Perception of Farmers towards Climate Change Impact on Agriculture Production and Adaptation Practices in Pokhara

Ananta Raj Dhungana, Assistant Professor
School of Development and Social Engineering, Pokhara University, Nepal

ABSTRACT
Climate change has become serious problem which has threatened human civilization in many ways. Although adaptation practices against climate change impact have been explored into practice in massive scale, the impact of climate change in agriculture production is challenging. This study aims to explore the farmers’ perception towards climate change impact on agriculture production and adaptation practices in Pokhara. For this purpose, two wards (30 and 33) of Pokhara were selected purposively. Out of 3,982 households in these wards, 216 households (at 6.5% margin of error and 5% level of significance) were selected for the information collection. Then the information was collected by using structured questionnaire through interview techniques with household head or a household member having age 40 years and over and residing in that locality for last 10 years. A systematic sampling technique was carried out to select the samples. Chi-squared test was applied to find the factors associated with farmers’ adaptation practices for the climate change impact on agriculture production. Rice, maize, wheat, mustard and millet are the major crops in the study area. Majority of the respondents perceived increase in rice production, decrease in maize, wheat and millet production, and no change in mustard production. Majority of the respondents increase the use of improved seeds, chemical fertilizer and pesticides, do not change the cropping pattern and cropping altitude for the adoption of climate change in agriculture production. Use of seeds that can be cultivated in any seasons, fertilize of compost manure production on own field, water collection through pond, water and tank, tunnel crop, practice of off seasons crops are some adoption practices that they could not apply or they did not apply. Agriculture skill and the major occupation of the respondents are the common major factors associated with adaptation practices for climate change impact on agriculture production.

KEYWORDS: Adaptation practices, agriculture production, climate change, farmer, perception

INTRODUCTION
The scientific evidence has shown that climate change is a global challenge facing humans and their socio-economic activities, health, livelihood, and food security (Romieu, Welle, Schneiderbauer, Pelling, & Vinchon, 2010; Amjath-Babu, Krupnik,)
Aravindakshan, Arshad, & Kaechele, 2016). Agriculture is one of the main economic activities of Nepal and about two-thirds of the population employs on it (CBS, 2017). In Zimbabwe, maize productivity in some agricultural production zones may decrease primarily as a result of temperature increases (Makadho, 1996; Jones & Thornton, 2003). The projected mean change in yield of all crops is −8% by the 2050s in Africa and South Asia. Across Africa, mean yield changes of −17% (wheat), −5% (maize), −15% (sorghum) and −10% (millet) and across South Asia of −16% (maize) and −11% (sorghum) were estimated. No mean change in yield was detected for rice (Knox, Hess, Daccache & Wheeler, 2012).

Nepal is no exception in being country vulnerable to the impacts of climate change due to its fragile mountain ecosystem, weak geological condition and diverse nature climate. Nepal may experience a great impact even with the slight changes over the natural climate system. Moreover, being a developing country, Nepal has low adaptive capacity to cope with the effects of climate change. Different sectors, directly linked to livelihoods of Nepalese people such as agriculture, health, water resources, biodiversity and forest, and natural disasters are destined to bear the brunt of climate change irrespective of fact that Nepal has negligible share in global emission of green house gases (GHG). This clearly indicates that country like Nepal needs to be prepared for adopting changing climate. The policy and action should focus to adopt a combined strategy of reducing GHG emission and adaptation to the impacts of climate change consistently at global, regional, national and local level (NAST, 2013).

Though climate change is a global phenomenon, it has highly localized impacts and needs adaptation at the local level (Agrawal, Perrin, Chhatre, Benson & Cononen, 2009; UNCDF, UNDP & UNEP, 2010).

In countries like Senegal, China, Ghana, Nepal, Bangladesh, Nigeria, United States of America, farmers have been mentioned to perceive and even adapt to changes in the climate (Mertz, Mbow, Reenberg, & Diouf, 2009; Byg & Salick, 2009; Fosu-Mensah, Vlek, & Manschadi, 2010; Maharjan, Sigdel, Sthapit, & Regmi, 2011; Haque, Yamamoto, Malik, & Sauerborn, 2012; Salau, Onuk, & Ibrahim, 2012; Arbuckle, Morton, & Hobbs, 2013). Socioeconomic and environmental factors have been demonstrated in various studies to influence farmers’ perception and adaptation to changes in the climate (Deressa, Hassan, & Ringler, 2011), those include education, household size, livestock ownership, agro-ecological zone, farm size and access to credit among others.

As previous authors have found, perception and coping strategies to climate change are influenced by a number of socioeconomic and environmental factors (Nhemachena & Hassan, 2007; Deressa, Hassan, Ringler, Alemu, & Yusuf, 2009; Nhemachena, 2009). Overall impacts of climate change on both crops and livestock appear to be highly negative, much more on maize (62.8%), yam (52.2%), poultry (67%) and cattle (63.2%). Smallholder farmers are particularly vulnerable to climate change since the majority of them do not have enough resources to cope (Ayanlade, Radeny, & Morton, 2017).

Khanal, Wilson, Hoang and Lee, (2018) found that the adaptation strategies employed by farmers significantly increase rice yields. Furthermore, results indicate that both adapters and non-adapters would benefit from the adaptation of the identified strategies. This study, therefore, provides supportive evidence for policy makers to take into consideration farmers’ existing knowledge and skills in adapting to climate change. The findings show that it is imperative to involve farmers in climate change adaptation planning processes if the full benefits of such policy action are to be realized.
While this information on farmers’ perceptions towards climate change impact on agriculture production and adaptation practices have been more evident, there have not been done sufficiently such type of study in the particular area of mid hill part of Nepal. In overall climate change trend, Kaski has been identified as very high risk (0.580-1.00) (NAPA, 2010). Therefore, this study aims to fill the gap for exploring the perception of people towards climate change impact on agriculture production and adaptation strategies for climate change impact on agriculture production in Pokhara.

DATA AND METHODS

As this study aims to explore the farmers’ perception towards climate change impact on agriculture production and adaptation practices in Pokhara, exploratory type of research design was applied for this study. Further it also found the factors associated with some adaptation practices of farmers against climate change impact on agriculture production. Multistage sampling technique was applied for choosing the study units. In overall climate change trend Kaski have identified as very high risk (0.580-1.00) (NAPA, 2010). So, at first mid hill part of western Nepal i.e. Kaski District is selected purposively. At second stage, as ward number 33 of Pokhara Metropolitan City (which was previously rural VDC) which is still rural setting of Kaski and ward number 30 which is semi-urban setting are selected purposively. From 3,982 households of these wards, 216 households (at 6.5% margin of error and 5% level of significance) were selected for the information collection. At final stage, a household head or a household member having age 40 years and over and residing in that locality for last 10 years were considered as an ultimate respondent for interview and were selected by using systematic sampling techniques in the interval of eighteen households. If the criteria of the respondent for the selected household did not meet, the respondent from next household was selected. Both descriptive as well as inferential statistics were used for this study. Chi-squared test was applied to find the factors associated with some adaptation practices for the climate change impact on agriculture production.

FINDINGS

Based on the information collected from 216 respondents, this study has the following findings regarding farmers’ perception towards climate change impact on agriculture production and adaptation practices against climate change impact on agriculture production as well as the factors associated with some adaptation strategies.

Farmers’ Perception towards Climate Change Impact on Agriculture Production

Here, farmers’ perception towards climate change impact on agriculture production is explored. For this, the respondents were asked to mention any four major agriculture productions and their situation as increase, decrease, do not know and no change. The major crops of the respondents in the study area are rice, maize, wheat, mustard and millet. All the respondents are aware about the climate change impact on agriculture production.

Perception towards Major Production

Rice is one of the major crops of all the respondents in study area. Out of these 216 respondents, majority (56.96%) of the respondents’ perception about rice production is that it is increased followed by no change (29.6%), and decrease (13.4%). Further, maize is another major crop of 98 percent respondents in the study area. Among 210 respondents, majority (41.9%) of the respondents’ perception about maize production is that it is decreased followed by increase (30%) and no change (28.1%). Similarly, wheat
is another major crop of more than one third (36.1%) respondents. Out of 78 respondents, majority (48.7%) of the respondents’ perception about wheat is that it is decreased followed by no change (32.2%) and increased (19.2%). Millet is the fourth major crop of around one third respondents. Among 73 respondents, majority (39.7%) of the respondents’ perception about millet is that it is decreased followed by increase (34.2%) and no change (26%). Finally, mustard is another major crop of more than one fifth respondents. Out of 50 respondents, majority (42%) of the respondents’ perception about mustard is that there is no change in the production followed by increased (34%) and decrease (24%).

Table 1: Perception on major crops production

| Crops | Increase | | Decrease | | No change | | Total |
|-------|----------|---------|----------|---------|----------|---------|-------|
|       | N        | %       | N        | %       | N        | %       | N     |
| Rice  | 123      | 56.9    | 29       | 13.4    | 64       | 29.6    | 216   |
| Maize | 63       | 30      | 88       | 41.9    | 59       | 28.1    | 210   |
| Wheat | 15       | 19.2    | 38       | 48.7    | 25       | 32.2    | 78    |
| Millet| 25       | 34.2    | 29       | 39.7    | 19       | 26      | 73    |
| Mustard| 17   | 34      | 12       | 24      | 21       | 42      | 50    |

Source: Field Survey, 2018

Perception on Climate Change as a Problem in Agriculture Production and Reduction

In this section, perception of the respondents on climate change as a serious problem in agriculture production and its reduction is explored. The perception is explored with some scale as strongly agree, agree, neutral, and strongly disagree. Almost three fifth (74.1%) of the respondents are strongly agree with the statement that climate change is a serious problem in agriculture production. Further one fourth of the respondents are agreeing with the above statement. Very few of the respondents are neutral with that statement.

Similarly, more than half (50.5%) of the respondents are strongly agree with the statement that climate change impact in agriculture can be reduced followed by agree (39.9%) and neutral (9.3%) respectively. Very few i.e. one of the respondents is strongly disagree about the statement that climate change impact in agriculture can be reduced. For that respondent, climate change is automatic process that nobody can stop it.

Table 2: Perception on climate change in agriculture production and its reduction

| CC is a serious problem | Frequency | Percent |
|------------------------|-----------|---------|
| Strongly agree         | 160       | 74.1    |
| Agree                  | 54        | 25.0    |
| Neutral                | 2         | 0.9     |

| Climate change impact in agriculture can be reduced | Frequency | Percent |
|------------------------------------------------------|-----------|---------|
| Strongly agree                                       | 109       | 50.5    |
| Agree                                                | 86        | 39.8    |
| Neutral                                              | 20        | 9.3     |
| Strongly disagree                                    | 1         | 0.5     |

Total 216 100.0

Source: Field Survey, 2018
Adaption and Coping Strategies of the Respondents

There are different adaption and coping strategies of respondents for climate change. Here, adaptation and coping strategies towards irrigation facility, improved irrigation facility, use of water pumps, use of pond construction, use of well construction, use of improved seeds, use of compost fertilizer, use of chemical fertilizer, use of pesticides, use of cropping pattern and use of cropping altitude are explored.

Irrigation Facility

More than one third of the respondents (36.6%) have increased the irrigation facility for the adaption of climate change impact on agriculture production. More than one fifth (27.3%) of the respondents has decreased the irrigation facility. Almost one third of the respondents responded that there is no change in irrigation facility.

Table 3: Irrigation facility

| Irrigation Facility | Frequency | Percent |
|---------------------|-----------|---------|
| Increase            | 79        | 36.6    |
| Decrease            | 59        | 27.3    |
| No change           | 67        | 31.0    |
| Do not know         | 11        | 5.1     |
| Total               | 216       | 100.0   |

Source: Field Survey, 2018

Improved Irrigation Facility

Almost two third of the respondents have never used the improved irrigation facility where around one third have always used the improved irrigation facility and very few of the respondents have sometimes used the improved irrigation facility.

Table 4: Improved irrigation facility

| Improved Irrigation Facility | Frequency | Percent |
|------------------------------|-----------|---------|
| Never                        | 142       | 65.7    |
| Sometimes                    | 5         | 2.3     |
| Always                       | 69        | 31.9    |
| Total                        | 216       | 100.0   |

Source: Field Survey, 2018

Use of Improved Seeds and Compost Fertilizer

Almost all the respondents have increased the use of improved seeds for the adaption of climate change for agriculture production. Very few have decreased the use of improved seeds. Almost half of the respondents replied that there is decrease in the use of compost fertilizer for agriculture production. More than two fifth of the respondents have increased the use of compost fertilizer for agriculture production.

Table 5: Use of improved seeds and compost fertilizer

| Use of Improved Seeds | Frequency | Percent |
|-----------------------|-----------|---------|
| Increase              | 211       | 97.7    |
| Decrease              | 2         | 0.9     |
Use of Compost Fertilizer

| Use of Compost Fertilizer | Frequency | Percent |
|---------------------------|-----------|---------|
| Increase                  | 96        | 44.4    |
| Decrease                  | 104       | 48.1    |
| No change                 | 14        | 6.5     |
| Do not know               | 2         | 0.9     |
| Total                     | 216       | 100.0   |

Source: Field Survey, 2018

Use of Chemical Fertilizer and Pesticides

Almost nine tenth (88.4%) of the respondents have increased the use of chemical fertilizer for the adaption of climate change for agriculture production. Almost one tenth of the respondents have not changed the use of chemical fertilizer for the adaption of climate change for agriculture production. Very few have decreased the use of chemical fertilizer. More than half of the respondents have increased the use of pesticides for the adaption of climate change for agriculture production. Almost one third of the respondents do not know about the use of pesticides for the adaption of climate change for agriculture production. More than one tenth of the respondents do not change in the use of pesticides for agriculture production. Very few of the respondents have decreased the use of pesticides for agriculture production.

Table 6: Use of chemical fertilizer and use of pesticides

| Use of Chemical Fertilizer | Frequency | Percent |
|---------------------------|-----------|---------|
| Increase                  | 191       | 88.4    |
| Decrease                  | 6         | 2.8     |
| No change                 | 18        | 8.3     |
| Do not know               | 1         | 0.5     |

| Use of Pesticides | Frequency | Percent |
|-------------------|-----------|---------|
| Increase          | 115       | 53.2    |
| Decrease          | 8         | 3.7     |
| No change         | 24        | 11.1    |
| Do not know       | 69        | 31.9    |
| Total             | 216       | 100.0   |

Source: Field Survey, 2018

Use of Cropping Season and Cropping Altitude

More than half of the respondents do not change the cropping season whereas almost forty six percent of the respondents change the cropping season for adaptation of climate change for agriculture production. Similarly almost two third of the respondents do not change the cropping altitude whereas more than one third of the respondents change the cropping altitude for adaptation of climate change for agriculture production.

Table 7: Use of cropping season and cropping altitude

| Use of Cropping Season | Frequency | Percent |
|------------------------|-----------|---------|
| Change                 | 98        | 45.4    |

Source: Field Survey, 2018
Knowledge about any Adoption Practice that did not or could not Apply

More than four fifth of the respondents are not familiar with other adoption practice that they did or could apply. Whereas more than one tenth of the respondents are familiar with some adoption practices that they did not or could not apply. Use of seeds that can be cultivated in any seasons, Fertilize of compost manure production on own field, water collection through pond, water and tank, tunnel crop, practice of off seasons crops are some adoption practices that they could not apply or they did not apply.

Table 8: Knowledge about any adoption practice that did not or could not apply

| Knowledge | Frequency | Percent |
|-----------|-----------|---------|
| Yes       | 26        | 12.0    |
| No        | 190       | 88.0    |
| Total     | 216       | 100.0   |

Factors Associated with Use of Cropping Season and Use of Cropping Altitude

Among the different adaptation practices for climate change impact on agriculture production by the farmers, this section shows the different factors associated with use of cropping season and use of cropping altitude to adapt the climate change impact on agriculture production. For this, chi-squared test was applied.

It is found that there is significant association of use of cropping season with age, educational status, major occupation, agriculture skill and location of the respondents at one percent level of significance (P<0.01). However there is no any significant effect of sex, caste/ethnicity, and farming experience in the use of cropping season of the respondents for the adaption of climate change impact on agriculture production.

Similarly there is significant association of use of cropping season with location of the respondents at one percent level of significance (P<0.01). Further there is significant association of use of cropping altitude with educational status, caste/ethnicity and major occupation of the respondents at five percent level of significance (P<0.05). However there is no any significant effect of sex, age, agriculture skills and farming experience in the use of cropping altitude of the respondents for the adaption of climate change impact on agriculture production. It shows that age, agriculture skill, education, major occupation and location of the respondents are the major factors associated with use of cropping season for the adaptation of the climate change impact on agriculture production. Further agriculture skill, caste/ethnicity and major occupation of the respondents are the major factors associated with use of cropping altitude for the adaptation of the climate change impact on agriculture production.
Table 9: Factors associated with the use of cropping season and the use of cropping altitude

| Variables          | Use of Cropping Season | Use of Cropping Altitude |
|--------------------|------------------------|--------------------------|
|                    | Change | No Change | Change | No Change |
| Age                |        |           |        |           |
| Upto 60 years      | 65     | 30.1      | 97     | 44.9      | 48     | 22.2      | 114    | 52.8 |
| > 60 years         | 33     | 15.3      | 21     | 9.7       | 25     | 11.6      | 29     | 13.4 |
| Sex                |        |           |        |           |
| Male               | 67     | 31.0      | 80     | 37.0      | 49     | 22.7      | 98     | 45.4 |
| Female             | 31     | 14.4      | 38     | 17.6      | 24     | 11.1      | 45     | 20.8 |
| Educational Status |        |           |        |           |
| No Formal Education| 40     | 18.5      | 11     | 5.1       | 33     | 15.3      | 18     | 8.3  |
| Primary            | 29     | 13.4      | 52     | 24.1      | 21     | 9.7       | 60     | 27.8 |
| Lower              | 15     | 6.9       | 16     | 7.4       | 12     | 5.6       | 19     | 8.8  |
| Secondary          |        |           |        |           |
| Secondary and above| 14     | 6.5       | 39     | 18.1      | 7      | 3.2       | 46     | 21.3 |
| Caste/Ethnicity    |        |           |        |           |
| Brahmin            | 46     | 21.3      | 50     | 23.1      | 27     | 12.5      | 69     | 31.9 |
| Chhettri           | 11     | 5.1       | 27     | 12.5      | 9      | 4.2       | 29     | 13.4 |
| Dalit              | 7      | 3.2       | 13     | 6.0       | 5      | 2.3       | 15     | 6.9  |
| Janajati           | 34     | 15.7      | 28     | 13.0      | 32     | 14.8      | 30     | 13.9 |
| Major Occupation   |        |           |        |           |
| Agriculture        | 36     | 16.7      | 65     | 30.1      | 23     | 10.6      | 78     | 36.1 |
| Non-agriculture    | 62     | 28.7      | 53     | 24.5      | 50     | 23.1      | 65     | 30.1 |
| Agriculture Skill  |        |           |        |           |
| Yes                | 71     | 32.9      | 58     | 26.9      | 52     | 24.1      | 77     | 35.6 |
| No                 | 27     | 12.5      | 60     | 27.8      | 21     | 9.7       | 66     | 30.6 |
| Farming Experience(Years) |        |           |        |           |
| 10- 20             | 51     | 23.6      | 61     | 28.2      | 43     | 19.9      | 69     | 31.9 |
| 21-30              | 32     | 14.8      | 37     | 17.1      | 23     | 10.6      | 46     | 21.3 |
| 31 and above       | 15     | 6.9       | 20     | 9.3       | 7      | 3.2       | 28     | 13.0 |
| Location           |        |           |        |           |
| Ward 30            | 69     | 31.9      | 13     | 6.0       | 52     | 24.1      | 30     | 13.9 |
| Ward 33            | 29     | 13.4      | 105    | 48.6      | 21     | 9.7       | 113    | 52.3 |

(P-value is based on chi-squared test)
Source: Field survey, 2018

CONCLUSION
Based on the information collected from two hundred and sixteen respondents, rice, maize, wheat, mustard and millet are the major crops in the study area. All the respondents are aware about the climate change impact on agriculture production.
Majority of the respondents perceived increase in rice production, decrease in maize production, wheat production and millet production, no change in mustard production. Majority of the respondents increase the use of improved seeds, the use of chemical fertilizer and pesticides, do not change the cropping pattern and cropping altitude for the adoption of climate change in agriculture production. Use of seeds that can be cultivated in any seasons, fertilize of compost manure production on own field, water collection through pond, water and tank, tunnel crop, practice of off seasons crops are some adoption practices that they could not apply or they did not apply. Agriculture skill and the major occupation of the respondents are the common major factors associated with adaptation practices for climate change impact on agriculture production.

ACKNOWLEDGEMENTS
I would like to acknowledge the students of School of Development and Social Engineering, Pokhara University, Rajan Pun, Bishwa Prakash Bhattarai and Yeknath Acharya for their valuable effort during data collection. Further, I would like to acknowledge Pokhara University Research Center (PURC), Pokhara University for providing grant to do this research.

REFERENCES
Agrawal, A., Perrin, N., Chhatre, A., Benson, C. & Cononen, M. (2009). Climate policy processes, local institutions and adaptation actions: Mechanisms of translations and influence. Social Development Paper 119. Washington D.C: The World Bank, pp. 1-16.

Amjath-Babu, T., Krupnik, T. J., Aravindakshan, S., Arshad, M., & Kaechele, H. (2016). Climate change and indicators of probable shifts in the consumption portfolios of dryland farmers in Sub-Saharan Africa: Implications for policy. Ecological Indicator, 67, 830-838.

Arbuckle, J. G., Morton, L. W., & Hobbs, J. (2013). Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. Climatic Change, 118, 551-563. http://dx.doi.org/10.1007/s10584-013-0700-0

Ayanlade, A., Radeny, M. & Morton, J. F. (2017). Comparing smallholder farmers’ perception of climate change with meteorological data: A case study from southwestern Nigeria. Weather and Climate Extremes,15, 24-33.

Byg, A., & Salick, J. (2009). Local perspectives on a global phenomenon-Climate change in Eastern Tibetan villages. Global Environmental Change, 19, 156-166.

CBS. (2017). Central Bureau of Statistics, Nepal.

Deresa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yusuf, M. (2009). Determinants of farmers’ choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Global Environmental Change, 19(2), 248-255.

Deresa, T. T., Hassan, R. M., & Ringler, C. (2011). Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. Journal of Agricultural Science, 149(1), 23-31. http://dx.doi.org/10.1017/S0021859610000687

Fosu-Mensah, B. Y., Vlek, P. L. G., & Manschadi, A. M. (2010). Farmers’ Perception and Adaptation to Climate Change: A Case Study of Sekyedumase District in Ghana. Paper presented at Tropentag 2010 “World Food System-A Contribution from Europe”. 14-16th September, 2010, Zürich, Switzerland.

Haque, A., Yamamoto, S. S., Malik, A. A., & Sauerborn, R. (2012). Households’ perception of climate change and human health risks: A community perspective. Environmental Health, 11(1), 1-12. http://dx.doi.org/10.1186/1476-069X-11-1
Jones, P.G. & Thornton, P. K. (2003). The potential impacts of climate change on maize production in Africa and Latin America in 2055. Global Environmental Change, 13, 51-59.

Khanal, U., Wilson, C., Hoang V. & Lee, B. (2018). Farmers’ adaptation to climate change: Its determinants and impacts on rice yield in Nepal. Ecological Economics, 144, 139-147.

Knox, J., Hess, T., Daccache, A., & Wheeler, T. (2012). Climate change impacts on crop productivity in Africa and South Asia. Environmental Research Letters, 7(3), 1-8.

Maharjan, V., Sigdel, E. R., Sthapit, B. R., & Regmi, B. R. (2011). Tharu community’s perception on climate changes and their adaptive initiations to withstand its impacts in Western Terai of Nepal. International NGO Journal, 6(2), 35-42.

Makadho, J. M. (1996). Potential effects of climate change on corn production in Zimbabwe. Climate Research, 6, 147-151.

Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel. Environmental Management, 43(5), 804-16. http://dx.doi.org/10.1007/s00267-008-9197-0

NAPA. (2010). Nepal’s National Adaptation Programme of Action.

NAST. (2013). Environment and Natural Resources. Nepal Academy of Science and Technology. Kathmandu.

Nhemachena, C. (2009). Agriculture and future climate dynamics in Africa: Impacts and adaptation options. Ph.D. Thesis. Department of Agricultural Economics, Extension, and Rural Development, University of Pretoria, South Africa.

Nhemachena, C., & Hassan, R. (2007). Micro-level analysis of farmers’ adaptation to climate change in Southern Africa. IFPRI Discussion Paper 714. International Food Policy Research Institute. Washington DC, USA.

Romieu, E., Welle, T., Schneiderbauer, S., Pelling, M., & Vinchon, C. (2010). Vulnerability assessment within climate change and natural hazard contexts: revealing gaps and synergies through coastal applications. Sustainability Science, 5(2), 159-170.

Salau, E. S., Onuk E. G., & Ibrahim, A. (2012). Knowledge, perception and adaptation strategies to climate change among farmers in Southern agricultural zone of Nasarawa State, Nigeria. Journal of Agricultural Extension, 16(2), 199-211.

UNCDF, UNDP & UNEP. (2010). Local governance and climate change. United Nations Climate Development Fund, United Nations Development Program and United Nations Environment Program.