Research article

Assessing Factors Influencing Farmers' Perceptions on Adaptation to Climate Change: A Case of Apple Farmers in Cheongsong, Korea

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Abstract One of the most important consequences of climate change in Korea is the moving of the adequate cultivation area for apple. To respond adequately to such consequences, the farmers require performing on the adaptation measures. Although Korean government puts great efforts to develop adaptation measures, the livelihoods of agriculture and rural communities are still posing great threats from climate variability and change. It is because the most of adaptation studies and policies fail to address the perception of farmers who decide and perform the adaptation measures. Without an understanding of farmers' perceptions, private adaptation strategies are unlikely to be effective. This paper, therefore, aims to investigate and analyze factors influencing farmers' perception on adaptation behaviors. To meet such objectives, this study based on theory, a Model of Private Proactive Adaptation to Climate Change (MPPACC), explaining individual's intention of adaptive behavior is based on socio-cognitive aspects including perceived adaptation measure efficacy, self-efficacy and adaptation costs. To analyze the factors influencing farmers' perception and behavior of climate change adaptation, 170 apple farmers in Cheongsong County is selected for farm household survey. By analyzing through multiple linear regressions, the results were found that the farmers' perceptions of adaptive efficacy are significantly associated with farm household demographic and socioeconomic factors including investment in crop insurance, and contents and sources of information. This implies that to enhance the farmers' motivation to adaptation, the local government should pay further attention to improve credibility of crop insurance efficacy and the quality and source information to increase farmers' adaptive capacity through increased farmers' perception on adaptation efficacy.

Keywords climate change, adaptation behaviors, perceived adaptation efficacy, apple farming

INTRODUCTION

Agricultural communities in Korea have already experienced the impact of climate change, including crop and livestock losses from severe drought and flooding, large-scale losses from weather-related disasters, shifts in planning and harvesting times and cultivation lands (MoE, 2015). According to Ministry of Environment (2015), the assessment of the climate change vulnerability and its impact on apple cultivation in Korea indicated that adequate apple cultivation area, which has been in the southern, eastern parts of Korea, is moving to the northern parts of the Korean peninsula. Moreover, in the Northern Provinces in Korea, it is already increasing apple production in the area. Although Cheongsong County, one of the top apple-producing counties in southern parts, is increasing its apple

production until recent years, the County is also projected to become inadequate to produce the apple crops from the 2030s (RDA, 2015). Not only the projected climate is shown to change apple cultivation in the County, the current climate variability already has been increasing farmers' awareness on the climate variability and adaptation behaviors. To increase farmers' resilience to climate change, enhancing the adaptation capacity is vital. The farmers have been conducting adaptation behaviors to prevent and lessen the damage of climate variability and change. The private adaptation behaviors can be influenced by farmers' perceptions and assessments on the specific adaptation measures. However, only limited studies has examined the factors influencing farmers' perceptions on the adaptation behaviors.

The Model of Private Proactive Adaptation to Climate Change (MPPACC) is one of the limited research to examine the socio-cognitive perspective of adaptation behaviors derived from discourses in psychology and behavioral economics (Grothmann and Patt, 2005). According to this model, individuals' adaptation behavior to climate change can be influenced by some socio-cognitive factors including perceived adaptation efficacy which is measured by individuals' perceptions of 1) adaptation measure efficacy (PME), 2) self-capacity to perform the adaptation measures (PSE), and 3) the cost associated with such performance (PAC). In this study, the factors hypothesized to influence such perceptions are farm households' characteristics (socioeconomic factors), previous experience with climate change, and information (climate change, adaptation) from various sources. To enhance the apple farmers' resilience to increasing climate risks, it is important to not only to develop adequate adaptation measures but also to understand what factors may motivate the farmers to perform the adaptation measures.

OBJECTIVE

The main objective of this paper is to suggest some policy implications for enhancing farmers' adaptation capacity by investigating and analyzing farmers' perceptions on the effectiveness of private climate change adaptation behaviors and the factors influencing such perceptions.

METHODOLOGY

As shown in Fig. (1), North Gyeongsang Province is located in the southeastern part of Korea and Cheongsong County is located in the eastern part of the Province. The Province produced 372,627 tons of apples in 2015 which is about 64 percent of total apple produced in Korea (RDA, 2015). Cheongsong County is evaluated as one of the top County to produce the highest quality apples in Korea (Cheongsong County, 2016). Because of its location, altitude and temerature, the County has been well-suited for producing high-quality apples. The County is surrounded by mountains that provide a high diurnal range which is an advantage climate for apple cultivation. Moreover, the County usually has less rainfall compared to neighbor Counties which are also an advantage climate factor for apple cultivation. The County's annual average temperature, although increased from 12.5 in 2014, is recorded as 12.9 in 2015 (KMA, 2016). Since the County has been known to have the suitable environment and climatic for apple cultivation, about 80% of farmers are engaged in apple cultivation in the County (Cheongsong County, 2016). The County, not only produces the high-quality apples, but it also organizes several major events including the biggest apple festival in Korea. Apple cultivation is not only an extremely important economic source, but it also has become a part of the lives of the people living in the County.

The farmers' adaptation behaviors to climate change are collected through intensive review of previous studies and government reports. After listing all the adaptation measures that are applicable to the apple farmers, the authors conducted interviews with the farmers and the local agricultural officials for final selection. Finally, 9 adaptation measures were selected and analyzed in this study includes:

adjusting farming dates, adjusting use of pesticides, switching to different crop, paying attention to climate information, diversifying crops, buying crop insurance, improving soil condition, changing to other apple variety and searching for non-farming job.

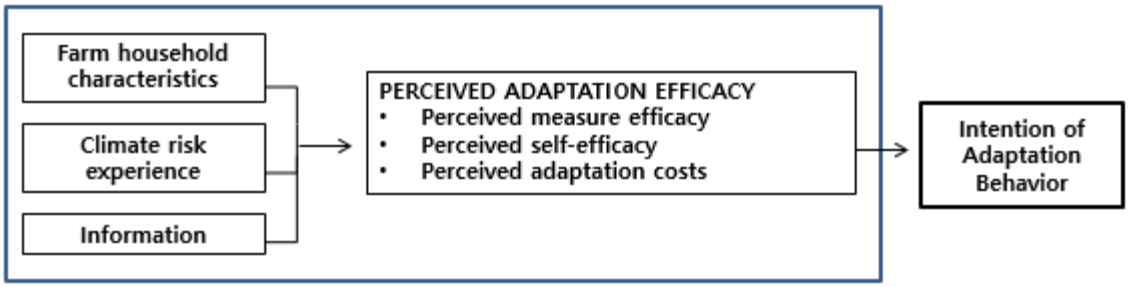

Fig. 1 Conceptual framework

From April to June 2016, a farm household survey with 170 apple farmers in Cheongsong County was conducted with structured questionnaires, also, in-depth interviews and focus group discussions were conducted to collect the data on farmers' characteristics, experiences with climate change and climate change and adaptation information from various sources including neighbors, community leaders, local agricultural extension services, public media and cooperatives. Farmers were also asked about their perceptions of the adaptation effectiveness including their perception of adaptation measure effectiveness, self-ability to perform measures, and the costs performing the 9 specific adaptation measures. For perceptions of measure effectiveness and self-capacity, farmers were asked to scale 1 (not effective at all) to 4 (extremely effective) while on the costs were scaled as 1(extremely expensive) to 4 (not expensive at all). Four linear regressions were conducted for analyzing the factors affecting farmers' perceptions on adaptation efficacies. For the regression, farmers' adaptation assessments were represented by four dependent variables: perceived measure efficacy (PME), perceived self-efficacy (PSE), perceived adaptation cost (PAC) and overall perception of adaptation efficacy. The overall perception of adaptation efficacy is calculated by adding three adaptation perceptions and divided by three to weigh all three perceptions equally.

Overall Perceived Adaptation Efficacy = (PAE + PSE + PAC) / 3

The explanatory variables considered in the regression are farm household characteristics, socioeconomic factors such as income, sales mechanisms, crop insurance status, previous experience in climate risk and information from various sources. Previous studies on individuals' adaptation behavior found that some demographic and socioeconomic factors such as age, experience, gender, income, education and sales mechanisms influence farmers' adaptation behaviors (Bryan et al., 2013; Deressa et al., 2011; Fujisawa and Kobayashi, 2011; Grothmann and Patt, 2005). Personal experience with climate risk can also motivate private adaptation by influencing one's cognitive factors (Grothmann and Patt, 2005). Moreover, information can play a vital role in the farmers' perception on the adaptation efficacies (Grothmann and Patt, 2005). Not only the contents itself but how farmers receive such information can have a diverse effect on them. Therefore, in this study, both climate and adaptation information are considered to be disseminated by public media, neighbor farmers, village leaders, agriculture extension service centers, and agricultural cooperation. This study assumes that climate change and adaptation information from different sources can have a different influence on the farmers' perception of three adaptation efficacies. The models were tested for the R-squares, multicollinearity, normality, linearity and homoscedasticity of the residuals

Perceived Adaptation Efficacy = *f* (farm household characteristics, climate risk experiences, climate change information, adaptation information)

RESULTS AND DISCUSSION

To analyze the factors influencing farmers' cognitive adaptation capacity, particularly on the cognitive evaluation of adaptation behaviors are found from the four regression models. Table 1 shows the results of the regressions, and it was found that farmers' perceptions of adaptation measure efficacy, self-efficacy, adaptation costs and overall adaptation behaviors are influenced by some farm household characteristics, socioeconomic factors, and climate and adaptation information from various sources. Moreover to all the regression coefficients presented in Table 1, Table 2 demonstrates the R^2, adjusted R^2, F-test (p-value) and VIF. The R^2 for all models indicated that the statistically significant explanatory variables could explain 46 to 57% of the variation of farmers' adaptation perceptions. The variance inflation factor (VIF) for all explanatory variables were less than 3and this indicates that there is no multicollinearity problem found for the variables.

Farm Household Characteristics

Farm household characteristics found to have the significant influence on farmers' assessment of adaptation behaviors. According to the regression results, farmers' age is statistically significant in relation to farmers' perception on the measure efficacy. The coefficient indicates that as the farmer is younger, they perceive adaptation measures as more effective. Gender is also found to be a significant factor. The female farmers than male farmers perceive overall adaptation behavior as effective. In addition, years of education seems to be negatively related to the farmers' perceptions, particularly significant with the overall adaptation behaviors. Farm area is positively related to how farmers perceive adaptation measure effectiveness while negatively correlated with adaptation cost. With increasing farming area, farmers perceive adaptation measures as effective while the costs associated with the adaptation measures expensive. Income can play an important role in farmers' assessment of the cost of the measures. According to the results, a farmer with higher income can perceive the adaptation cost as more expensive. In general, farming is a family business that sons usually take over the farm from their parents. Having successor can influence farmers' perception on adaptation, especially related to the perception on self-capacity to carrying on the measures on their farms. Moreover, the number of participation in the agricultural training programs does show the significant relation with how farmers assess their own adaptation capacity.

The apple farmers sell their apple through direct or indirect markets. Direct sellers can receive feedbacks and new information. According to the regression model, the farmers with such market channels can have a higher perception of the adaptation measure and overall adaptation behavior as effective. Crop insurance plays an important role not only to recover the damages from the natural disasters but to prevent and remedy farmers from future disasters. Farmers who bought the crop insurance are more likely to perceive adaptation cost as less expensive and have a higher perception of the overall adaptation behaviors. However, simply buying crop insurance and how many years the farmers with crop insurance can have a different influence on their perceptions. Interestingly, as the cumulative years of buying crop insurance increases, farmers' perception on the adaptation measure, self –capacity and overall adaptation behaviors can diminish. This indicates that as the years of farmers' buying crop insurance increases, they find the fraud in the system and feel that they do not get any benefit of buying the insurance. This induces the necessity of improving the current insurance system.

Climate Risk Experiences

Climate risk experiences with increasing temperature, changing patterns and intensity of precipitation and extreme weather events including typhoon can influence farmers' motivation to perform adaptation measures; however, according to the regression results in this study, climate risk experiences did not

show any statistically significant influence on the farmers' perceptions, particularly related to the adaptation efficacies. However, it could be worth of mentioning that according to previous studies, it was found that previous climate-related risk experiences can have influence on farmers' motivation or intention to adaptation. Therefore, although not directly influencing the farmers' perceptions related to adaptation measures, it could have an influence on other cognitive factors that influence farmers' motivation to climate change adaptation behaviors.

Table 1 Multiple linear regression models on farmers' perceptions of adaptation behaviors

Explanatory variables	Perceived Measure Efficacy	Perceived Self-efficacy	Perceived Adaptation Costs	Overall Perception
Farm household characteristics				
Age (continuous)	-0.0085*	-0.0018	-0.0021	-0.0124
Gender (1=male, 0= female)	-0.1663	-0.1197	-0.0866	-0.3725*
Education level (continuous)	-0.0224	-0.0113	-0.0259	-0.0597**
Farming area (continuous)	0.0966**	0.0664	-0.0960*	0.0671
Farming Experience (continuous)	0.0032	-0.0001	-0.0017	0.0013
Income (continuous)	-0.0047	0.0398	-0.0822***	-0.0471
%of income from apple (continuous)	-0.0001	0.0026	0.0004	0.0029
Successor (1=yes, 0=no)	0.1136	0.2233**	0.1030	0.4399**
Agricultural training (continuous)	0.0040	0.0230***	-0.0119	0.0151
Smart-phone use (1=yes, 0=no)	-0.1632	-0.0712	-0.2509**	-0.4854
Sales channels (1=indirect, 0=direct)	-0.1084**	-0.0658	0.0181	-0.1562**
Land ownership (1=yes, 0=no)	-0.0121	-0.0183	0.0337	0.0033
Buying crop insurance (1=yes, 0=no)	0.1830	0.0781	0.4582***	0.7193***
Yrs. crop insurance (continuous)	-0.0472***	-0.0250*	0.0087	-0.0636**
Other crops (1=yes, 0=no)	0.0559	0.0195	0.0216	0.0972
Climate Risk Experiences (1=not at all, 2=barely, 3=have experience, 4=extremely)				
Risk Experience (Temperature)	0.0207	-0.0085	0.1027	0.1149
Risk Experience (Precipitation)	-0.0605	-0.0998	-0.0224	-0.1827
Risk Experience (Extreme weather)	0.0329	0.0319	-0.0395	0.0253
Information (1=not at all, 2=sometimes, 3=often, 4=always)				
Climate change info. (Public media)	0.1195*	0.1043*	0.0015	0.2253*
Climate change info. (Neighbor farmers	0.0405	-0.0032***	0.0270	-0.0618
Climate change info. (Village leader)	-0.0837	0.0220	-0.1639**	-0.2256*
Climate change info. (Agri. Ext. center)	0.1138*	0.0943	0.1130	0.3210***
Climate change info. (Agri. Cooperative)	0.1414**	0.1479**	-0.0208	0.2686**
Adaptation Info. (Public media)	0.0428	0.0403	-0.0387	0.0444
Adaptation Info. (Neighbor farmers)	0.0792	0.2847***	-0.0224	0.3414***
Adaptation Info. (Village leaders)	0.2003***	-0.1358**	0.0635	0.1281
Adaptation Info. (Agri. Ext. center)	0.1734***	0.0134	-0.0952	0.0916
Adaptation Info. (Agri. Cooperative)	-0.1095*	0.0173	0.0786	-0.0136

Significant at 10% level (p<0.1), ** significant at 5% level (p<0.05), * significant at 1% level (p<0.001)*

Information

As explained in the previous section, the contents and the sources of information can influence farmers' perceptions. According to the regression results, information on climate change received from public media, agricultural extension center and cooperatives can positively influence farmers' perceptions on measure efficacy, self-efficacy, and overall adaptation efficacy. However, the information from neighbor farmers and village leaders can negatively influence farmers' perceptions, particularly on self-efficacy, costs and overall adaptation efficacy. From these results, it can be

analyzed that the farmers perceive adaptation efficacies positively associated with climate change information from objective sources. Interestingly, unlike the climates change information, the farmers' perception of adaptation efficacies is positively and significantly related with adaptation information from neighbors and village leaders. It can be analyzed that the farmers' perception on adaptation efficacies, which would eventually increase farmers' motivation to perform on the adaptation can be enhanced if adaptation information could be disseminated by neighbors and village leaders, who the farmers are personally connected with. The inclusion of subjective opinion or the personal experience in disseminating the information related to adaptation measures could bring greater success in delivering adaptation information to farmers.

Table 2 Assessing the fit of regression models and multicollinearity

Dependent variables in the models	R^2	Adjusted R^2	F test, *p*-value	VIF
Perceived measure efficacy	0.53	0.38	0.00	
Perceived self-efficacy	0.49	0.33	0.00	Max: 2.92
Perceived adaptation costs	0.46	0.28	0.00	Min: 1.14
Overall perception	0.57	0.43	0.00	

CONCLUSION

To enhance the adaptive capacity of farmers, this study aims to investigate and analyze the factors affecting the cognitive capacity of the apple farmers, in Cheongsong, Korea. According to the MPPACC, the cognitive capacity to motivate adaptive behavior includes individuals' perception of adaptation behaviors and adaptation perception can be measured through perceived measure efficacy, perceived self-efficacy, and perceived adaptation costs. This study conducted multiple regressions, and as a result, demographic and socioeconomic factors and information from different sources can have an influence on the farmers' perceptions differently. In sum, among the demographic and socioeconomic factors, crop insurance and years of buying the insurance seem to influence farmers' perceptions on adaptation assessment. Moreover, climate information from objective sources, such as public media and public centers can have higher influence than neighbors and village leaders, however, with regard to adaptation information, the farmers' perception of adaptation behaviors can be influenced more by information from neighbors and village leaders. There was no statistically significant correlation was found with previous climate risk.

The results of this study suggest some directions for how to achieve successful dissemination of adaptation policies in the agricultural sector. Not only the contents but sources and quality of information should be considered as important due to the potential influences on farmers' perceptions and their adaptation evaluations. Moreover, an improvement on the system of crop insurance in addition to increasing credibility is deemed a necessity for successful adaptation strategies in Cheongsong County. By understanding different elements that induce farmers' perception on adaptation appraisal, apple farming communities can increase its adaptive capacity and lessen the damage from the impacts. However, there is the tendency of ignoring the importance of cognitive factors. Enhancing broader application of measuring cognitive capacity should have a clearer understanding of climate change adaptation capacity in apple farming communities. Moreover, this study can be more developed to be applied to other regions and other sectors to be referred in integrated climate change vulnerability assessment of rural agricultural communities.

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REFERENCES

Bryan, E., Ringler, C., Oloba, B., Roncoli, C., Silverstri, S. and Herrero, M. 2013. Adapting agriculture to climate change in Kenya, Household strategies and determinants. J. Environ. Manage., 114, 26-35.

Choi, S.Y. and Yamaji, E. 2015. Local level climate change vulnerability assessment using three indices, A case of four municipals of Gyeonggi Province in Korea. Journal of Rural Planning Association, 34, Special Issue, 261-266.

Cheongsong County. 2016. The statistical report for apple production [data file]. Retrieved from http://www.cs.go.kr/countyOffice/

Deressa, T.T., Hassan, R.M. and Ringler, C. 2011. Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. The Journal of Agricultural Science, 149, 23-31.

Fujisawa, M. and Kobayashi, K. 2011. Climate change adaptation practices of apple growers in Nagano, Japan. Mitig Adapt Strateg Glob Change, 16, 865-877.

Grothmann, T. and Patt, A. 2005. Adaptive capacity and human cognition, The process ofindividual adaptation to climate change. Global Environmental Change, 15 (3), 199-213.

Ministry of Environment. 2015. Korea climate change assessment report 2014. Climate change impact and adaptation. Ministry of Environment, Korea.

Korea Meteorological Administration. 2016. National climate data service system. Climate Information [data file] http://sts.kma.go.kr.

Rural Development Administration. 2015. Manual of organic apple. National Institute of Horticultural & Herbal Science.