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Factors influencing urban farmers' intention to adapt to climate change in Addis Ababa, Ethiopia: a protection motivation theory

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Globally, climate change (CC) is a widely recognized fact, particularly in the past few decades. Developing nations like Ethiopia have been experiencing climate change and its effects on agriculture. In this regard, urban agriculture is one of the sectors significantly impacted by adverse change in climate. However, there is scant empirical evidence on the factors influencing urban farmers' intention to adapt to climate change in urban centers of Ethiopia. To fill the research gap, this study aimed to identify factors influencing urban farmers' intention to adapt to climate change in Addis Ababa, Ethiopia. In doing so, a quantitative research approach with a random sampling technique was applied. Based on the protection motivation theory (PMT), primary data were collected from 364 respondents using a survey questionnaire. Accordingly, structural equation modeling (SEM) was used to identify and analyze the underlying relationships among the nine constructs used in this study. Hence, the results revealed that selecting new crop varieties, water management practices, adjusting dates of sowing crops with changing local climatic conditions, and sowing drought-resistant crops were major adaptation practices. Hence, the perception of CC indicators, the perceived effects of CC, incentives, subjective norms, adaptation efficacy, and self-efficacy were found to positively and significantly influence urban farmers' intention to adapt. In contrast, urban farmers (UFs) show less intention to adapt to CC when subjected to maladaptive behaviors. Based on this, the study recommends strengthening the capacity of local institutions, farmer training and education, climate information dissemination such as early warning systems, access to extension services, and access to finance to equip urban farmers to undertake practical adaptation strategies in the face of climate change.

KEYWORDS
climate change, intention to adapt, urban agriculture, urban farmers, PMT, SEM

1 Introduction

Globally, climate change is unequivocally a well-established fact (IPCC, 2014). Climate system drivers contribute to climate change by altering the Earth's energy balance, which is described in terms of its effective radiative forcing (RF) (IPCC, 2021). Negative RF values exert a warming influence, mainly caused by the emission of greenhouse gases from anthropogenic activities. The last four decades have been considered the hottest years (IPCC, 2021, 2014). In addition to this, climate change (CC hereafter) is expected to increase in the future (between

1.5°C and 2°C toward the end of this century) (IPCC, 2014). This climate change, predominantly a rise in temperature and unreliable rainfall, is becoming a detrimental challenge to human beings now and in the future (Ochieng et al., 2016). In this regard, the ramifications of CC are becoming a growing concern for developing nations (IPCC, 2014) due to their heavy reliance on the climate-sensitive sector, agriculture (Elum et al., 2016; Temsgen et al., 2014; Deressa et al., 2008). Sub-Saharan Africa (SSA) is one of the most susceptible regions to climate change-related threats (Gebrechorkos et al., 2019; Feyissa et al., 2018; Elum et al., 2016). Studies have shown that changes and variability in climate parameters have hampered the yields of crops such as teff and sorghum in the northern parts of Ethiopia (Destaw and Fenta, 2021).

Urban agriculture (UA hereafter), which is considered an agricultural activity (such as the cultivation of crops along with livestock rearing) within or at the periphery of the urban landscape (Aubry et al., 2012; Appeaning, 2010), provides up to 15% of the food consumed in metropolitan areas, with expectations to double in the next two decades. In the majority of cities in developing countries, it has played a substantial role in alleviating food and nutrition insecurity as well as hunger among both rich and poor urban residents in recent years (Chari and Ngcamu, 2022). Despite this, it is not exempt from the detrimental impacts of climate change (Chari and Ngcamu, 2022; Wahab and Popoola, 2019; Lunyelele et al., 2016). This is due to the fact that it is largely a climate-dependent economic sector in major cities in Africa (Lwasa et al., 2014). Additionally, climate is a key component of the urban physical environment where urban agriculture is practiced (Ajadi et al., 2011). Concerning this, research by Adelekan et al. (2014) underlined that extreme climate events such as heavy rainfall and flooding have direct effects on urban food production systems. Wahab and Popoola (2019) further added that changes and variability in climate are affecting UA, which, in turn, can lead to livelihood shock, pressure, and doubt among urban farmers. A study by Lwasa et al. (2014) in cities of Africa (Ibadan, Dakar, and Kampala) also indicated that climate change adversely affected urban agricultural productivity, whereas Padgham et al. (2015) disclosed the escalating blunts of climate change on urban agriculture in nine African cities. In Ethiopia, as there is a stark linkage between agriculture, particularly crop production (Asfew and Bedemo, 2022; Conway and Schipper, 2011), changes in climate threaten agriculture and farmers' livelihoods in urban centers of the country. Existing literature revealed that CC will likely jeopardize Addis Ababa city's urban agriculture productivity potential and UFs' livelihoods (Feyissa et al., 2018; Birhanu et al., 2016). This, in turn, makes food security worse and thereby draws the farming society into a vicious circle of poverty (Degefu et al., 2021).

Addis Ababa city is characterized by a rapid rate of urbanization (Woldegerima et al., 2017), approximately 4.45% per year (World Population Review, 2022), making them demand more food from urban agriculture. Implementing climate change adaptation strategies (Lwasa et al., 2014), which serve as shockproof for sustainable urban agricultural productivity against threats related to altered climatic conditions, has become an indispensable option (Kifunda, 2023). Climate change adaptation strategies entail an adjustment in natural and/or human systems (ecological, social, or economic) attributed to changes in climate stimulus (actual or expected changes) and their threats on farming activities, besides moderating harms and taking advantage of its new opportunities (Lwasa et al., 2014; Grothmann and Patt, 2005; Adger et al., 2013). Concerning this, Wahab and Popoola (2018) called for unveiling the best adaptation strategies to tackle threats related to climate change, focusing on local actors and urban farmers in this context. Although fragmentary, several scholars (Deressa et al., 2011, 2009; Bryan et al., 2009; Hassan and Nhemachena, 2008) have identified diverse adaptation strategies, including improved varieties of crops, adjusting planting dates, practicing irrigation, agroforestry, soil conservation, livelihood diversification, drought-tolerant crops, mixed farming, and intercropping to tackle the impacts of climate change on the agricultural sector of Ethiopia.

On the other hand, urban farmers' intention is a proxy for actual behavior (Demski et al., 2017) to implement adaptation strategies, which is influenced by a myriad of socioeconomic, behavioral, and institutional factors (Asfaw et al., 2018; Belay et al., 2017; Abid et al., 2016; Dang et al., 2014; Odewumi et al., 2013; Tessema et al., 2013). Furthermore, farmers' decision to implement adaptation options is influenced not only by the way the environment is but also by the way they perceive it (Odewumi et al., 2013; Weber, 2010; Deressa et al., 2011). Similarly, Hart and Feldman (2014) noted that people act to deal with a problem, like climate change threats, when they believe their activities will be effective (response efficacy). Additionally, Grothmann and Patt (2005) concluded that self-efficacy predicts the adaptive behavior of farmers more accurately than other predictors. Apart from this, social capital influences how adaptation strategies are implemented by an individual (Rojas, 2016). In this study, based on protection motivation theory (PMT), an attempt was made to identify factors influencing urban farmers' (UFs) intention to adapt to climate change in Addis Ababa city. This is because this theory has been applied in predicting many environmental problems, such as natural hazards, earthquakes in the USA (Mulilis and Lippa, 1990), floods in Germany and France (Grothmann and Reusswig, 2006; Poussin et al., 2014; Bubeck et al., 2013), electric vehicles adoption in the Netherlands (Bockarjova and Steg, 2014), and farmers engagement in adaptation practices in Germany and Zimbabwe, as well as in Vietnam, Iran, and Sri Lanka (Keshavarz and Karami, 2016; Truelove et al., 2015; Dang et al., 2012, 2014; Grothmann and Patt, 2005). In doing so, this research is expected to add new knowledge in the field of climate science nexus urban agriculture by offering crucial insights and unlocking the determinants of UFs' intention to adapt in the face of changing climatic conditions in Addis Ababa. Additionally, the findings of this study would be worthwhile for producing bottom-up solutions for sustainable urban agricultural productivity that, in turn, help urban farmers enhance their resilience against the effects of climate change at the local level.

2 Materials and methods

2.1 Study area

This study, using a survey approach, was conducted in Addis Ababa, Ethiopia (Figure 1), which covers an area of 540 km^2 (Worku, 2017). Typically, its highest summit is represented by Mount Entoto at 3041 m above sea level, while its lowest point, approximately 2051 m above mean sea level (msl), is the Akaki Plain (Feyissa et al., 2018).

Presently, the city hosts 30% of Ethiopia's urban population (World Population Review, 2022). Climatically, it is experiencing a modified type of equatorial climate, as it is situated in an elevated landscape. Its average daily temperature is approximately 16°C (Duressa, 2007),

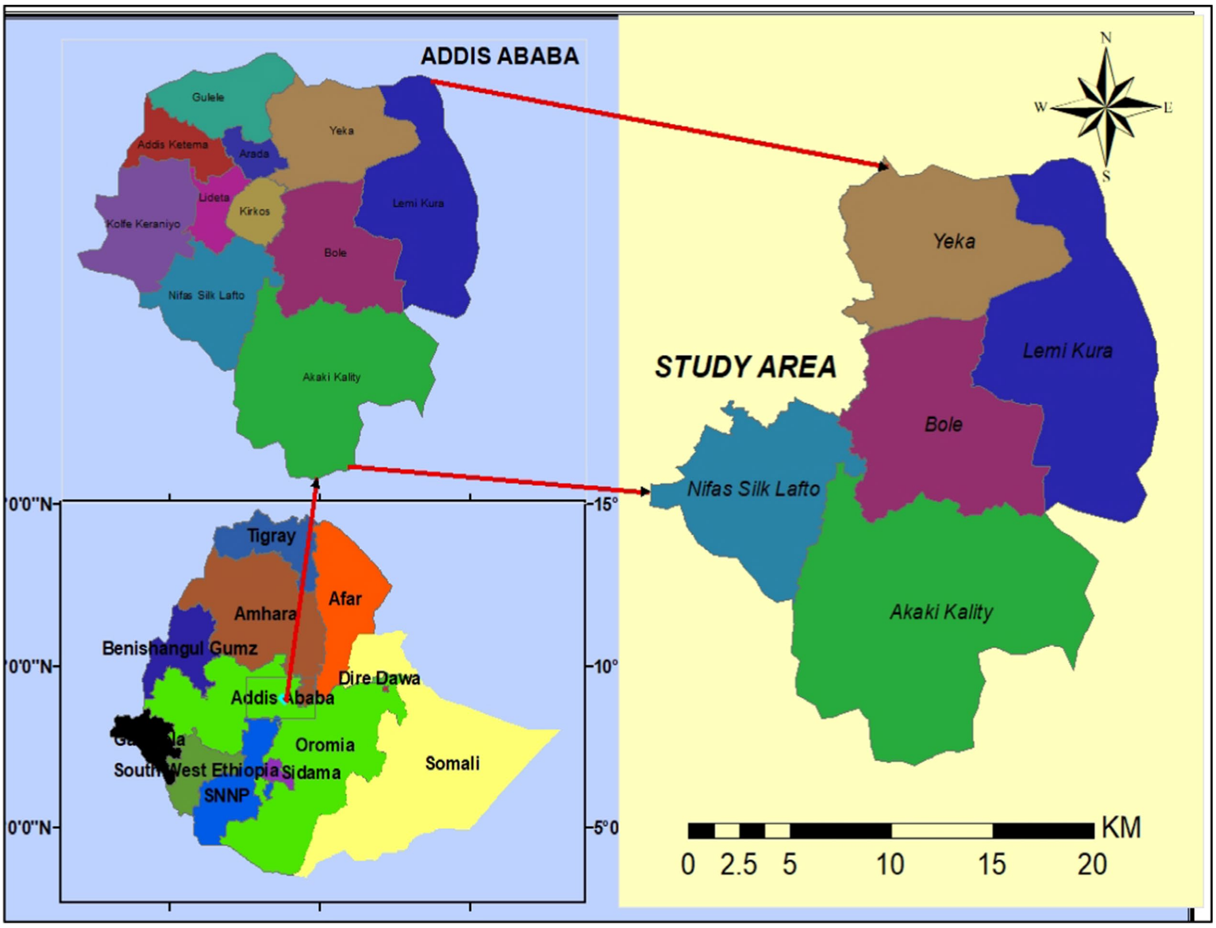

FIGURE 1
Location of the study area.

while its mean annual temperature is approximately 15.6°C. Apart from this, the city is endowed with perennial major and small rivers, such as Big Akaki, Little Akaki, and Kebena River, as well as numerous intermittent streams (Worku, 2017). In addition to this, the presence of suitable soil and its altitude is good for urban agricultural activities in the study area (Weldesilassie et al., 2011). As a consequence, urban agriculture activities have been seen being practiced in all 11 sub-cities of Addis Ababa, particularly in Akaki-Kality, Bole, N/S Lafto, Kolfe Keraniyo, and Yeka sub-cities of Addis Ababa city. That is, in all the sub-cities of Addis Ababa City, the cultivation of different cereal crops and leafy vegetables such as cabbage, carrot, lettuce, cauliflower, celery, and potatoes are frequently observed for either market and/or home consumption (Duressa, 2007). In this respect, urban agriculture plays a crucial role in creating employment opportunities and serves as a source of food and income for a significant number of city residents (Alemu et al., 2024). According to the Addis Ababa city development plan (2002–2012), more than 51,000 households within the city are reliant on urban agriculture as a means of their livelihoods.

2.2 Data types and sources

A sample of 364 urban farmers was selected and included in this study using the Kothari (2004) formula, with a margin of 0.05 error. In doing so, UFs were selected randomly from sampled districts among sampled sub-cities. Primary data were gathered cross-sectionally via structured questionnaires among sampled urban farm household heads, which were used for the analysis of this study. The data collected through the questionnaire has two sections. The first section addresses the types of adaptation strategies implemented by the respondents. The second section focused on nine (9) perceptual and operationally defined factors (intention to adapt, perception of climate change, maladaptation, incentives, disincentives, subjective norms, self-efficacy, response efficacy, and perceived effects of climate change), influencing UFs' intention to adapt. In this regard, urban farmers were asked about the extent to which they agreed or disagreed with each of the items using a 5-point Likert scale (1 = Strongly disagreed to 5 = Strongly agreed), as shown in Table 1.

2.3 Data analysis

The items included in the questionnaire were first prepared in English and then translated into Amharic language to ease communication among respondents. The validity and reliability of the questionnaire were also tested before embarking on the study. In this regard, a pilot test was conducted among 15 UFs over the study area. Consequently, the collected questionnaire was tested using Cronbach's

TABLE 1 Variables and measurements used in the study.

S.N.	Constructs	Operational definition	Measurement units or scales
1	Perception of CC parameters	The extent to which you perceive that a change in climate is happening	1–5 Likert scale (that ranges from strongly disagree to strongly agree)
2	Perceived effects of CC	Farm household head's perception of the severity of CC threat	1–5 Likert scale (that ranges from strongly disagree to strongly agree)
3	Perceived self-efficacy	Farm household head's perception of his or her ability to implement adaptation strategies	1–5 Likert scale (strongly unable to strongly able to do)
4	Adaptation strategies efficacy	Farm household head's perception of the effectiveness of adaptation strategies in reducing CC threats	1–5 Likert scale (strongly ineffective to strongly effective)
5	Maladaptation	The extent to which maladaptive activities influence your intention to implement adaptation strategies	1–5 Likert scale (that ranges from strongly disagree to strongly agree)
6	Incentives	The extent to which government activities influence your intention toward CC adaptation strategies	1–5 Likert scale (Not at all to very much)
7	Disincentives	The extent to which disincentives influence your intention toward CC adaptation strategies	1–5 Likert scale (Not at all to very much)
8	Subjective norms	The extent to which other important factors influence you in implementing CC adaptation strategies	1–5 Likert scale (strongly disagree to strongly agree)
9	Intention to adapt	The level to which you intend to implement the five adaptation strategies considered in this study to offset CC effects	1–5 Likert scale (not at all to very large extent)

Field survey, 2024.

alpha coefficients, where the output showed above the threshold value (above 0.7). Additionally, respondents were also told that they have the right to withdraw from answering a question at any time they feel uncomfortable with it. Thus, before beginning the data analysis, all responses were checked to ensure each question was fully answered. Next, all properly collected questions were initially entered into SPSS-23 software to produce descriptive statistics. Apart from this, the skewness, kurtosis, and multicollinearity values were checked to inspect the presence of any violation of the normality assumption. Finally, based on PMT and applying SEM-Amos software, an attempt was made to test the model and thereby determine the variables that predict UFs' intention toward climate adaptation strategies in the study area.

2.3.1 Factor analysis (FA)

In this study, relevant constructs (factors) along with their respective items were included by reviewing different empirical literature. In doing so, the interrelationships among the latent constructs were illustrated by applying covariance-based structural equation modeling (SEM) using SPSS-Amos 24 version software. To this effect, first, the data generated from the survey was subjected to factor analysis. In doing so, the Kaiser–Meyer–Olkin's (KMO) and Bartlett's tests were applied to decide whether it was adequate to conduct factor analysis. Hence, the KMO value yielded a promising result of 0.834 (above 0.5), a criterion of sampling adequacy is met. Furthermore, Bartlett's test of sphericity is also statistically significant ($p < 0.05$), indicating that our correlation matrix is statistically unlike an identity matrix as required. Thus, based on the outcome of the factor analysis, the nine components (perceiving climate change parameters, perceiving severity of CC, intention to adapt, self-efficacy, adaptation efficacy, incentives, disincentives, maladaptation, and subjective norms) explain 47.446% of the total variance within the data set. Hence, the result shows that our factors have a good level of validity.

2.3.2 Reliability, validity, and goodness-of-fit tests

In this study, using SPSS-Amos 24 versions, a two-stage approach was applied to analyze the collected data. At the initial stage, to test and obtain a satisfactory measurement model, a confirmatory factor analysis (CFA) that shows how the individual underlying factors (latent variables) relate to their indicators (observed variables or items) was performed. In other words, a measurement model demonstrates the interrelationship between the underlying latent constructs and response items executed. Accordingly, the measurement model (CFA) used in this study is composed of nine latent variables as well as 42 observed variables, where each of them is related to a single construct.

In doing so, the reliability and validity of the constructs included in the measurement model were evaluated. Accordingly, the standardized factor loading coefficients for the 42 observed variables of the nine constructs in the whole model were determined and found to be above the 0.5 cutoff values. The Cronbach's alpha coefficients for the reliability of the nine constructs also range between 0.743 and 0.883. This figure also implies that the construct used in the study exhibited good internal consistency, and the items measuring their respective constructs are reliable. Along with this, convergent and discriminant validity were also computed to evaluate the validity of measurement models. In this regard, the convergent validity that measures the extent of the correlation of the multiple indicators within the same construct is in agreement and is assessed by three indicators: composite reliability (CR), factor loading, and the average variance extracted (AVE).

Hence, to check the convergent validity, according to Hair et al. (2010), the values of the standardized factor loading for each item or indicator should at least have a value of 0.5 and above (mostly above 0.7), as this value designates that the observed indicators are strongly related to the associated latent variables. As a consequence, results computed in this model also showed that the standardized factor loadings are statistically significant since most factors were loaded with their respective exogenous constructs, with loading values of 0.6 and above indicating good convergent validity (Hair et al., 2017). Regarding composite reliability (CR), as another criterion to measure convergent validity, its value should be above 0.70 (the threshold). Hence, as presented in Table 2, the composite reliability (CR) of each of the nine latent variables ranges from 0.75 to 0.89. Hence, convergent validity with a CR value above the threshold (the 0.7 cutoff) was confirmed to have robust and acceptable reliability. Third, to confirm adequate convergence, the average variance extracted (AVE) values for each of the latent variables should at least be 0.5 and above, as put forth by Hair et al. (2010). In accordance, the computed AVE value for most of the constructs included in this study (except for adaptation efficacy and incentives, which were slightly less than the marginal threshold value of 0.5), was above 0.5, indicating that the model had a higher convergence of constructs.

Alternatively, the discriminant validity states the level to which the constructs included are empirically different from one another, or it is a measure of distinct constructs when two or more latent variables should not theoretically be related to each other. Based on Hair et al. (2010), discriminant validity is established when the value of the maximum shared variance (MSV) is less than that of the average variance extracted (AVE) for all latent variables (constructs). In this study too, all the inter-construct correlations were lower than the square root of the AVE (SQR AVE), which is shown boldly by the diagonal line for all variables (see Table 3), implying that each of the constructs is truly different from the other constructs included in the model based on Fornell and Larcker's (1981) criteria. Hence, the variables used in the model have good discriminant validity. In total, all the constructs included based on the CR (> 0.7), the AVE value (>0.5), the MSV values (less than their respective AVE), and the SQR AVE for all variables were checked and fit the threshold as displayed in Table 3.

As Amos allows the use of modification indices (M.I.) to make a better-fit model, modification indices were also considered in this study. Henceforth, based on MI suggestions, the error terms of the observed variables within the same latent variables having an MI of 20 and above were co-varied. In accordance with this, after incorporating the covariance between error terms of the observed variables into the re-specified model, it is tested for its goodness-of-fit. Consequently, the re-specified measurement model's goodness-of-fit was assessed through a number of model fit indices. According to Hair et al. (2010), using commonly used model fit indices such as the chi-square of 1020.167 and the normed fit indices (CMIN/DF) =1.311 (less than 3) indicates a good fit. Furthermore, using other goodness-of-fit indices, such as the root mean error of approximation (RMSEA), with less than 0.06 (0.029), was within an acceptable threshold value to confirm the fitness of the model. Additionally, the comparative fit index (CFI) (0.964), the Tucker–Lewis index (TLI) (0.961), the normed fit index (NFI) (0.867), and the incremental fit index (IFI) (0.965), with their minimum value of 0.9 and above, designate an acceptable model fit. In total, the computed result depicted that the measurement model satisfied the threshold value. That is, it is possible to conclude that the measurement model and sampled data are relatively good fits (above the threshold value) based on the computed goodness-of-model fit indices criteria suggested by Hair et al. (2010).

2.3.3 The structural model testing

The structural model is a model that displays the strength and the direction of the interrelationships among the constructs used in the given study. Henceforth, after validating the measurement model (CFA), it is possible to conduct a structural model using a path analysis. In this respect, the interrelationships among observed and unobserved variables in measurement models are assembled and represented, in line with the theoretical framework, using path diagrams. Accordingly, its graphical representation was established by linking latent variables from the measurement model using an arrow from the latent variables (independent variables) toward the dependent variable, as shown in Figure 2.

Subsequently, testing the goodness-of-fit (GOF) of the structural model continued. According to Byrne (2016) and Hair et al. (2010), to assess the overall fitness of the structural model, the rule of thumb is to use the chi-square test along with at least one other index. In this regard, the model's goodness-of-fit indices from path analysis include a chi-square of 1022.51, the chi-square/df = 1.308 (below 3), and a *p*-value of 0.000. Additionally, the comparative fit index (CFI) value of 0.965 and the incremental fit index (IFI) of 0.965 were both above the acceptance range and considered good fits to the model. Furthermore, the Tucker–Lewis index (TLI) value of 0.976 and the Root Means Square Error of Approximation (RMSEA) value of 0.031 were within the acceptable threshold (less than 0.08). Only the adjusted goodness-of-fit index (AGFI) of 0.866 was slightly below the threshold value. In total, the findings on GOF tests disclosed that the structural model was

TABLE 2 Construct reliability and validity test.

Constructs	Items factor loadings range	Cronbach's α values	CR (>0.6)	Average (>0.5)
Perceiving CC	[0.63,0.84]	0.857	0.86	0.554
Perceived effects of CC	[0.63,0.91]	0.871	0.88	0.642
Self-efficacy	[0.53,0.87]	0.838	0.85	0.538
Adaptation efficacy	[0.66,0.73]	0.863	0.86	*0.470*
Disincentives	[0.69,0.86]	0.799	0.80	0.579
Incentives	[0.63,0.80]	0.846	0.84	0.461
Subjective norms	[0.64,0.80]	0.743	0.75	0.502
Maladaptation	[0.70,0.82]	0.805	0.81	0.583
Intention to adapt	[0.64,0.86]	0.883	0.89	0.578

Field Survey, 2024.

TABLE 3 Discriminant validity analysis test.

Latent variable inter-correlation (LVC)	Disincentive	Self -efficacy	Maladaptation	Perceiving effects of CC	Intention	Incentives	Perceiving CC	Subjective norms	Adaptation efficacy	MSV
Disincentives	**0.76**									0.01
Self-efficacy	−0.04	**0.73**								0.05
Maladaptation	0.05	0.07	**0.76**							0.02
Perceiving effects of CC	0.07	−0.04	0.08	**0.80**						0.09
Intention to adapt	0.03	0.22	0.02	0.30	**0.76**					0.26
Incentives.	−0.01	0.21	0.04	0.14	0.51	**0.69**				0.26
Perceiving CC	0.02	−0.03	−0.13	0.14	0.46	0.21	**0.74**			0.21
Subjective norms	0.11	0.10	0.03	0.17	0.46	0.30	0.19	**0.71**		0.21
Adaptation efficacy	0.07	−0.03	−0.04	0.11	0.33	0.10	0.20	0.14	**0.69**	0.11

Field Survey, 2024. The values in bold indicates how much a variable changes in relation to itself overtime.

within an acceptable level or a good fit based on scholars' thresholds (Byrne, 2016; Hair et al., 2010). Next to validating the structural model, assessing the relationship among the underlying factors continued.

2.4 Demographic variables

In this section, the socio-demographic characteristics of the respondents are presented. More than two-thirds (68.4%) were male-headed, while 31.6% were female-headed households. This implies that men are more engaged in urban agriculture practices than women in the study area. The majority of urban farmers (80%) were between the age limits of 25 and 55 years. The remaining 12 and 8% are older than 55 years and less than 25 years, respectively. It is observed that most of the residents practicing urban farming are middle-aged people. Regarding the educational level of the respondents, most of them (58%) completed only primary education, while 25% of them attended up to secondary education. Only 8.5% of them achieved an education level of technical and vocational education and training (TVET) and above. Therefore, most of the farming practices in the study area are taking place by individuals with low education levels, which are limited to primary education.

The family sizes of the respondents vary from one household to another. The majority of the respondents (64.3%) had family sizes between 3 and 4, followed by family sizes between 5 and 6, which made up 24%. This is slightly above the national average of urban areas in the country. Therefore, urban agriculture is mainly practiced by relatively large size families as a means of generating additional income to support the family. Overall, sex, age, level of education, and family size were the major variables linked to factors influencing urban farmers' intention to adapt to climate change.

3 Results and discussion

3.1 Types of adaptation strategies

Urban farmers of Addis Ababa practiced different kinds of adaptation strategies to reduce the adverse effects of climate on their agricultural productivity. There were approximately nine strategies identified out of which sowing new types of crop varieties, practicing water management activities, and adjusting crop sowing dates were identified to be the top priority strategies, ranked from 1st to 3rd, respectively, based on their calculated mean score as shown in Table 4. This is consistent with Deressa et al. (2009, 2011), who reported similar strategies practiced in the agriculture sector in Ethiopia. On the other hand, the shift to non-farm activities, the shift from crop production to livestock rearing and vice versa, and the sowing of early maturing crop varieties were among the strategies relatively less favored by urban farmers in Addis Ababa. In addition, factors influencing the intention of urban farmers to implement adaptation strategies toward climate change are presented in the next section.

3.2 Determinants of UFs' intention to adapt

Analysis of determinants of farmers' intention to adapt is important to enhance our understanding of those factors that are

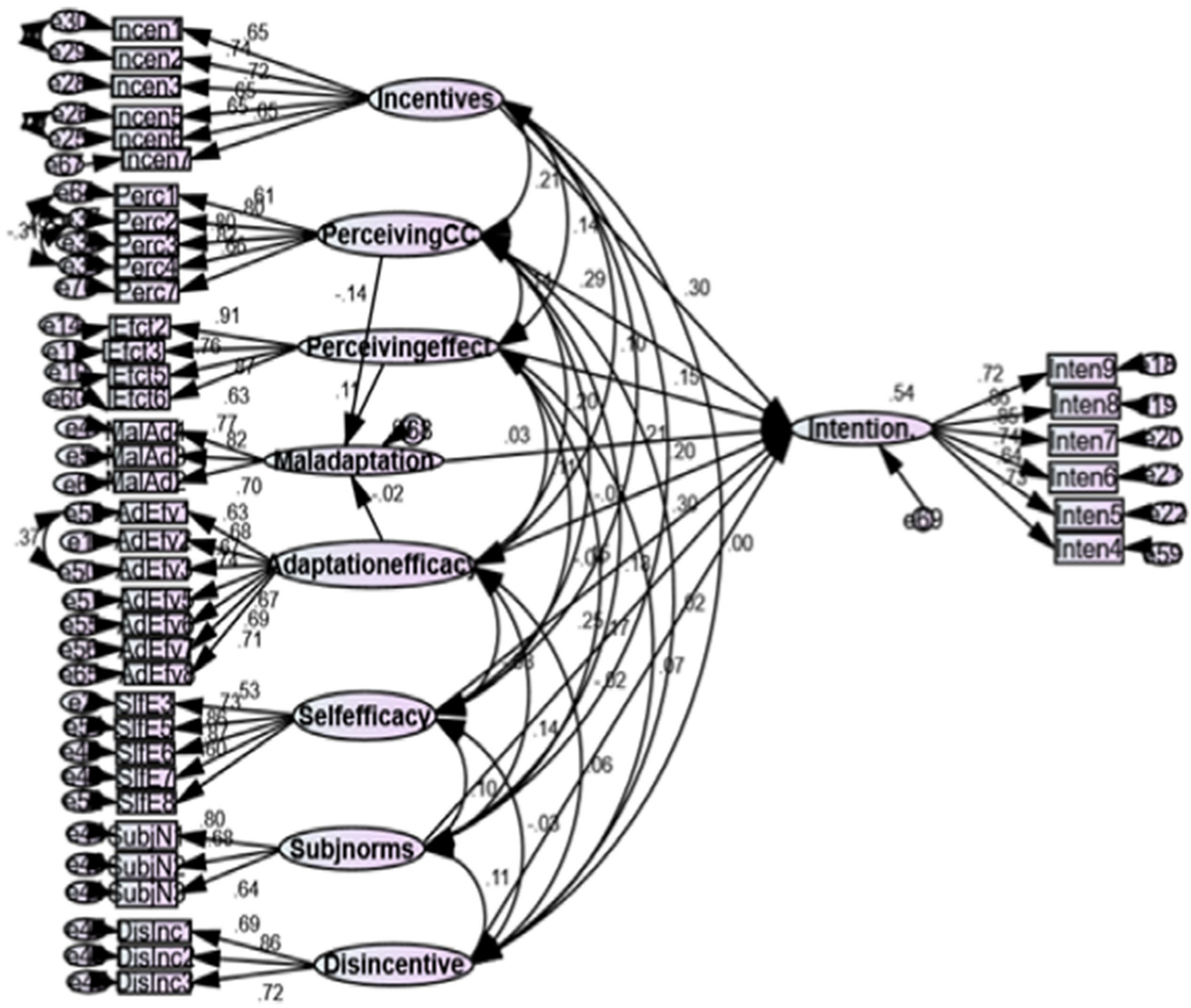

FIGURE 2
The path diagram. Model fit indices: CMIN = 1022.512; DF = 782; CMIN/DF = 1.308; RMSEA = 0.031; CFI = 0.975; TLI = 0.976; NFI = 0.866; AGFI = 0.866, and IFI = 0.965.

more critical in influencing their propensity to adapt at the farm level. In this respect, the SEM model, which enables us to work with latent variables (Hair et al., 2010) and is also expected to have a good capacity for predicting urban farmers' intention to adapt, was found relevant for this study. Therefore, this section focused on ascertaining the role of factors in influencing UFs' intention toward adaptation options for offsetting the effects of changing climate on urban farm households in the context of the study area. In doing so, using the SEM model, the overall results on influences of all predictors on the endogenous variables (intention to adapt) and tests of the significance of model parameters are presented in Table 5.

Different variables (constructs) were found to significantly influence urban farmers' decisions toward implementing adaptation options for abating the impacts of changing climates on their agriculture and their lives. Specifically, perceptions of change in the local climatic parameters are one of the factors that were predicted to influence urban farmers' tendency toward espousing adaptation strategies in the study area. Urban farmers' observation of the changing climate is crucial for assessing the probability of implementing adaptation options to address the effects linked to climate change. In this study, perceiving change in local climatic indicators, such as temperature, rainfall, flooding, and other extreme climatic events, among urban farmers was found to have a positive influence on urban farmers' propensity to implement adaptation strategies ($\beta = 0.294, P < 0.001$). Meaning, the perceptions of change in climatic parameters significantly augment positively the probability of implementing different adaptation strategies among urban farmers. This also suggests that urban farmers who observed climate change developed a greater likelihood (approximately 0.29) of intending to adapt toward acclimatizing than their counterparts, who did not perceive it in the study area. Dang et al. (2014) also highlighted that one's observations on climate change parameters are also a central predictor of the adaptation behavior of farmers. The UNFCCC (2007) also added that households that have observed alterations in climate can adapt to them, making them less susceptible to the menaces of climate change compared to those who do not perceive them. Hence, this study's result is similar to Maddison's (2007) finding, which revealed that perceiving change in climate upsurges the probability of implementing adaptation strategies to counter the effects of changing climate. It is also in congruence with a finding conducted by Bagagnan

TABLE 4 Types of adaptation strategies implemented by urban farmers of Addis Ababa.

S.N	Types of adaptation strategies	Mean score (Out of 5%)	Rank
1	Sowing new types of crop varieties	4.34	1
2	Sowing drought-resistant crops	3.98	4
3	Use of pest and disease-resistant crops	3.91	5
4	Practicing water management activities	4.07	2
5	Adjusting dates of crop sowing	3.99	3
6	Sowing early maturing crop varieties	3.73	7
7	Application of agricultural inputs use (chemicals, fertilizer, etc.)	3.84	6
8	Change from farm to non-farm activities	3.46	9
9	Shift from crop production to livestock rearing and vice versa	3.56	8

Field Survey, 2024.

et al. (2019), in which farmers' observation of the changing climate positively affects their intention to protect their agriculture from climate change-induced effects. Findings by Regassa and Akirso (2019) in Ethiopia too indicated that perceiving changes in climatic parameters is a vital factor in influencing farmers' decisions to abet climate change effects.

Perceiving climate change as a threat was also found to be significant in affecting urban farmers' intention to adapt in the study area. It has the greatest impact on urban farmers' intention toward adaptation strategies, with an estimate of approximately 0.15. In other words, urban farmers' intention to adapt substantially depends on their observation of climate change as a threat to their agriculture and livelihoods. This figure also implies that urban farmers who perceive the changing climate as a threat are more likely to implement adaptive strategies than those who do not perceive it, and vice versa. Dube et al. (2021) also disclosed that urban farmers who perceived change in climate as adversely affecting their farming activities implemented repeated planting, preferring drought-tolerant crop varieties, securing new pastures with water sources, and purchasing supplementary feed for their cattle. Furthermore, Luu et al. (2019) disclosed that farmers who perceived a higher threat of climate change on their agricultural production, income, health, and other aspects of their livelihood are more tempted to adapt than their counterparts. A study by Keshavarz and Karami (2016) also disclosed that the perceived harshness of climate change and subsequent incidence of drought meaningfully stimulated farmers to engage in soil and water conservation practices as adaptation strategies.

Furthermore, urban farmers' own capacity (self-efficacy) assessment in responding to the perceived threat of climate change was another critical factor in influencing their intention toward adaptation options in this study. That is, perceived self-efficacy is a vital component for comprehending farmers' temptation to adapt to offset climate change-induced threats. In this study, urban farmers who perceived they were capable of implementing adaptation strategies were more tempted to adapt than their counterparts. Accordingly, the computed outcome in the above table indicated that the perceived self-efficacy to implement the CC adaptation option positively and significantly affected $\left(\beta = 0.148, P < 0.05\right)$ farmers' intention to adapt over the studied area. Hence, this study's finding is congruent with a research result by Dang et al. (2014) in the Mekong Delta, Vietnam. Research conducted by Regassa and Akirso (2019) in the Konta district in southwestern highland parts of Ethiopia also unveiled that self-efficacy significantly predicts farmers' tendency to implement changing cropping calendars to counter climate change effects. Similarly, a study by Burnham and Ma (2016) and Ung et al. (2015) revealed that having higher perceived self-efficacy is positively linked with adaptation to natural disasters.

Similarly, ascertaining the perceived effectiveness of adaptation strategies for offsetting effects attributed to the changing climate is also one of the determinants that is considered to have its own influence on urban farmers' propensity to adapt in the study area. As a consequence, the computed result in the SEM model also depicted that the perceived effectiveness of response strategies positively influenced urban farmers' temptation to adapt $\left(\beta = 0.199, t = 4.00, P < 0.001\right)$ in response to climate change effects. The perceived effectiveness of adaptation strategies is a significant positive predictor of urban farmers' intention to adapt, as depicted in the structural path estimate, 0.199. In this regard, an urban farmer who perceives less or is not certain of the effectiveness of adaptation options is less likely to intend to adapt to avert climate change threats than his or her counterparts. This agrees with the study carried out by Dang et al. (2014), where farmers in Long An in the Mekong Delta, Vietnam, are more tempted to adapt when they perceive an increase in the effectiveness of adaptation strategies. Abid et al. (2021) also depicted that the intention to adapt was positively related to the greater effectiveness of adaptation strategies.

Furthermore, subjective norms were another construct considered and anticipated to have its own effect on urban farmers' inclination toward implementing adaptation options in the study area. That is, urban farmers were more tempted to adapt when they were influenced by subjective norms (friends, co-farmers, families, relatives, neighbors, and others around them). This is because farmers who more frequently communicate on climate change and adaptation options with other people around them were found to implement more adaptation strategies than their counterparts. In this study, subjective norms are central in instigating and shaping the behavior of urban farmers to decide whether to engage in adaptation strategies. Accordingly, the computed result demonstrated that urban farmers' propensity to implement adaptation strategies was strongly and significantly influenced by subjective norms ($\beta = 0.253, t = 4.452, P < 0.001$). This finding is consistent with Dang et al. (2014), Siyao and Sanga (2023), and Abid et al. (2021), where farmers were found to be more tempted to implement adaptation strategies when they perceived pressure from friends, relatives, neighbors, and other people around them.

The availability and access to incentives like agricultural inputs, extension, and credit services, as well as training on climate and related issues, were also other factors considered to have an influence on the likelihood of UFs' intention to implement CC adaptation options. In this study, urban farmers' intention to implement adaptation strategies was significantly and positively affected by the availability of incentives ($\beta = 0.299, t = 5.059, P < 0.001$). That is, access to incentives like agricultural inputs (improved crop varieties, agricultural chemicals, fertilizer, credit and extension services, training

TABLE 5 SEM results on determinants of UFs' intention to adapt.

Path	Standardized Z value	Standard error	C.R.	*P*-value
Intention ← Perceiving CC	0.294	0.040	5.581	***
Intention ← Adaptation efficacy	0.199	0.039	4.000	***
Intention ← Self-efficacy	0.148	0.050	3.130	0.002
Intention ← Subjective norms	0.253	0.037	4.452	***
Intention ← Disincentive	−0.020	0.042	−0.427	0.670
Intention ← Maladaptation	0.029	0.034	0.617	0.537
Intention ← Incentives.	0.296	0.046	5.059	***
Intention ← Perceiving effects of CC	0.150	0.048	3.199	0.001

*** are significant at 1% level of significance. Field Survey, 2024.

facilities, climate and related information, and so on) significantly improves urban farmers' intention to engage in adaptation strategies. This is supported by Alemu et al. (2024), where the availability and accessibility of land, agricultural inputs, the application of effective farming practices, and the timely input supply of other hurdles in the field are some of the factors that affect the productivity and production of cereal production in urban environments, like Addis Ababa city. Abid et al. (2021) also exhibited that farmers' intention to adapt was positively related to the accessibility of incentives among farmers in regions of Hindu Kush Himalaya.

Disincentives, on the other hand, were one of the other factors impacting urban farmers' decisions to adapt in this study. The influence of deterrent factors (disincentives), like an increase in the price of improved crop varieties, agricultural chemicals, fertilizer, etc., was found to influence urban farmers' intention to adapt negatively but non-significantly. Thus, its relationship is also shown with a standardized coefficient of ($\beta = -0.020, t = 0.427, P = 0.67$) at a 95% confidence level. This implies that disincentives in the form of a rise in prices of agricultural inputs are insignificantly but negatively correlated with urban farmers' intention to adapt. In other words, the figure suggests that, with the rise in prices of agricultural inputs, fertilizers, improved crop varieties, and so on, urban farmers are less likely to intend to adapt to avert the impact of climate change and its related phenomena on their agriculture. Accordingly, the absence of the government's support systems in providing new crop varieties, agricultural fertilizers, chemicals, and so on is one of the limiting factors for urban farmers' intention to adapt. This study result is in agreement with Alemu et al. (2024), where the shortage and high cost of necessary commodities such as improved seeds and fertilizers have been a source of unanimity among cereal crop producers in Addis Ababa city. However, Abid et al. (2021) disclosed that farmers' Intention toward climate-smart agricultural practices was not determined by disincentives like an increase in the prices of electricity, fertilizer, and fuel.

Urban farmers' temptation to adapt was influenced relatively less by maladaptation practices in the study area. Hence, it insignificantly but positively impacted urban farmers' intention to adapt ($\beta = 0.029, t = 0.617, P = 0.537$) at a 95% confidence level. This implies that urban farmers exhibiting maladaptation behavior were likely though insignificantly, to intend to adapt to tackle the effects of climate change compared to their counter-urban farmers, and vice versa. This means that the more the belief in protection from God or the incapability of the adaptation options in offsetting effects linked with climate change, the more the intention of urban farmers to adapt, and vice versa. Despite this, maladaptation has the least positive influence in the structural path (0.03) on urban farmers' intention to adapt. Hence, this study agrees with Dang et al. (2014), where farmers in Dong Thap and Long An in the Mekong Delta of Vietnam are less likely to be tempted to adapt when they perceive wishful thinking, denial, or fatalism about climate change threats. According to Grothmann and Patt (2005), maladaptive behavior, such as wishful thinking, denial, or fatalism about climate change threats among individuals, does not stimulate adaptive behavior.

In general, the computed result in the SEM depicted that, out of the eight estimates of the path coefficients, six of them (perceptions toward change in climatic parameters, perceiving the severity of climate change threats, self-efficacy, adaptation efficacy, subjective norms, and incentives) were found to be positively and statistically significant in resonating urban farmers' intention to adapt in the studied area. Hence, the squared multiple correlations (R^2) indicated that a higher proportion of variations considered in urban farmers' intention to adapt were explained by a significant number of variables included in the study. Meaning, the squared multiple correlations (R^2) exhibited that approximately 54.2% (greater than 0.5) of the total variation in adaptation intention among urban farmers in the study area can be accounted for by significant constructs (independent variables) considered in the SEM model. Therefore, the test results of the SEM model are relatively strong, and hence, the PMT is a suitable framework for predicting urban farmers' intent to adapt to the study area.

4 Conclusion

Climate change is a grave concern for urban agriculture in general, and urban farmers' in Addis Ababa implemented several adaptation strategies, including sowing new types of crop varieties, practicing water management strategies, adjusting dates of crop sowing changing climatic conditions, and sowing of drought resistant varieties to reduce associated risks. Hence, several factors influenced the urban farmers' intention to adapt to climate change in the study area. That is, their intention was positively and significantly determined by the availability of incentives, perception of climate change parameters, subjective norms, response efficacy, self-efficacy, and perceived severity of climate change threats. In other words, threat appraisal and coping appraisal have a positive and statistically significant influence on urban farmers' intention to adapt in the study area. Despite this, maladaptation and disincentives have insignificant relationships with urban farmers' intention to adapt in the study area.

Hence, a call for implementing appropriate adaptation options by integrating scientific evidence on changing climatic conditions and addressing factors influencing urban farmers' intention to adapt at the micro-levels is very crucial. The study proposes the need to rethink, communicate, and address the likely key factors influencing urban farmers' intention to adapt to the study area. In this regard, this study suggests strengthening the capacity of local institutions, farmer training and education, climate information dissemination such as early warning systems, and access to extension services, including farm inputs, credits, and finance to equip urban farmers with the necessary facilities to undertake practical adaptation strategies in the face of climate change.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the [patients/participants OR patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

EG: Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. BA: Supervision, Writing – review & editing. KS: Supervision, Writing – review & editing. MW: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could potentially create a conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

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