}\right)\right) \right],$$

where z_i^{yy}, z_i^{nn}, z_i^{yn}, and z_i^{ny} are dummy variables that take the value of one or zero depending on each case for each farmer i. The mean WTP is then estimated using the following equation:

$$E(WTP|\tilde{x}, \beta) = -\frac{\widehat{\alpha}}{\widehat{\delta}}, \text{where } \widehat{\alpha} = \frac{\widehat{\beta}}{\widehat{\sigma}} \text{ and } \widehat{\delta} = \frac{1}{\widehat{\sigma}}.$$

3.2. Data collection and analysis

We conducted face-to-face surveys with a total of 151 heads of households in two coffee production areas, Lam Dong and Dak Lak, where the WII products were piloted in 2021. The sample in this study focused on the 100 farmers who have participated in the piloted WII products and an additional 51 non-participants. All respondents are coffee sustainable program farmers with ECOM, and the 51 non-participants were randomly selected using ECOM's list of farmers in the two provinces. We selected head of the households for interviewing given that the household head can make important decisions on behalf of all other family members in local community in the study area. The questionnaires, particularly the contingent valuation questions, were trained to enumerators who were ECOM's coordinators at local districts. The survey was implemented in local language, Vietnamese.

The questionnaire utilized for the data collection was comprised of five parts. The first two parts focused on asking questions about farmers' socio-demographic and farming characteristics in the study site. In the third part, farmers were asked about their perception and experiences with the impacts of climate change on their coffee production and their capacity to manage climate change consequences. The fourth part consisted of questions regarding farmers' risk attitudes, awareness, and exposure to different types of agricultural insurance products, including the two products that have been piloted. These questions were motivated by previous literature on WTP for WII products that have identified risk attitude and insurance awareness as determinants on farmers' decision to participate in the WII schemes. For example [21], showed that there was a negative relationship between risk aversion and demand for insurance, whereas [38] indicated that a higher level of risk aversion increased the probability of farmers to purchase index insurance by splitting risk aversion from the whole uncertainty [38]. further documented that farmers with and without previous insurance displayed a significant difference in risk aversion. This shows that previous insurance experience is an important factor influencing farmers' preference for insurance products. It should be noted that various elicitation methods exist to assess farmers' risk perception, from simple self-assessing risk questions [70,71] to hypothetical or non-hypothetical lottery-choices [72,73]. Given that detailed risk assessment was not the focus of this study, we used a simple direct self-assessment question to explore farmers' attitudes toward risks. In addition, several studies showed that using self-assessing questions for risk assessment generated consistent results with lottery choices [70,74,75].

In the fifth part, we explored farmers' WTP for WII using double-bounded dichotomous choice questions. It began with a description of the hypothetical WII products, which were derived from the actual design of the piloted products, as follows:

Suppose that there are two types of weather index insurance offered for your coffee production. The first type will cover the low rainfall season (from April to May). The second type will cover the high rainfall season (from July to August). For the two types of insurance products, the payout depends on the amount of rainfall during the coverage period, not on the percentage of your crop production lost. This means that payout if any will be received faster than under a traditional crop insurance scheme that requires time to assess your crop damages. Alternatively, the payout depends upon the cumulative rainfall during the coverage period. If it exceeds or falls below the agreed threshold (depending on which product you choose), you will receive a payout. The payout can be up to 30 million VND per policy and the probability of payout is 10 % per the duration of the policy.

Farmers were then asked whether they would want to purchase these insurance products and which type of products they would prefer. A set of dichotomous choice questions was only presented to farmers if they were willing to participate in one of the insurance schemes. The first and the second bid values were determined based on the results of the focus group discussions in 2021. This was then followed by an open-ended question asking for their maximum WTP. In addition, respondents were also asked to indicate their preference for several contract designs including weather risks to be covered, the risk coverage period, and distribution channels. These designs were selected given that they are highly sensitive to types of crops, local context and climate. Previous literature of insurance policy designs has explored farmers' preferences for weather risks that insurance covers and the coverage period. For example [65], investigated Burmese farmers' preferences for different designs of WII packages for rice including the types of disaster that the insurance covers. They found that the majority of farmers ranked drought as their first preference for disaster to be covered, followed by cyclone and flood. They also found heterogeneity in farmers' preference for covering salt damage [76]. revealed from a choice experiment study that farmers in Pakistan are sensitive to coverage periods. They would require a discount if coverage periods were limited to pre-sowing or post-harvest months. The preference of coffee farmers in Vietnam for weather risks and coverage period contributes to exploring different levels of these attributes in a WII product that could be tested on a larger scale in the latter phase of the project.

A binary logit regression model, shown in Eq. (1), was used to investigate the determinants of farmers' willingness to participate in the WII schemes. Based on the empirical literature, we initially included all relevant variables that potentially affect farmers' decisions in participating in the insurance schemes, such as: (i) education and knowledge [24,33,36]; (ii) credit or liquidity constraints [21,24]; (iii) gender differences [33,64]; (iv) risk aversion and previous experience in insurance [21,38,77]; and (v) climate change experience [78–80]. The model was then refined by removing non-significant variables and variables that strongly correlate with other variables to address the multicollinearity issue. The final model was selected based on the Akaike Information Criterion (AIC) value [81]. A lower AIC value indicates a better-fit model. Finally, the DB-DC model was run using the DOUBLEB package in STATA [82].

4. Results

4.1. Descriptive analysis results

In this subsection, the descriptive analysis results on farmers' socio-demographic and farming characteristics, and their perception and awareness of climate change were presented.

4.1.1. Socio-demographic and farming characteristics

Table 1 presents the summary of the respondents' socio-demographic and farming characteristics, while the details of the two study sites (Lam Dong province and Dak Lak province) are provided in Appendix.

The number of surveyed farmers in the two provinces was closely equivalent, with 49.7 % and 50.3 % in Lam Dong and Dak Lak, respectively. Most of the respondents belong to Kinh ethnic group (93 %), were male (79 %) and married (92 %). The average age of the surveyed coffee farmers was 51.9 years, with an average household size of 4.6 persons. Around half of the respondents indicated that they belong to at least one of the local organizations such as farmers' unions and cooperatives. The average annual income of the farmers was approximately US$9530. However, this varies significantly across the respondents, as indicated by a high standard deviation of US$5450.

Regarding farming characteristics, the respondents own an average of around 2.1 ha of land, of which more than 90 % (1.9 ha) is used for coffee plantation. Similar to annual income, the income from coffee farming also varies among the respondents, while the

Table 1
Socio-demographic and farming characteristics.

Variable	Description	Value
Lam Dong prov	The percentage of respondents living in Lam Dong province	49.7
Dak Lak prov	The percentage of respondents living in Dak Lak province	50.3
Ethnicity	The percentage of Kinh respondents	93
Male	The percentage of male respondents	79
Age	Average age of respondents (years)	51.9 (10.2)[a]
Marital status	The percentage of respondents who are married	92
Education	The percentage of respondents having a high school degree or higher	37
HHsize	Average number of persons living in a household	4.6 (1.7)
Adult	Number of adults (from 18 years old)	3.4 (1.2)
Child	Number of children (<15 years old)	0.9 (1.0)
Labor	Number of labor in the household	2.7 (1.1)
Agrilabor	Number of labor in agriculture	2.3 (0.8)
Org	The percentage of respondents being a member of a social organization	57
Income	Average annual income ('000 US$)	9.53 (5.45)[b]
Coffeeinc	Average annual income from coffee ('000 US$)	5.70 (3.91)[b]
Land	Average area of cultivated land (ha)	2.1 (1.3)
CoffeeLand	Average area of land for growing coffee (ha)	1.9 (1.3)
Coffee harvest	Average annual coffee harvest (tons)	7.0 (4.9)
Coffee price	Average price of coffee sold (US$/kg)	1.33 (0.00)[b]

[a] Value in the bracket represents the standard deviation.
[b] 1 US$ = 23,500 VND (March 2023).

coffee price was reported consistently at US$1.33/kg of dry beans. This variation in the farmers' coffee income can be explained by the high variation in the average coffee plant area and the annual coffee production.

4.1.2. Climate change perception and experiences

Around 92 % of respondents indicated that extreme weather events had impacted their farming activities in the last five years. Table 2 reports farmers' experiences with various types of extreme weather events.

The impacts of drought on yield loss and income were perceived as the highest among all extreme weather events. Drought was experienced by most surveyed farmers (91 %), followed by excessive rainfall (23 %), high temperature (13.9 %), and strong wind (6 %). The respondents reported that drought led to an average of 23 % reduction in yield and 21 % in income. The second factor was excessive rainfall, which caused a 19 % loss in yield and a 17 % loss in income. High temperatures and strong winds did not significantly impact yield and income, as the average loss was reported at less than 10 %. The average capacity management for extreme weather events claimed by the farmers was at a moderate level, except for the strong winds, which were poorly managed. The table does not present other types of weather risks that were reported by a few respondents, including cloudy and wet weather (2.7 %) and fog (6.7 %).

4.1.3. Risk and insurance awareness

The descriptive results of the farmers' risk attitude and their insurance awareness are summarized in Table 3. The respondents were asked to indicate their risk attitude based on a scale of 0 (risk-averse) to 10 (highly risk-seeking). The average risk scale of the respondents was at around the mid-point, with a mean of 4.9 and a standard deviation of 2.7. The result shows that most of the farmers in the study area were not risk-takers.

While most farmers (around 70 %) indicated that they were aware of crop insurance products, only around 48 % purchased insurance. The types of insurance products that they purchased were the two piloted products: the low rainfall index insurance (bought by 29.8 % of the farmers), and the high rainfall index insurance (bought by 17.8 % of the farmers). Apart from these two piloted insurance products, neither of the other insurance schemes for agriculture was reported in the survey. The farmers' decision to participate in the insurance schemes was mainly motivated by the co-contribution to the premium cost provided by ECOM (27.7 %). Farmers' concern over the risk of extreme weather events imposed on their coffee production was the second most selected reason (17.5 %) for participating in the insurance schemes. For those who were aware of the crop insurance but did not purchase it (33 respondents, equivalent to 47 %), the most cited reason was the lack of suitable insurance products in the area (51.5 %), followed by failure of insurance to mitigate the risks of crop loss (36.4 %) and lack of trust in the insurers (33.3 %). More details are presented in Table 3.

We also asked the respondents to rank their knowledge of insurance and the importance of insurance on a scale of 0 (lowest) to 10 (highest). The results reveal that, on average, farmers ranked their knowledge of crop insurance at 4.6 out of 10 points. The extent of farmers' knowledge of crop insurance may explain the low ranking given to the importance of crop insurance (4.3 out of 10).

4.1.4. Farmers' preference for weather risk coverage period

Four types of weather and climate risks, drought, excessive rainfall, high temperatures, and strong winds, were experienced the most by the farmers in the sample. They also indicated the impacts of these weather risks on their coffee production, as shown in Table 2.

Various coverage periods for each weather risk were reported in Table 4. The most preferred coverage period for drought is from February to April as indicated by 41.3 % of respondents who preferred drought to be covered. For excessive rainfall, 70.6 % of respondents who preferred this weather risk to be covered indicate September to November as the coverage period. In terms of high temperatures, the coverage period of May to June and June to July were preferred by 47.6 % and 52.4 % of respondents who preferred such weather risks, respectively. Of those respondents who preferred strong winds, the most reported coverage period was July (38.9 %), followed by September (33.3 %) and August (16.6 %). The risk of strong winds on coffee production was reported by fewer respondents (n = 18) compared to other risk types. Respondents also mentioned cloudy and wet weather and fog, but the frequency was low and is thus not reported.

4.2. Binary-logit model results

Factors influencing farmers' willingness to purchase WII products are presented in Table 5. Education level and farm size for coffee positively influence farmers' willingness to participate in the WII schemes, as indicated by the positive coefficients and statistically significant p-values associated with the *Education* and *CoffeeLand* variables. Regarding insurance awareness, a strong positive correlation was found between farmers' knowledge ranking (*InsurKnowledgeRank*) and the likelihood of purchasing WII products. Farmers'

Table 2
Climate change perception and experiences of farmers.

Type of extreme weather risk	Affected (%)	Average % of coffee yield loss	Average % of income loss	Capacity management[a]
Drought	91.4	22.7 (8.8)	20.7 (10.4)	3.0 (0.7)
Excessive rainfall	22.5	18.5 (7.2)	17.4 (8.3)	3.1 (0.8)
High temperature	13.9	7.6 (3.2)	3.2 (1.0)	3.0 (0.0)
Strong wind	6.0	5.1 (3.8)	3.8 (2.7)	2.6 (0.7)

Note: The value in the bracket represents the standard deviation.
[a] Average value: 1- Out of control; 2- Low capacity; 3-Moderate capacity; 4- Good capacity.

Table 3
Risk attitude and crop insurance awareness and experiences.

Variable	Description	Value
Risk attitude	Average value: 0: risk-averse to 10: highly risk-seeking	4.9 (2.7)
Crop insurance awareness	The percentage of respondents aware of insurance products for crop	70
Crop insurance purchase	The percentage of respondents purchasing crop insurance products	48
• Low rainfall index insurance purchase	The percentage of respondents purchasing low rainfall index insurance	29.8
• High rainfall index insurance purchase	The percentage of respondents purchasing high rainfall index insurance	17.8
Reason for purchasing insurance	The percentage of respondents	
• For compensation in case of crop loss due to extreme weather events		17.5
• Observing increased climate variability		4.4
• For experiment		2.9
• ECOM contribution for the first year		27.7
Information sources about insurance	The percentage of respondents	
• ECOM		45.7
• Mass media		6.6
• Extension officers		3.9
Reason of not purchasing insurance (n = 33)	The percentage of respondents	
• Lack of suitable insurance products		51.5
• Comfortable being exposed to risks		24.2
• Lack of government subsidy		30.3
• Failure of insurance to effectively mitigate risks		36.4
• Time required to buy insurance and make claims is long		24.2
• Excessive complexity of insurance		30.3
• Lack of trust that insurers will play valid claims		33.3
• High premium cost		30.3
• Difficulty in claims		0
• Insurers are too far		6.1
• Not aware of insurance benefits		6.1
Insurance knowledge rank	Average value: 0: not knowledgeable at all to 10: very knowledgeable	4.6 (2.3)
Insurance importance rank	Average value: 0: not important at all to 10: very important	4.3 (2.8)

Note: The value in the bracket represents the standard deviation.

Table 4
Farmers' preference on weather risks and period of coverage.

Weather risks	**Period of coverage**[a]	**% of respondents**
Drought (n = 63)	February–April	41.3
	March–April	23.8
	April–May	15.9
	April–June	6.4
	Others[b]	12.6
Excessive rainfall (n = 34)	September–November	70.6
	Others	29.4
High temperature (n = 21)	May–June	47.6
	June–July	52.4
Strong wind (n = 18)	July	38.9
	September	33.3
	August	16.6
	Others	11.2

[a] Coverage period was reported in lunar calendar and was converted to the normal calendar. Lunar calendar is from 1 to 1.5 months behind the normal calendar.
[b] Note: Others - combined all other least preferred periods.

income (*LogIncome*) negatively affects their willingness to purchase insurance, meaning that the higher their income, the less likely they are to join the insurance schemes.

The model's results also show that farmers in Lam Dong did not prefer insurance, while the Dak Lak farmers were interested in purchasing it. In terms of climate change experiences, it was found that among farmers whose farming activities were impacted by climate change (*ImpactCC*), the higher the yield loss was caused by drought (*YieldLossDrought*), the more likely they were to participate in the WII schemes. Statistically significant p-values were not found for other extreme weather events, and these variables were thus removed from our model.

4.3. Estimation of WTP pay for WII products

Around 48 % of the 151 respondents agreed to participate in the WII schemes presented in the hypothetical WII scenario. Among respondents who were willing to join either one of WII schemes, 67 % of them were in Dak Lak. Regarding the 100 early participants in

Table 5
Binary logit regression results.

Variable	Coefficient	Standard error	95 % Confidence Interval
Constant	9.23	6.09	[-2.71; 21.17]
Province (Lam Dong = 1; Dak Lak = 0)	−2.51***	0.63	[-3.74, −1.27]
HHsize	−0.02	0.13	[-0.28; 0.24]
Age	−0.03	0.02	[-0.08, −0.12]
Education (≥ highschool)	0.89*	0.49	[-0.08,1.85]
CoffeeLand	0.63***	0.23	[0.19, 1.09]
LogIncome	−1.12**	0.49	[-2.07, −0.17]
ImpactCC	2.66***	1.03	[0.65, 4.67]
YieldLossDrought (%)	7.53**	3.00	[1.65, 13.41]
InsurKnowledgeRank	0.26***	0.09	[0.09, 0.44]
RiskAttitude	0.09	0.08	[-0.08, 0.25]
Number of observations	151		
Log likelihood	−76.72		
Akaike Information Criteria (AIC)	175.44		

Note: ***p < 0.01; **p < 0.05; *p < 0.1.

the piloted schemes, only 54 % of them would be willing to rejoin the WII schemes. A total of 4 % of the respondents were willing to pay equal to or higher than the high follow-up bid (yes-yes cases), while 13.25 % rejected both the initial and the low follow-up bids (no-no cases). The remainder of the respondents were equally distributed into bids ranging from US$106.40 to US$212.80 (16.6 %) and US $42.60 to US$106.40 (14.6 %). Fig. 2 shows the distribution of the accepted and rejected bids for insurance.

Table 6 presents the results of the DB-DC model. Without accounting for the effects of control variables, the mean WTP for WII premium was estimated at US$92.30 (2.17 million VND) per policy, equivalent to 1.6 % of the average annual income from coffee. We included control variables in the model and found that only the province variable (*Province*) was statistically significant. Thus, the Province variable was included in the final model while other variables were removed. The result indicated that farmers in Lam Dong were willing to pay more for the WII products. After adjusting for the control variable, the mean WTP was calculated at US$102.60 (equivalent to 2.41 million VND) per policy.

5. Discussions

Our results confirmed that there is a demand for coffee WII in Vietnam although only half of respondents including non-participants in the pilot schemes were willing to participate in WII. Our expectation was that the co-contribution of ECOM may increase its contracting farmers to join or rejoin the insurance scheme given the advantages of having a long-standing relationship with farmers, as is evidenced in the case of PepsiCo with its potato farmers in India. Our finding indicates that only 54 % of early participants in the piloted WII scheme with 100 % of ECOM's support on premium cost would rejoin the schemes. However, the unexpectedly low percentage of early participants' willingness to rejoin the scheme may be explained by the designs of the piloted WII schemes in the two provinces. Recall, drought index insurance was piloted in Dak Lak and it seems to be preferred by local farmers given the high damage of drought that they have experienced. Thus, they were more likely to join or rejoin. In Lam Dong, rainfall index was piloted, and this might not be suitable here as Lam Dong farmers also reported drought as their most preferred weather perils to be covered by the

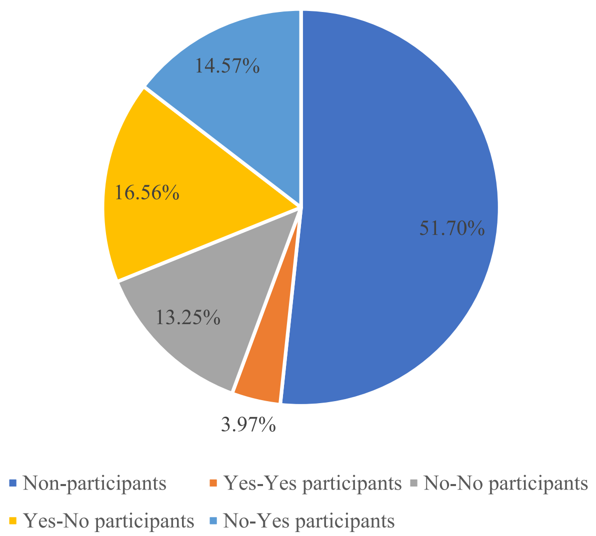

Fig. 2. Distribution of farmers' responses in contingent valuation scenario.

Table 6
Farmers' willingness to pay for weather index insurance products for coffee.

n = 73	Mean WTP[a]	Standard error	95 % Confidence Interval
WTP (bids only)	2.17***	0.25	[1.68,2.67]
WTP (with province as covariate)	2.41***	0.25	[1.91,2.90]

***p < 0.01; **p < 0.05; *p < 0.1.
[a] Value is in million VND, 1 US$ = 23,500 VND.

insurance. Our results indicate that farmers in Dak Lak were more likely to participate in the WII than those in Lam Dong. This finding provides a valuable insight to redesign the index that could be more appropriate to Lam Dong farmers. For example, introducing the piloted drought index in Dak Lak and adjusting its design to match with farmers' preference on coverage period could be an option to attract more Lam Dong farmers to join the scheme.

We found a positive WTP of US$92.30 per policy for WII products. When adjusted with the covariate, *Province* (Lam Dong = 1), the average WTP increases to US$102.60. The WTP obtained for coffee index insurance in this research is significantly higher than WTP for other crops (including mainly rice) in Vietnam that was reported in Ref. [83]; at US$56.60 per farm. In another study, WTP for flood insurance for rice in Vietnam was estimated at about US$10 per hectare/season [84]. Although many factors may influence the amount of WTP, in general, the index insurance for coffee, as a commercial crop, seems to receive higher WTP than that of other subsistence crops in Vietnam.

The positive WTP for WII schemes highlights an opportunity to gradually reduce industry co-contribution for the premium, which is in line with the project's targets in phase II and phase III. The average WTP is about 90 % of the current premium cost of piloted WII products ($100 per policy), and the minimum WTP (US$71 or 1.67 million VND) is about 70 %. This percentage could be used to guide the implementation of industry co-contribution reduction. However, caution must be taken when adjusting premium contribution given that farmers' willingness to participate and WTP are heterogeneous across the two provinces. For example, we found that Lam Dong farmers who were willing to join the WII would be willing to pay higher premium cost. The high premium can be attributed to the fact that more farmers in Lam Dong have higher education levels and larger coffee farms, thus higher coffee income than Dak Lak farmers. Recall, Lam Dong coffee productivity was recorded highest among the five provinces. However, the coffee income variable was removed in the model given that it is correlated with the coffee farm size.

A surprising result is that income negatively influenced farmers' willingness to participate in the WII scheme. This contrasts with our intuition that wealthy farmers have a better financial potential to purchase WII products. However, this finding is consistent with those reported in previous studies [37,85,86]. Here, the possible explanation is that farmers with higher incomes are better equipped to adopt adaptation strategies, which makes them less vulnerable to the effects of climate change. As a result, they may not have a demand for insurance products. For example, several farmers in Dak Lak have implemented sprinkler irrigation, or have adopted mulching to conserve soil moisture during drought periods [54]. In addition, farmers with higher income may not heavily depend on coffee as they may have various sources of income. Income diversification results in less vulnerability to climate change, and thus coffee insurance might not be preferred [37,86].

Our results highlight a positive relationship between factors, such as education, coffee land size, insurance knowledge, climate change perception and experiences, and farmers' willingness to participate in WII schemes. The findings are in line with those reported in the literature on the relevant determinants of farmers' participation in crop insurance. The higher education level indicates an individual's financial literacy ability. As the WII is one type of complex financial product, a better understanding of its compensation facilitates farmers' participation in the scheme [38,87,88]. Similarly, farmers with a high level of insurance knowledge and awareness are also willing to be involved in the WII scheme [89]. Households with larger coffee land are more likely to participate in and pay for the WII scheme. This suggests that if a large proportion of farmers' income comes from coffee cultivation, they would be willing to use insurance to protect their coffee from climate change [24,85,90].

Farmers who have experienced the adverse impact of climate change, i.e., notably higher yield losses due to droughts, are more likely to join the insurance scheme [78,79,91]. The results suggest that there is a definite need for a training program on WII insurance and its benefits, as well as raising awareness to local farmers on the serious impact of climate change on coffee farming to increase the farmers' uptake rate [89]. In addition, it is essential to encourage those who have better education, have experienced drought impact, and have a good experience with pilot insurance products to share the knowledge and information with the neighboring farmers in their communities. This could be one of good strategies to increase farmers' participation in WII as abundant literature have emphasized the role of neighbors on influencing the insurance uptake [24,92].

Several reasons for not purchasing WII products in the future were also revealed in this study, including a lack of suitable insurance products, failure of insurance to mitigate the risk of crop loss, and a lack of trust in insurers. Our findings, particularly those related to the farmers' preferences for weather risk coverage, and coverage period contribute to addressing farmers' concerns, which may alter their decisions. Therefore, designing a product using a bottom-up approach where preferences and demand of local stakeholders, particularly farmers, are considered is imperative to increase the chances of success for such a product. The current design of piloted WII products was simplified with a fixed coverage period and covering two major weather risks which may not address local needs. Our findings indicate that farmers preferred different coverage periods for each weather peril. For drought and rainfall, the majority of farmers preferred a 3-month coverage period, from February to April and September to November respectively. For other types of weather perils, one-month coverage seems to be sufficient. The piloted design of coverage period (April–May for drought and July–August for rainfall) relied on weather data which might not reflect the local demand and horticultural context. Although the period from February to April may not be the driest months, this period is critical for coffee blossom in the Central Highland of Vietnam. Unfavorable weather during this period would lead to changes in flowering, ripening, early harvesting, and consequently reducing yields [93]. For rainfall, the period from September to November is important as it is the harvest season of coffee in the study area. Excessive rainfall during this period can lead to mold growth, disease, excessive fermentation which decreases the quality of coffee beans [94]. This finding is essential to help the project team conduct further research on the design of basis risk and coverage for the insurance schemes. The information on different periods and their duration could be used as levels of the coverage period attribute (i.e., 1 month, 2 months, 3 months) associated with a premium cost range in a future choice experiment study to refine the piloted WII schemes.

This study was conducted as follow-up research that needs to be aligned with the framework and objectives of the DeRISK SE Asia project, as such, it is subject to several limitations. Given that the main aim of this study was to investigate holistically farmers' WTP for the piloted WII schemes to explore the possibility of reducing premium support, we used a contingent valuation method in a limited sample size, mostly covering all participants in the first phase. Future studies can employ more complex methods, such as choice experiments, to examine more specific designs of each component of the WII products once the piloted scale expands beyond ECOM's contracted farmers. The initial findings from this study on farmers' preference on types of weather perils to be insured, the coverage periods, and the WTP levels for premium cost provide valuable inputs to determine the number of attributes and attributes' levels in a future CE. The sample size of this study is currently limited to ECOM's coffee sustainable program farmers which fits the purpose of this project, however it might not represent the whole farmers population of the two provinces. Future studies can expand the sample size to cover a larger number of farmers when the products are commercialized beyond ECOM's responsibility. Given the novelty and complexity of WII, the questionnaire design could be improved by considering more facets of the insurance products and farmers' community environments. Finally, this study only explored the demand side of insurance products. Although the results indicate that farmers are willing to pay, on average, 1.6 % of their annual coffee income or about 2.17 million VND (US$92.3) per policy for the premium cost, it might not be sufficient to attract interest from local insurance companies. The pilot schemes were designed under the DeRISK SE Asia, with active support from the global ECOM coffee trading and WTW. To sustain the insurance schemes, further research should be conducted to explore the preferences of local insurance providers.

6. Conclusions

As an important cash crop with billions of consumers, concerns about how the coffee sector and growers adapt with climate change have received great attention from multiple stakeholders. Being considered as a climate change adaptation tool, WII has been proposed and piloted in several large coffee producing regions by private sectors and international donors. However, in the absence of demand studies of WII for coffee, the scalability of these piloted schemes would be challenging. For the WII products to be well-accepted in the farming community, farmers' demands and preferences must be explored and embedded in the product design. This paper explores farmers' preferences and willingness to pay for WII schemes for coffee in the Central Highlands of Vietnam, a home of the second largest coffee production in the world. This is not the first study assessing the WTP for WII schemes for crops, however, with the focus on coffee production it is one of the first studies. The study was follow-up research of DeRISK SE Asia project where the first phase focused on exploring and piloting WII products at a small commercial scale in Dak Lak and Lam Dong, two most popular coffee growing provinces in Vietnam.

Our result revealed a positive WTP for coffee WII products, an average of US$92.30 per policy, which equals to 90 % of the current industry contribution. We also found that there is a heterogeneity in farmers' willingness to participate and WTP across provinces. More surveyed farmers in Dak Lak were willing to join WII while there were less in Lam Dong. However, respondents in Lam Dong who were interested in joining the scheme would be willing to pay a higher premium, on average US$102.6 per policy.

Other important findings from this paper relate to the positive correlation between the willingness to participate in WII schemes and socio-demographic characteristics (education, farm size), as well as knowledge and experiences of insurance and climate change. The results show that respondents who have better education, larger coffee area, have knowledge of insurance, and have experienced impacts of climate change would be willing to participate in WII schemes. The variable "income", however, was found to be negatively influenced the willingness to purchase WII products.

The results of this study have practical implications for the next phases of DeRISK SE Asia project which aims to promote and expand WII for coffee. First, the positive WTP is promising as it shows farmers' ability to pay for insurance products with less premium support from private sectors. The average amount of WTP could be used to guide the modification of premium contribution regime to help WII more sustainable. Second, the WII product for Lam Dong farmers might need to be redesigned as the piloted rainfall index seems fail to meet with local needs. Since Lam Dong farmers gave a high priority to drought risks to be insured, the drought index scheme should be trialed there instead of the rainfall index scheme. Third, the coverage period and duration in the pilot schemes were not preferred by the majority of respondents. They expressed their preferences on a longer period of coverage (3 months rather than 2 months), covering the most critical months of coffee blossom (for drought) and coffee harvest (for rainfall). Finally, a training program on insurance and awareness raising campaign on climate change impacts on coffee would be vital to promote WII and guarantee the success of the projects.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Appendix. Analysis of farmers in the two study sites

Table A
Descriptive analysis of farmers in Lam Dong and Dak Lak

Variable	Description	Value	
		Lam Dong	Dak Lak
Province	Number of respondents	75	76
Ethnicity	Number of Kinh respondents	67	73
Male	Number of male respondents	66	54
Age	Average age of respondents (years)	51.3 (12.1)[a]	52.7 (7.8)
Marital status	Number of respondents who are married	69	70
Education	Number of respondents having a high school degree or higher	37	19
HHsize	Average number of persons living in a household	4.4 (1.7)	4.8 (1.6)
Adult	Number of adults (from 18 years old)	3.1 (1.1)	3.7 (1.2)
Child	Number of children (<15 years old)	0.7 (0.9)	1.0 (0.9)
Labor	Number of labor in the household	2.5 (0.9)	2.9 (1.2)
Agrilabor	Number of labor in agriculture	2.2 (0.7)	2.4 (0.8)
Org	Number of respondents being a member of a social organization	33	54
Income	Average annual income (Million VND)	228 (127)	220 (130)
Coffeeinc	Average annual income from coffee (Million VND)	141 (96)	127 (88)
Land	Average area of cultivated land (ha)	2.6 (1.5)	1.6 (0.8)
CoffeeLand	Average area of land for growing coffee (ha)	2.4 (1.5)	1.5 (0.7)
Coffee harvest	Average annual coffee harvest (tons)	8.7 (6.1)	5.3 (2.7)
Coffee price	Average price of coffee sold ('000 VND/kg)	31.1 (3.3)	31.6 (1.4)
CCaffect	The percentage of respondents experiencing climate change impacts	71	68
Drought	The percentage of respondents experiencing impacts of drought	70	68
• Impact on yield	Average percentage of yield loss due to drought	18.5 (9.1)	27.0 (6.1)
•Impact on income	Average percentage of income loss due to drought	14.6 (9.9)	27.0 (6.1)
•Capacity management[b]	Average capacity management[b] (scale)	3.4 (0.5)	2.6 (0.5)
Excessive rainfall	The percentage of respondents experiencing impacts of excessive rainfall	34	0
•Impact on yield	Average percentage of yield loss due to excessive rainfall	18.5 (7.2)	Not
•Impact on income	Average percentage of income loss due to excessive rainfall	17.4 (8.3)	applicable
•Capacity management	Average capacity management (scale)	3.1 (0.8)	
High temperature	The percentage of respondents experiencing impacts of high temperature	21	0
•Impact on yield	Average percentage of yield loss due to high temperature	7.6 (1.0)	Not
•Impact on income	Average percentage of income loss due to high temperature	3.2 (1.0)	applicable
•Capacity management	Average capacity management (scale)	3 (0)	
Strong wind	The percentage of respondents experiencing impacts of strong wind	9	0
•Impact on yield	Average percentage of yield loss due to strong wind	5.1 (3.8)	Not
•Impact on income	Average percentage of income loss due to strong wind	3.8 (2.7)	applicable
•Capacity management	Average capacity management (scale)	2.6 (0.7)	
Risk attitude	Average scale of risk (0: risk-averse – 10: highly risk seeking)	4.8 (2.5)	5 (2.9)
Insurance awareness	Number of respondents aware of crop insurance	52	53
Purchase insurance	Number of respondents who have purchased crop insurance before	36	45
Insurance knowledge rank	Average scale, from 0 (not knowledgeable) to 5 (very knowledgeable)	4.2 (3.2)	3.1 (1.8)
Importance of insurance rank	Average scale, from 0 (not important) to 5 (very important)	3.7 (3.2)	5.0 (1.8)
Willingness to participate in insurance products	Number of respondents who were willing to participate in insurance products	28	49
•Low rainfall insurance	Number of respondents who were willing to participate in low rainfall insurance	3	36
•High rainfall insurance	Number of respondents who were willing to participate in high rainfall insurance	18	1
•Both	Number of respondents who were willing to participate in both	7	12

(continued on next page)

Table A (*continued*)

Variable	Description	Value	
		Lam Dong	Dak Lak
Drought	Number of respondents selecting insurance for drought	63	0
•Jan–March	Number of respondents selecting this period	26	Not applicable
•Feb–March		15	
•March–April		10	
•March–May		4	
•Others		8	
Excessive rain	Number of respondents selecting insurance for excessive rain	34	0
•August–October	Number of respondents selecting this period	25	Not applicable
•September–October		2	
•Others		7	
High temperature	Number of respondents selecting insurance for high temperature	21	0
•April–May	Number of respondents selecting this period	10	Not applicable
•May–June		11	
Strong wind	Number of respondents selecting insurance for strong wind	2	16
•May–July	Number of respondents selecting this period	1	0
•July–August		1	0
•June		0	7
•July		0	3
•August		0	6
Satisfaction level	Average scale, from 0 (not satisfied) to 5 (very satisfied)	3.0 (2.8)	4.7 (1.1)
Sufficient information	Number of respondents indicating that sufficient information on the insurance was provided	49	42
Rejoin	Number of respondents who were willing to re-purchase the insurance	16	28

[a] Value in the bracket represents the standard deviation.
[b] Average value: 1- Out of control; 2- Low capacity; 3-Moderate capacity; 4- Good capacity.

References

[1] C. Gay, F. Estrada, C. Conde, H. Eakin, L. Villers, Potential impacts of climate change on agriculture: a case of study of coffee production in Veracruz, Mexico, Clim. Change 79 (3) (2006) 259–288.
[2] P. Läderach, J. Ramirez–Villegas, C. Navarro-Racines, C. Zelaya, A. Martinez–Valle, A. Jarvis, Climate change adaptation of coffee production in space and time, Clim. Change 141 (1) (2017) 47–62.
[3] I. Koh, R. Garrett, A. Janetos, N.D. Mueller, Climate risks to Brazilian coffee production, Environ. Res. Lett. 15 (10) (2020), 104015.
[4] A.P. Davis, T.W. Gole, S. Baena, J. Moat, The impact of climate change on indigenous arabica coffee (Coffea arabica): predicting future trends and identifying priorities, PLoS One 7 (11) (2012), e47981.
[5] A. Bastianin, A. Lanza, M. Manera, Economic impacts of El Nino southern oscillation: evidence from the Colombian coffee market, Agric. Econ. 49 (5) (2018) 623–633.
[6] S.J. Fain, M. Quiñones, N.L. Álvarez-Berríos, I.K. Parés-Ramos, W.A. Gould, Climate change and coffee: assessing vulnerability by modeling future climate suitability in the Caribbean island of Puerto Rico, Clim. Change 146 (1) (2018) 175–186.
[7] Y. Pham, K. Reardon-Smith, S. Mushtaq, G. Cockfield, The impact of climate change and variability on coffee production: a systematic review, Clim. Change 156 (4) (2019) 609–630.
[8] IPCC, Climate change 2022: mitigation of climate change. *Intergovernmental Panel On Climate Change (IPCC)*, Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 2022. https://www.ipcc.ch/report/ar6/wg3/.
[9] C.M. Bacon, W.A. Sundstrom, I.T. Stewart, D. Beezer, Vulnerability to cumulative hazards: coping with the coffee leaf rust outbreak, drought, and food insecurity in Nicaragua, World Dev. 93 (2017) 136–152.
[10] C. Bilen, D. El Chami, V. Mereu, A. Trabucco, S. Marras, D. Spano, A Systematic review on the impacts of climate change on coffee agrosystems, Plants 12 (1) (2022) 102.
[11] C. Bunn, P. Läderach, O. Ovalle Rivera, D. Kirschke, A bitter cup: climate change profile of global production of Arabica and Robusta coffee, Clim. Change 129 (1) (2015) 89–101.
[12] O. Ovalle-Rivera, P. Läderach, C. Bunn, M. Obersteiner, G. Schroth, Projected shifts in coffea arabica suitability among major global producing regions due to climate change, PLoS One 10 (4) (2015), e0124155.
[13] M. Jayakumar, M. Rajavel, U. Surendran, G. Gopinath, K. Ramamoorthy, Impact of climate variability on coffee yield in India—with a micro-level case study using long-term coffee yield data of humid tropical Kerala, Clim. Change 145 (2017) 335–349.
[14] G.B. Bianco, Climate change adaptation, coffee, and corporate social responsibility: challenges and opportunities, Int. J. Corp. Soc. Resp. 5 (1) (2020) 1–13.
[15] F.J. Zimmerman, M.R. Carter, Asset smoothing, consumption smoothing and the reproduction of inequality under risk and subsistence constraints, J. Dev. Econ. 71 (2) (2003) 233–260.
[16] V.H. Smith, M. Watts, Index based agricultural insurance in developing countries: feasibility, scalability and sustainability, Gates Open Res 3 (65) (2019) 65.
[17] B.J. Barnett, O. Mahul, Weather index insurance for agriculture and rural areas in lower-income countries, Am. J. Agric. Econ. 89 (5) (2007) 1241–1247.
[18] M. Carter, A. de Janvry, E. Sadoulet, A. Sarris, Index insurance for developing country agriculture: a reassessment, Ann. Rev. Resour. Econ. 9 (1) (2017) 421–438.
[19] M.J. Miranda, J.W. Glauber, Systemic risk, reinsurance, and the failure of crop insurance markets, Am. J. Agric. Econ. 79 (1) (1997) 206–215.
[20] A. Shee, C.G. Turvey, Collateral-free lending with risk-contingent credit for agricultural development: indemnifying loans against pulse crop price risk in India, Agric. Econ. 43 (5) (2012) 561–574.
[21] S. Cole, X. Giné, J. Tobacman, P. Topalova, R. Townsend, J. Vickery, Barriers to household risk management: evidence from India, Am. Econ. J. Appl. Econ. 5 (1) (2013) 104–135.
[22] M.A. Tadesse, B.A. Shiferaw, O. Erenstein, Weather index insurance for managing drought risk in smallholder agriculture: lessons and policy implications for sub-Saharan Africa, Agricultural and Food Economics 3 (1) (2015) 1–21.
[23] P.-A. Chiappori, B. Salanié, Testing for asymmetric information in insurance markets, J. Polit. Econ. 108 (1) (2000) 56–78.
[24] X. Giné, R. Townsend, J. Vickery, Patterns of rainfall insurance participation in rural India, World Bank Econ. Rev. 22 (3) (2008) 539–566.

[25] N. Jensen, C. Barrett, Agricultural index insurance for development, Appl. Econ. Perspect. Pol. 39 (2) (2017) 199–219.
[26] M.J. Miranda, K. Farrin, Index insurance for developing countries, Appl. Econ. Perspect. Pol. 34 (3) (2012) 391–427.
[27] S.A. Cole, W. Xiong, Agricultural insurance and economic development, Annual Review of Economics 9 (2017) 235–262.
[28] A.M. Mobarak, M.R. Rosenzweig, Informal risk sharing, index insurance, and risk taking in developing countries, Am. Econ. Rev. 103 (3) (2013) 375–380.
[29] J. Cai, The impact of insurance provision on household production and financial decisions, Am. Econ. J. Econ. Pol. 8 (2) (2016) 44–88.
[30] G. Elabed, M.R. Carter, Compound-risk aversion, ambiguity and the willingness to pay for microinsurance, J. Econ. Behav. Organ. 118 (2015) 150–166.
[31] H.P. Binswanger-Mkhize, Is there too much hype about index-based agricultural insurance? J. Dev. Stud. 48 (2) (2012) 187–200.
[32] K.W. Sibiko, P.C. Veettil, M. Qaim, Small farmers' preferences for weather index insurance: insights from Kenya, Agric. Food Secur. 7 (1) (2018) 1–14.
[33] S. Akter, T.J. Krupnik, F. Rossi, F. Khanam, The influence of gender and product design on farmers' preferences for weather-indexed crop insurance, Global Environ. Change 38 (2016) 217–229.
[34] E. Doherty, S. Mellett, D. Norton, T.K. McDermott, D. O'Hora, M. Ryan, A discrete choice experiment exploring farmer preferences for insurance against extreme weather events, J. Environ. Manag. 290 (2021), 112607.
[35] J.A. Gómez-Limón, R. Granado-Díaz, Assessing the demand for hydrological drought insurance in irrigated agriculture, Agric. Water Manag. 276 (2023), 108054.
[36] J.A. Adjabui, P.R. Tozer, D.I. Gray, Willingness to participate and pay for index-based crop insurance in Ghana, Agric. Finance Rev. 79 (4) (2019) 491–507.
[37] X. Liu, Y. Tang, J. Ge, M.J. Miranda, Does experience with natural disasters affect willingness-to-pay for weather index insurance? Evidence from China, Int. J. Disaster Risk Reduc. 33 (2019) 33–43.
[38] T.K. Belissa, R. Lensink, M. Van Asseldonk, Risk and ambiguity aversion behavior in index-based insurance uptake decisions: experimental evidence from Ethiopia, J. Econ. Behav. Organ. 180 (2020) 718–730.
[39] G. Kuehne, R. Llewellyn, D.J. Pannell, R. Wilkinson, P. Dolling, J. Ouzman, et al., Predicting farmer uptake of new agricultural practices: a tool for research, extension and policy, Agric. Syst. 156 (2017) 115–125.
[40] O. Westermann, W. Förch, P. Thornton, J. Körner, L. Cramer, B. Campbell, Scaling up agricultural interventions: case studies of climate-smart agriculture, Agric. Syst. 165 (2018) 283–293.
[41] R.S. Llewellyn, B. Brown, Predicting adoption of innovations by farmers: what is different in smallholder agriculture? Appl. Econ. Perspect. Pol. 42 (1) (2020) 100–112.
[42] H. Wang, H. Zhang, On the possibility of a private crop insurance market: a spatial statistics approach, J. Risk Insur. 70 (1) (2003) 111–124.
[43] J.W. Glauber, Crop insurance reconsidered, Am. J. Agric. Econ. 86 (5) (2004) 1179–1195.
[44] S. Fisher, S. Surminski, The roles of public and private actors in the governance of adaptation: the case of agricultural insurance in India. Working Paper, Centre for Climate Change Economics and Policy, The Munich Re Programme, and Grantham Research Institute on Climate Change and the Environment, 2012.
[45] C. McIntosh, F. Povel, E. Sadoulet, Utility, risk and demand for incomplete insurance: lab experiments with Guatemalan co-operatives, Econ. J. 129 (622) (2019) 2581–2607.
[46] M.A. Naranjo, J. Pieters, F. Alpízar, Credit, insurance and farmers' liability: evidence from a lab in the field experiment with coffee farmers in Costa Rica, J. Econ. Behav. Organ. 166 (2019) 12–27.
[47] S. Fahad, W. Jing, Evaluation of Pakistani farmers' willingness to pay for crop insurance using contingent valuation method: the case of Khyber Pakhtunkhwa province, Land Use Pol. 72 (2018) 570–577.
[48] M.T. Vu, S.V. Raghavan, D.M. Pham, S.-Y. Liong, Investigating drought over the Central Highland, Vietnam, using regional climate models, J. Hydrol. 526 (2015) 265–273.
[49] V. Phan, T. Ngo-Duc, V. Nguyen, A Review of Evidence of Recent Climate Change in the Central Highlands of Vietnam. *Initiative For Coffee and Climate*, vol. 49, 2013.
[50] T.L.A. Dinh, F. Aires, E. Rahn, Climate change impacts on Robusta coffee production over Vietnam. *Authorea Preprints*, Working paper, LERMA, Observatoire de Paris and International Center for Tropical Agriculture, 2023.
[51] J. Kath, V.M. Byrareddy, A. Craparo, T. Nguyen-Huy, S. Mushtaq, L. Cao, et al., Not so robust: robusta coffee production is highly sensitive to temperature, Global Change Biol. 26 (6) (2020) 3677–3688.
[52] Q.V. Luong, L.W. Tauer, A real options analysis of coffee planting in Vietnam, Agric. Econ. 35 (1) (2006) 49–57.
[53] N.A. Dzung, V.T.P. Khanh, T.T. Dzung, Research on impact of chitosan oligomers on biophysical characteristics, growth, development and drought resistance of coffee, Carbohydr. Polym. 84 (2) (2011) 751–755.
[54] V. Byrareddy, L. Kouadio, S. Mushtaq, J. Kath, R. Stone, Coping with drought: lessons learned from robusta coffee growers in Vietnam, Climate Services 22 (2021), 100229.
[55] T.Q. Ho, V.-N. Hoang, C. Wilson, T.-T. Nguyen, Which farming systems are efficient for Vietnamese coffee farmers? Econ. Anal. Pol. 56 (2017) 114–125.
[56] FAO, The state of food and agriculture 2016: climate change, agriculture, and food security. Food and Agriculture Organization of the United Nations, 2016. http://www.fao.org/3/a-i6030e.pdf.
[57] R.T. Carson, Contingent valuation: a user's guide, in: Environmental Science and Technology, vol. 34, ACS Publications ed., 2000, pp. 1413–1418.
[58] W. Adamowicz, P. Boxall, M. Williams, J. Louviere, Stated preference approaches for measuring passive use values: choice experiments and contingent valuation, Am. J. Agric. Econ. 80 (1) (1998) 64–75.
[59] N. Hanley, D. MacMillan, R.E. Wright, C. Bullock, I. Simpson, D. Parsisson, et al., Contingent valuation versus choice experiments: estimating the benefits of environmentally sensitive areas in Scotland, J. Agric. Econ. 49 (1) (1998) 1–15.
[60] N. Hanley, R.E. Wright, V. Adamowicz, Using choice experiments to value the environment, Environ. Resour. Econ. 11 (1998) 413–428.
[61] R. Carson, M. Czajkowski, in: The Discrete Choice Experiment Approach to Environmental Contingent Valuation, Edward Elgar Publishing Cheltenham, 2014.
[62] J. He, J. Dupras, G. Poder, T, The value of wetlands in Quebec: a comparison between contingent valuation and choice experiment, J. Environ. Econ. Pol. 6 (1) (2017) 51–78.
[63] V. Rayamajhee, W. Guo, A.K. Bohara, The perception of climate change and the demand for weather-index microinsurance: evidence from a contingent valuation survey in Nepal, Clim. Dev. 14 (6) (2022) 557–570.
[64] S.A. Abugri, J. Amikuzuno, E.B. Daadi, Looking out for a better mitigation strategy: smallholder farmers' willingness to pay for drought-index crop insurance premium in the Northern Region of Ghana, Agric. Food Secur. 6 (1) (2017) 1–9.
[65] H. Aizaki, J. Furuya, T. Sakurai, S.S. Mar, Measuring farmers' preferences for weather index insurance in the Ayeyarwady Delta, Myanmar: a discrete choice experiment approach, Paddy Water Environ. 19 (2) (2021) 307–317.
[66] I. Bateman, D.o.T. Großbritannien, Economic Valuation with Stated Preference Techniques: A Manual, vol. 50, Edward Elgar Cheltenham, 2002.
[67] M. Hanemann, J. Loomis, B. Kanninen, Statistical efficiency of double-bounded dichotomous choice contingent valuation, Am. J. Agric. Econ. 73 (4) (1991) 1255–1263.
[68] T.C. Haab, K.E. McConnell, Valuing Environmental and Natural Resources: the Econometrics of Non-market Valuation, Edward Elgar Publishing, 2002.
[69] A. Alberini, J. Kahn, Handbook on Contingent Valuation, Edward Elgar Publishing, 2006.
[70] T. Dohmen, A. Falk, D. Huffman, U. Sunde, J. Schupp, G.G. Wagner, Individual risk attitudes: measurement, determinants, and behavioral consequences, J. Eur. Econ. Assoc. 9 (3) (2011) 522–550.
[71] H. Hansson, C.J. Lagerkvist, Measuring farmers' preferences for risk: a domain-specific risk preference scale, J. Risk Res. 15 (7) (2012) 737–753.
[72] C.A. Holt, S.K. Laury, Risk aversion and incentive effects, Am. Econ. Rev. 92 (5) (2002) 1644–1655.
[73] P. Crosetto, A. Filippin, The "bomb" risk elicitation task, J. Risk Uncertain. 47 (2013) 31–65.
[74] S.C. Maart-Noelck, O. Musshoff, Measuring the risk attitude of decision-makers: are there differences between groups of methods and persons? Aust. J. Agric. Resour. Econ. 58 (3) (2014) 336–352.

[75] M. Meraner, R. Finger, Risk perceptions, preferences and management strategies: evidence from a case study using German livestock farmers, J. Risk Res. 22 (1) (2019) 110–135.
[76] R.K. Ghosh, S. Gupta, V. Singh, P.S. Ward, Demand for crop insurance in developing countries: new evidence from India, J. Agric. Econ. 72 (1) (2021) 293–320.
[77] M. van Asseldonk, D. Muwonge, I. Musuya, M. Abuce, Adoption and preferences for coffee drought index-based insurance in Uganda, Stud. Agric. Econ. 122 (3) (2020) 162–166.
[78] Y. Tang, H. Cai, R. Liu, Farmers' demand for informal risk management strategy and weather index insurance: evidence from China, Int. J. Disaster Risk Sci. 12 (2) (2021) 281–297.
[79] M.S. Hossain, G.M. Alam, S. Fahad, T. Sarker, M. Moniruzzaman, M.G. Rabbany, Farmers' willingness to pay for flood insurance as climate change adaptation strategy in northern Bangladesh, J. Clean. Prod. (2022), 130584.
[80] E.F. Nordmeyer, O. Mußhoff, Understanding German farmers' intention to adopt drought insurance, J. Environ. Manag. 345 (2023), 118866.
[81] F. Akaichi, S. de Grauw, P. Darmon, C. Revoredo-Giha, Does fair trade compete with carbon footprint and organic attributes in the eyes of consumers? Results from a pilot study in Scotland, The Netherlands and France, J. Agric. Environ. Ethics 29 (2016) 969–984.
[82] A. Lopez-Feldman, Introduction to contingent valuation using Stata, MPRA Paper No. 41018, https://mpra.ub.uni-muenchen.de/41018/41012/MPRA_paper_41018.pdf, 2012.
[83] M. King, A.P. Singh, Understanding farmers' valuation of agricultural insurance: evidence from Vietnam, Food Pol. 94 (2020), 101861.
[84] N. Ngoc Que Anh, P. Thanh Binh, T. Dang Thuy, Willingness to pay for agricultural flood insurance in the Mekong River Delta, Environ. Hazards 18 (3) (2019) 212–227.
[85] J. Jin, Y. Gao, X. Wang, P.K. Nam, Farmers' risk preferences and their climate change adaptation strategies in the Yongqiao District, China, Land Use Pol. 47 (2015) 365–372.
[86] J.P. Dougherty, J.E. Flatnes, R.A. Gallenstein, M.J. Miranda, A.G. Sam, Climate change and index insurance demand: evidence from a framed field experiment in Tanzania, J. Econ. Behav. Organ. 175 (2020) 155–184.
[87] J. Jin, W. Wang, X. Wang, Farmers' risk preferences and agricultural weather index insurance uptake in rural China, Int. J. Disaster Risk Sci. 7 (4) (2016) 366–373.
[88] A.M. Maganga, L.S. Chiwaula, P. Kambewa, Parametric and non-parametric estimates of willingness to pay for weather index insurance in Malawi, Int. J. Disaster Risk Reduc. 62 (2021), 102406.
[89] W. Ali, A. Abdulai, R. Goetz, V. Owusu, Risk, ambiguity and willingness to participate in crop insurance programs: evidence from a field experiment, Aust. J. Agric. Resour. Econ. 65 (3) (2021) 679–703.
[90] G.T. Kwadzo, J.K. Kuwornu, I.S. Amadu, Food crop farmers' willingness to participate in market-based crop insurance scheme: evidence from Ghana, Res. Appl. Econ. 5 (1) (2013) 1–21.
[91] G.F. Patrick, Mallee wheat farmers' demand for crop and rainfall insurance, Aust. J. Agric. Econ. 32 (1) (1988) 37–49.
[92] H. Cai, Y. Chen, H. Fang, L.-A. Zhou, The effect of microinsurance on economic activities: evidence from a randomized field experiment, Rev. Econ. Stat. 97 (2) (2015) 287–300.
[93] P.L. Nguyen, M.D. Nguyen, Drought adaptation and coping strategies among coffee farmers in the Central Highlands of Vietnam, J. Agric. Environ. Sci. 8 (1) (2019) 52–66.
[94] M. Taniwaki, A. Teixeira, A. Teixeira, M. Copetti, B. Iamanaka, Ochratoxigenic fungi and ochratoxin A in defective coffee beans, Food Res. Int. 61 (2014) 161–166.