Nat. Volatiles & Essent. Oils, 2018; 5(1): 93-102
https://doi.org/10.52783/nveo.5467

Determinants Of Choice And Effect Of Climate Smart Agricultural Practices On Household Food Security

SRIPARNA SAHA

Department of School of Architecture and Planning, Graphic Era Hill University, Dehradun, Uttarakhand, India 248002

ABSTRACT

A significant barrier to agricultural expansion and sustainable intensification is the need to ensure social justice in programs aimed at enhancing food security. Two hundred and sixty-nine smallholder farm families (HHs) in Bihar, India, had their food security and means of subsistence evaluated. Before moving on to the next stage of our four-part research, we used a multivariate statistical approach to identify key distinctions across five distinct agricultural system categories. Finally, we used scenario analysis to investigate how the implementation of 'climate smart' agricultural (CSA) techniques including conservation agriculture (CA) and enhanced cattle husbandry, as well as climatic shocks, would affect HH PFA.

KEYWORDS PFA, Climate Smart Agriculture, smallholder, Development

INTRODUCTION

The effects of global warming on food supply systems are among the century's most pressing issues. Since attempts to limit climate change by keeping temperature rise below the 2 °C threshold have been unsuccessful, the world's population will have to learn to live with its consequences. This is because agricultural production methods will be required to meet the growing demands of a global population that is expected to reach 9.1 billion by 2050 and over 10 billion by the year 2100. The ability and resilience of agricultural systems must be increased in the face of climate change. There have already been serious consequences for water supplies, health, and food security as a result of climate change. As temperatures increase and precipitation becomes more erratic, farmers will see a decrease in their crop and animal yields. Due to the destructive consequences of climate change on local food production and family well-being, many areas of Delhi suffer from malnutrition, hunger, and chronic poverty.

Maintaining food security in the face of climate change is one of the biggest difficulties mankind confronts today, given the already severe and ubiquitous implications of climate change on our ecosystems. Although climate change's consequences are not instantly visible, prompt action is required to ensure that agricultural production systems have sufficient time to become more resilient. It is estimated that 161 million children under the age of five are stunted, and that about 800 million people worldwide are chronically undernourished. Meanwhile, half a billion people are overweight and another two billion lack the micronutrients they need to thrive. Urbanization, rising incomes, and rising populations all contribute to a shift in the structure of the food and feed markets. The United Nations' Food and Agriculture Organization predicts that, due to rising global populations and changing dietary preferences, food production would need to increase by at least 60% over the next few decades.

LITERATURE REVIEW

Robert Ugochukwu Onyeneke et.al (2018) The current situation of climate-smart agriculture (CSA) in southeast Nigeria was explored in this paper using both qualitative and quantitative methods. A total of 160 farmers from the area were selected. There were also individual discussions and chats among smaller groups. The information was analyzed using logit regression and qualitative content analysis. Important to CSA in southeast Nigeria are five behaviors that are highlighted in the report. enhancing mobility and social networks, changing agricultural production methods, and overseeing farm finances, diversifying outside the farm, and controlling and regulating knowledge. Reasons why some individuals in southeast Nigeria engage in CSA while others do not include leadership position, risk orientation, gender, land ownership, family size, and media exposure. The development and widespread use of climate-smart technology is essential if farmers are to be adequately prepared for the effects of climate change.

Fikeremaryam Birara Feleke et.al (2016) In many poor nations, rural residents rely heavily on income from the cattle industry. Sheep and goats, which can reproduce rapidly, are hardy, and can be sold for cash to help rural producers in Ethiopia, are the primary livestock species on which rural residents rely for subsistence. However, climate change and unpredictability are threatening the various benefits that sheep, goats, and other animals provide to rural farmers. Farmers are adapting to the effects of climate change in a variety of ways, with the methods they choose depending on a wide range of circumstances. Therefore, the purpose of this research is to examine the factors that influence the selection of adaptation techniques in response to climate change's effects on sheep and goat production, such as feed scarcity, heat stress, water scarcity, and a lack of pasture. Three different types of agro-ecological zones were utilized to represent the prospective livestock production areas from which 318 sample homes were recruited. Eighty-eight percent of respondents believe that rising temperatures and falling precipitation rates are the most visible manifestations of climate change in the recent decade. During times of forage shock, marketing was the most popular (95%) adaptation technique, followed by home feeding (89%). It was found that variables such as farmers' access to markets, household income, population density in their village, and the kind of farm they ran all had a role in how they made choices about how to adapt to climate change. Furthermore, Ordinary Least Squares analysis demonstrated that adaption tactics contributed positively to family income.

Munir Ahmad et.al (2015) In many poor nations, rural residents rely heavily on income from the cattle industry. Sheep and goats, which can reproduce rapidly, are hardy, and can be sold for cash to help rural producers in Ethiopia, are the primary livestock species on which rural residents rely for subsistence. However, climate change and unpredictability are threatening the various benefits that sheep, goats, and other animals provide to rural farmers. Farmers are adapting to the effects of climate change in a variety of ways, with the methods they choose depending on a wide range of circumstances. Therefore, the purpose of this research is to examine the factors that influence the selection of adaptation techniques in response to climate change's effects on sheep and goat production, such as feed scarcity, heat stress, water scarcity, and a lack of pasture. Three different types of agro-ecological zones were utilized to represent the prospective livestock production areas from which 318 sample homes were recruited. Simple descriptive statistics, a multivariate probit model, and Ordinary Least Squares (OLS) were used to examine the data. Climate change was recognized by almost all responders (98.6%). Eighty-eight percent of respondents believe that rising temperatures and falling precipitation rates are the most visible manifestations of climate change in the recent decade. During times of forage shock, marketing was the most popular (95%) adaptation technique, followed by home feeding (89%). Furthermore, Ordinary Least Squares analysis demonstrated that adaption tactics contributed positively to family income.

Eric O. Gido et.al (2015) The goal of this research was to learn more about the factors that affect extension service delivery to Kenya's small-scale maize farmers. This exploratory research relied heavily on data collected via in-person interviews with 352 randomly selected families. We conducted interviews and focus groups to learn more about the situation. According to the findings, organic farms communicated with extension providers three times year, whereas conventional farms spoke with them once. In order to enhance demand for agricultural extension programs among both organic and conventional farmers, the findings suggest that extension agents should adjust their services to the demographics of their clients. The study's originality and significance reside in its use of count data methods to the modeling of local factors influencing interest in extension services.

John Herbert Ainembabazi et.al (2014) This study looks at how familiarity with agricultural technology influences their use. The data comes from Ugandan farmers in rural areas, and we employ both non-parametric and parametric methods of estimate. Banana, coffee, and maize all show an inverted U-shaped link between technology adoption and prior expertise in the field. This shows that farmers' prior experience is valuable throughout the trial and error phase of adopting new technologies, which ultimately determines whether or not such technologies are kept or abandoned. Consequently, sustained adoption of agricultural technologies is dependent on slow but steady gains in technological development and constant retraining of farmers for particular crops.

CLIMATE CHANGE IMPACTS ON FOOD SECURITY: OVERVIEW OF LATEST KNOWLEDGE

The circumstances under which farming is practiced are changing drastically as a result of global warming. Plants, animals, and ecosystems everywhere in the globe respond to local climate by adapting to the circumstances. The plants and animals in the area are sensitive to changes in their environment; some may become less productive or even become extinct if the circumstances shift even marginally. The effects of a heat wave on a particular plant at a certain time in its development, for example, may be readily anticipated (given that the plant in question has been researched extensively). For example, predicting how a climate change would affect a whole ecosystem is challenging due to the complexity of the interplay between the many elements that make up that ecosystem. In the lab, for instance, a rise in atmospheric

CO2 is beneficial for many types of grown plants. However, numerous weeds also thrive under these conditions. Due to nutrient and water competition from weeds and the need for corrective agricultural methods, the yield of the cultivated plant may go up or down in the field. As the climate continues to change, we might expect pests and illnesses to spread to new places that are not as well equipped to deal with them biologically or institutionally. When agricultural output is threatened, so are the food supplies and nutritional condition of the people who depend on agriculture for their existence. They may also threaten the safety and health of people in far-flung areas by disrupting trade and driving up food costs. As seen in Figure 1, climate change endangers aero-ecosystems, which endangers agricultural output, which endangers economic and social ramifications, which endangers food security and nutrition. In this introductory section, we'll look at the many ways in which climate change is impacting our ability to eat well and stay nourished. What we now know about climate change is the starting point, with an emphasis on what we know today that is particularly relevant to the agricultural industries. Impacts on agriculture, cattle, forests, fisheries, and aquaculture are then briefly reviewed. The final part examines the social and economic effects of these influences on agricultural output. In the last section, we examine vulnerabilities and talk about how climate change is affecting food security and nutrition. The fifth section focuses on the effects on those four dimensions of food and nutrition security.

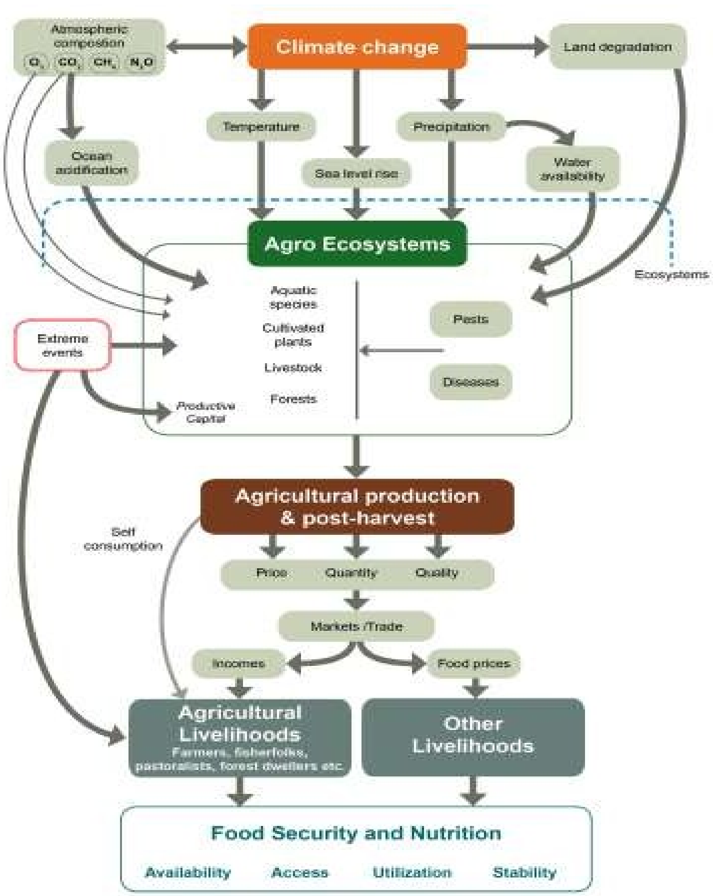

Figure 1. Schematic representation of the cascading effects of climate change impacts on food security and nutrition.

Through the five iterations of IPCC reports, there has been a deepening of the scientific foundation of our knowledge of climate change. The architecture and structure of the next phase of the Coupled Model Intercomparison Project (CMIP6) were finished in late 2014, signaling that climate change forecasts would be altered in the coming years. Until CMIP6 is finished, the greatest consensus on climate change forecasts may be found in IPCC AR5. Many socioeconomic and technical elements, as well as climate policy, will determine the extent of warming by the end of the twenty-first century. Soon, we will have access to important user-oriented data from the fast-developing area of decadal climate prediction.

METHODS

Place of research and survey methodology The Cereal Systems Initiative for South Asia (CSISA) farm household (HH) survey was conducted in 2010 and 2011 to document agricultural methods and sources of income in the IGP. Since Bihar is the poorest state in India and relies heavily on agriculture for its sustenance, it was included in the survey's extensive sample. Long-term agronomic experimental platforms in Bihar provide data for simulation studies by contrasting traditional crop management with CSA methods. Begusarai, Nawada, and Samastipur were some of the districts in Bihar where surveys were conducted. Three administrative blocks were selected within each, and then 18 HHs were split between two villages in each block (Fig. 1). A total of 269 HHs were collected via a completely random selection procedure.

Food security assessment

Hundreds of different definitions have been proposed for "food security" (FAO, 2003). Food security often refers to a situation in which all individuals (regardless of their socioeconomic status) have ready and affordable access to enough high-quality food to fulfill their dietary needs while also allowing them to engage in physically active and healthy lifestyles. This concept is all-encompassing, yet its intricacy makes precise measurement difficult. Conversely, food availability is the foundation for food access and food security, particularly at the family level (Mainuddin and Kirby, 2015). Using the information at hand, we derived a crude but effective index of food security: the ratio of potentially accessible foods per HH (shown in Fig. 2).

The potential food availability (PFA) index presented here is based on reported crop and livestock production and consumption, as well as consumption of food purchased with money earned from non-farm employment and/or sales of produced crop and live-stock products, and is calculated per farm household on a kilocalorie basis. This and nutrition go hand in hand, but it does not assess real intake. Dietary diversity scores at the household level and hunger and food insecurity access scales are two examples; PFA, however, is easier to quantify.

The observed HH's PFA is calculated as the total of their kilocalorie (kcal) intake from all sources of nutrition. When calculating the energy equivalents of the food and animal products a certain HH consumes, they utilize the formula: Eq. (1):

https://doi.org/10.52783/nveo.5467

$$\text{PFA}_{\text{direct energy}} = \sum_{fc} Y_{fc} \times E_{fc} \times \theta_{fc} + \sum_{l} Y_l \times E_l \times \theta_l$$

Food crop fc has a yield of Yfc, an energy density of Efc, and a consumption rate of fc by the HH of some fraction of the crop. Yl, El, and l represent the livestock equivalents of the numbers Y, El, and l, respectively. The most common animal byproduct was milk (l cow1 day1). The USDA (2015) coef-ficients were used to calculate the energetic coefficients of crops and animals.

Cash revenue (CINR, Indian Rupees (INR)) produced by HHs from the sale of farm goods and other non-farm income sources may be used to boost food availability via indirect con-sumption through the cash reserves mentioned in Eq:

$$C_{INR} = \sum_{fcs} Y_{fc} \times \beta_{fc} \times (1 - \theta_{fc}) + \sum_{ls} Y_l \times \beta_l \times (1 - \theta_l) + \sum_{of} \beta_{of} - \sum_{ie} \beta_{ie}$$

where ie represents the price of various inputs into a farm operation in Indian Rupees (INR) per unit, such as the cost of a tractor, fertilizer, water, manpower, etc. Food crops and livestock products sold for monetary gain are denoted by the s prefix after their respective nouns (fc and l). Median market prices (in Indian Rupees per kilogram) for food crops and animal goods were reported by survey respondents as fcs and Lls, respectively. More than 90 percent of the yearly harvest is considered cash crops (i.e., fc 0.1) because of their high market value. Therefore, Cash crops included cotton and other fiber crops like hemp and flax, while food crops like maize might be considered cash crops if Farm HH sold at least 90% of its annual production. Of represents non-farm income, such as wages, interest, and dividends from investments and remittances, as reported by farmers as a share of their total HH income.

In order to normalize the results obtained from indirect con-sumption calculations, the quantity of milled rice that could be bought with earned money at the median reported market price in each district was converted to energy equivalents. This straightforward method estimates the greatest amount of energy a family can acquire from the money they earn from things like a job or side hustle, and it may be used to help people plan their budgets:

$$\text{PFA}_{\text{Indirect}} = C_{INR} \times \frac{E_{rice}}{P_{rice}}$$

Only crops used for human consumption or sale were included in our estimates. Products that went bad or were thrown away were not counted. Then, the farm HH's total potential food intake was determined:

$\text{PFA}_{\text{total}} = \text{PFA}_{\text{direct energy}} + \text{PFA}_{\text{indirect energy}}$

Nat. Volatiles & Essent. Oils, 2018; 5(1): 93-102
https://doi.org/10.52783/nveo.5467

According to FAO (2001) guidelines, we first estimated adult man equivalents by subdividing HH members by gender and age groups before comparing the potential food available (in kcal) at the HH level.

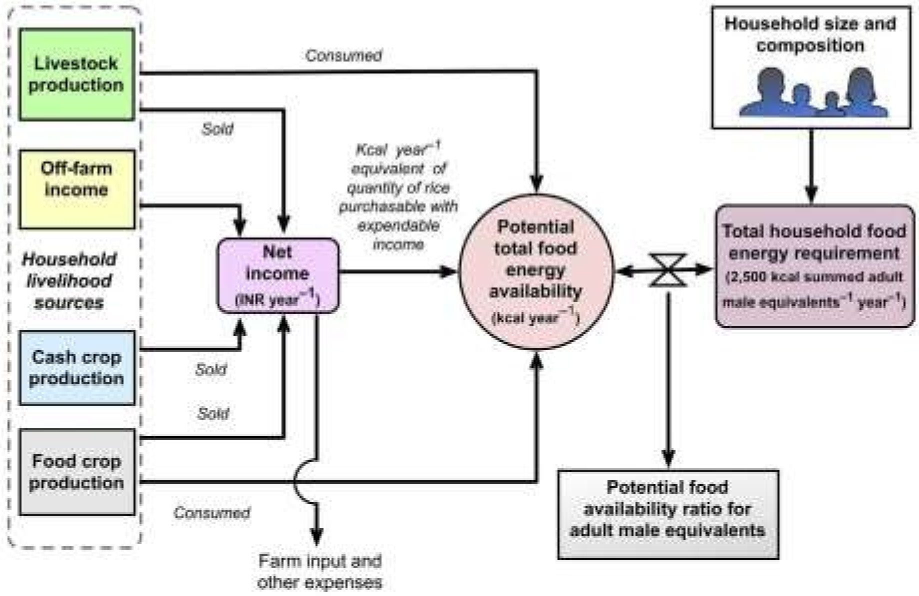

Fig. 2. A simple model of the potential food availability ratio

(also called "capita" below) based on the relative energy needs of people in three different age groups. We used a weight of 0.4 for children under the age of 6, 0.7 for children 6 to 15, 1, for men over the age of 15, and 0.9 for women over the age of 15 to calculate per capita equivalents. Then, we determined the average daily energy consumption (Ehh) needed by a farm:

$$E_{hh} = \sum_{i} n_i \times \alpha_i$$

where ni is the total number of people in age group i and i is their individual energy needs (in kilocalories per day), normalized to the standard population of 2,500. After compiling the aforementioned data, we were able to estimate next year's food supply:

$$\text{PFA}_{\text{ratio}} = \frac{\text{PFA}_{\text{total}}}{365 \text{ days year}^{-1} \times E_{hh}}$$

DATA ANALYSIS

Potential food availability across clusters

Ten percent of HHs across all farm clusters had insufficient PFA to meet their basic dietary requirements (Fig. 2). As more and more HHs are able to fulfill their food energy demands via cash crops, food crops sold, livestock, and off-farm income, the proportion of PFA that comes from the eating of food crops declines. However, only farm HHs with greater food availability ratios benefit from cash crops, indicating that a minimum amount of income and the capacity to invest is required.

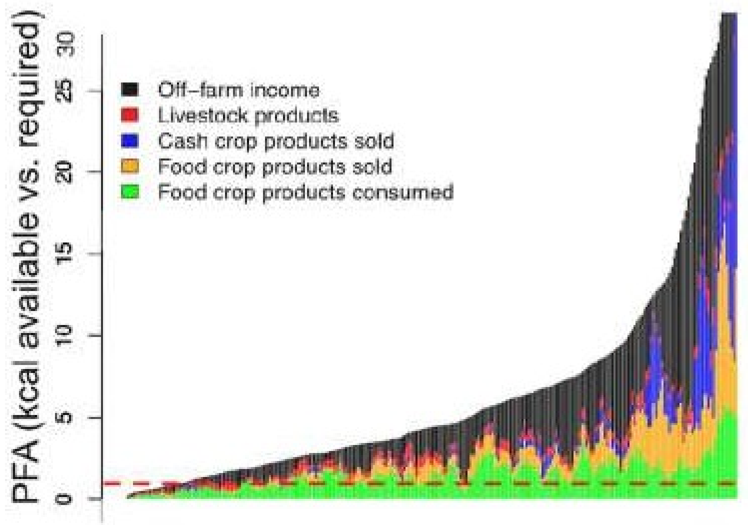

Fig. 2. Distribution of potential food availability for households observed in Bihar.

need-to-have if cash crops are going to help in feeding the world. Although livestock (representing up to 20% of the PFA) is essential for the sustenance of food security in low-income families, it does not seem to be a significant component of Bihar's agricultural systems to raise PFA generally. However, when PFA grows, the contribution of animals to PFA levels off. Finally, off-farm income is a major factor, accounting for the purchase of 40% of HH food resources.

Cluster comparisons and potential food availability

By comparing PFA ratios among agricultural system types (Fig. 3), we can see that households use a wide variety of techniques to ensure their food supply. Cluster 1 of part-time farmers rely heavily on non-farming food sources (both bought and eaten). While bigger farms were more market integrated, smaller farms tended to use their products themselves. The dietary energy needs of all but one of the HH in this cluster were consistently met. There is minimal evidence that time spent away from the farm affects the PFA ratio among the second group of farmers. Food and cash crop sales are their primary means of subsistence and possible source of revenue, with little livestock integration. These farmers have the greatest chance of food security compared to others since their observed distributions are growing at the steepest rate and 63 percent of their households can produce more than five times the food energy needed yearly. This demonstrates a skill in mitigating the dangers posed by food scarcity. The third group consists of subsistence farmers who raise a variety of crops and animals on a small scale; these farmers have the lowest PFA ratio growth rates and the lowest percentage of self-sufficient households (28%). This group of HHs relies largely on non-farm revenue, but their mixed crop-livestock systems provide a stable foundation for their PFA ratio. Despite having the lowest maximum PFA ratio (19), the right-most 9 FS-HHs in the distribution increasingly rely on non-farm sources of income.

The fourth group, medium-scale crop producers, showed the least uniformity in terms of how they made a living. Livestock is less popular than other sources of income, yet all of these activities contribute to the PFAs of various HHs. Eleven households here are struggling with hunger. Last but not least, the fifth group of underprivileged agricultural workers comprises of HHs who rely almost totally on off-farm employment to meet their food energy needs, with just a little contribution from foods grown on their own farm. Only eight households had PFA ratios of less than >1, thus even with limited resources, the vast majority of these farmers are able to satisfy the minimal calorie criterion; yet, only 28% are able to sustain PFA ratios of <5 or above.

CONCLUSION

We showed how quantitative systems analysis methods may be used to describe the variety of farming systems and evaluate how various scenarios of agricultural expansion and environmental shock can affect a basic measure of people's ability to put food on the table. Our study demonstrated that changes in crop and livestock product production, either positive or negative, can have a significant impact on food security, but that the direction of these effects will vary among individual farm households depending on their livelihood strategies and the degree to which they have diversified their farms. The five kinds of farms in our dataset have different responses to these events, we infer that families whose primary food security depends on cereal crop and animal production are at the greatest risk. Farmers that have diversified their sources of income are better equipped to withstand environmental shocks such as drought if they occur.

REFERENCE

1. John Herbert Ainembabazi & Johnny Mugisha (2014) The Role of Farming Experience on the Adoption of Agricultural Technologies: Evidence from Smallholder Farmers in Uganda, The Journal of Development Studies, 50:5, 666-679, DOI: 10.1080/00220388.2013.874556
2. Munir Ahmad et.al **"**Impact of Farm Households' Adaptations to Climate Change on Food Security: Evidence from Different Agro-ecologies of Pakistan"2015
3. Fikeremaryam Birara Feleke et.al **"**Determinants of adaptation choices to climate change by sheep and goat farmers in Northern Ethiopia: the case of Southern and Central Tigray, Ethiopia" Springer Plus (2016) 5:1692 DOI 10.1186/s40064-016-3042-3
4. Onyeneke, R.U., Igberi, C.O., Uwadoka, C.O. et al. Status of climate-smart agriculture in southeast Nigeria. GeoJournal 83, 333–346 (2018). https://doi.org/10.1007/s10708-017-9773-z
5. Eric O. Gido, Kenneth W. Sibiko, Oscar I. Ayuya & Joseph K. Mwangi (2015) Demand for Agricultural Extension Services Among Small-Scale Maize Farmers: Micro-Level Evidence from Kenya, The Journal of Agricultural Education and Extension, 21:2, 177-192, DOI: 10.1080/1389224X.2013.872045
6. Ango, T., & Bewket, W. (2009). Challenges and prospects for sustainable forest management in wondo genet area, Southern Ethiopia. Ethiopian Journal of Development Research, 29(2), 27–64. https://doi.org/10.4314/ejdr.v29i2.42709

7. Arora, N. K. (2019). Impact of climate change on agriculture production and its sustainable solutions. Environmental Sustainability, 2(2), 95–96. https://doi.org/10.1007/s42398- 019-00078-w
8. Belete, Y. (2006). Current experience on existing small scale irrigations. Best Practices and Technologies for Small Scale Agricultural Water Management in Ethiopia, 3–11.
9. Bezabih, M., Falco, S. D., & Mekonnen, A. (2014). On the impact of weather variability and climate change on agriculture: Evidence from Ethiopia. Environment for Development Discussion Paper-Resources for the Future (RFF), 14–15.
10. Connelly, L. M. (2008). Pilot studies. Medsurg Nursing, 17(6), 411–412. https://doi.org/10.1145/3081016.3081020
11. Demissie, T. K. (2019). Center for food security studies climate smart agricultural practices and its implications to food security in siyadebrina wayu Woreda, North Shewa, Ethiopia. Climatesmart Agricultural Practices, and its Implications to Food Security in Siyadebrina Wayu.
12. Dessie, G., & Kinlund, P. (2008). Khat expansion and forest decline in wondo genet, Ethiopia. Geografiska Annaler, Series B: Human Geography, 90(2), 187–203. https://doi.org/10.1111/ j.1468-0467.2008.00286.x
13. The Energy and Resources Institute. (2006). Adaptation to Climate Change in the Context of Sustainable Development (Background Paper) (pp. 1–29). https://sustainabledevelopment.un.org/content/documents/1490adaptation_paper.pdf
14. Justin, C. O., Wiliams, C. E., & Vera, T. S. (2017). Understanding the factors affecting adoption of subpackages of CSA in Southern Malawi. International Journal of Agricultural Economics and Extension, 5(2), 259–265. www.internationalscholarsjournals.org
15. Kim, K. (2014). Determinants of household food security in Rural Ethiopia: An empirical analysis. Journal of Rural Development/ Nongchon-Gyeongje, 37(2), 1–29.