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The Fight Against Climate Change: Adaptive and Strategies Activities Among Farmers

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ABSTRACT

Farmers are the ones who provide food to the people in the society and they are considered to be heroes of today. This study was conducted to determine the challenges experienced by farmers related to climate change, their coping strategies, and different means to ensure crop yield. Qualitative-phenomenology was employed. Findings revealed that farmers experienced failure due to unpredictable weather patterns, bad harvest, slow growth of crops, low quality of fruits, costs them much expenses with loss of capital because of climate change. They cope by employing waterworks and waited for government's assistance. To ensure crop yield, they applied fertilizers, chemicals, and waterworks.

INTRODUCTION

Farmers are the ones who provide food to the people in the society and they are considered to be the heroes of today. Being one take some skills, courage and determination to face all the difficulties and obstacles especially regarding to climate change. Climate change is one of the opponent of farmers for it can affect the growth, development and productivity of the crops.

The Philippines is located near the equator and is surrounded by ocean which makes it as one of the countries that is at risk of climate change. The most affected in this kind of phenomenon are in the field of agriculture specifically the farmers (Defiesta & Rapera, 2014). The negative effect of climate change are potentially evident in this time, which triggers farmers to have an agricultural adaptation in an instant. There are many options that farmers can practice in order to fight against the possible impact of the said phenomena and improve their cropping system (Howden et al., 2007). The current and available products for agriculture have been examined to create new technologies that are more efficient in ensuring crop yield (Rosegrant et al., 2015).

Due to the effect of climate change, many farmers specially the small-holders have lost their livelihood and led them in such deep problems (Chandra et al., 2011). The Philippine economy is projected to cost much money by year 2050 due to the impact of climate change in the field of agriculture (Rosegrant, et al., 2015). Adaptation strategies that will help increase the productivity growth in agriculture is expected to minimize the negative effect of climate change in the society (Rosegrant et al., 2015). The current strategies of farmers in their field can be enhanced or improved in order to significantly reduce the impact of climate change. As the years will pass by, the farmers can get more knowledge in the field that they are in and with this, they can get new techniques and strategies that are more effective than the previous ones (Lasco et al., 2011).

This study is significant among the farmers. It will help them think for the better strategies in order to combat climate change and increase crop yield. Moreover, this study is qualitative where it employed phenomenology. Though there were similar studies conducted (Ayeri et al., 2012; Hirpa et al., 2020), however, these were conducted in Africa. Some studies in the Philippines are on the contexts of case studies (Feola et al., 2015; Escarcha et al., 2020). Therefore, there was an urgency to conduct this study in the local contexts.

Correspondingly, this will give insights on the challenges faced by the farmers against climate change. The findings will serve as an additional bodies of knowledge to the farmers and to the different governmental agencies. Thus, this study was conceptualized and pursued.

Research Questions

1. What are the challenges experienced by farmers related to climate change?
2. How do farmers cope with this phenomenon?
3. What are the different means employed by farmers to ensure crop yield?

DATA & METHOD

This research study employed qualitative phenomenological research design. It aimed to understand and interpret a phenomenon making it a qualitative research and having phenomenological research design will enable the informants to share their experiences and give thoughts on a phenomenon based from their corresponding experiences (Gallagher, 2012). Qualitative phenomenology is an approach to research that centers on the experience of a person that answers a particular problem (Husserl & Gibson, 1983).

There were ten (10) informants in this study. The informants were selected through purposive sampling in which they were chosen based on the qualities they possess (Tongco, 2007; Etikan & Bala, 2017). Moreover,

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criterion-based sampling had been utilized since there were criteria set by the researcher in choosing the informants (Gehart et al., 2001). The criteria set for this study is that they are farmers who work on their own farm for at least five years. Five (5) informants took part as Key Informants and another five (5) for the Focus Group Discussion (FGD).

RESULTS AND DISCUSSIONS

Challenges experienced by farmers related to Climate change

Failure due to unpredictable weather patterns

Farmers revealed that due to unpredictable weather patterns they experienced failure in their farms. The unpredictable weather patterns had caused slow growth and damage to their crops which leads to the farmers' downfall. As the years pass by, climate change is getting worse which heavily affected the agricultural sector.

Due to the continuous unpredictable weather, they end up crop failures, reduced water level in tanks and wells to support their crops and new pest and diseases were found. Thus, they are trying to adapt this kind of phenomenon (Varadan & Kumar, 2014). Learning how the farmers notice the way rainfall uncommonly change is indeed important to know. Especially, looking forward to the effects of unusual changing climate patterns. Most of the farmers think that the rainfall usually starts earlier and end later. In the meteorological data, there's no evidence given to support on how the farmers think of the usual rainfall that would start as early as September or October. There is only one explanation the farmer's vision and meteorological evidence is that unusual rainfall changes can fluently confused with the changes in farming system (Simelton et al., 2013). The way farmer's see on how rainfall is changing is indeed important, especially expecting the possible effects of climate change. Nonetheless, even within the same location, people may think rainfall changes differently. The purpose of this they suggest to control the possible climate change impact scenarios need to be grounded, along the farmers & prolonging workers' understandings of how the weather is changing more carefully in order to improve the policy to implement (Simelton et al., 2011).

Bad harvest

Harvest is one of the awaited moment for the farmers for their crops. But due to the climate change, the farmers revealed that they may experience a bad harvest due to damaged crops. This will result to a poor income and low profit, and worst if they will not gain any and loss their capital. As the years pass by, a lot of agriculture policy analysts have discussed that incompletely subsidized crop insurance would be a more efficient and equitable way to protect farmers from disaster than unconsidered disaster aid.

Regardless of the high expectation and promises of the insurance of the crop redeem the efforts, it is doubtful

that the benefits of the nation have outreach the taxpayer cost (Skees, 2001). The assessment of climate impacts especially on water resources shows that an increase in average water availability in Russia, but it also has an enough increased frequency of high turnout events portion of central Russia, and more periodical how turnout events in the portion which is already dry crop growing regions in the South. These results shows that the increasing condition of extreme climate will act an huge threat not just the water resources, but also the food system of Russia (Alcamo, 2007).

Slow growth of crops

The season can affect the growth of the plants. The farmers revealed that during dry season, one of their problems is that the plants are growing slow and making it to become stunt. This will lead to a long time for plants to become fully developed. Both changes and temperature variability can affect crop processes.

Some crop processes, often associated with boom like photosynthesis and breathing, show non-stop and primarily nonlinear changes in their rates as temperature increases. Improvement and development rates through a lifestyle of crops (Porter & Semonov, 2009). Additionally, sources of growth in agricultural productivity are multifaceted and consist of funding levels for public and private look-up and development, soil quality adjustments, mineral fertilizer availability and rate, CO₂ and ozone (O₃) atmospheric concentrations, and temperature (T) and precipitation (P) changes (Lobell & Gourdji 2012).

Solar radiation affects crop growth and productivity deeply. Photosynthesis is generally impaired during the rainy season due to reduced light intensity and duration caused by the excessively cloudy weather. This is a major constraint on tropical rice productivity and production (Yoshida 1981). In different growth phases, the solar radiation requirements of a rice crop differ (Yoshida & Parao, 1976). Shading slightly affects rice growth and yield during the vegetative growth phase, while shading during the reproductive phase has a pronounced effect on sink capacity (spikelet number per panicle and per unit land area). Shading significantly reduces grain yield during maturation due to a spikelet sterility spurt (Yoshida, 1981).

Quality of the fruits are affected

The quality of fruit is one of the factor in knowing what will be the income of the farmers. It was discovered that because of high temperature, the fruits of the plants become undersized and causing it to have a meager harvest in the farm. Abiotic stress potential has a huge impact on the quality and nutrition within the fresh cut fruits and vegetables.

Nevertheless, it has been directed to defining and documenting the abiotic stresses that happen during fresh cut processing, packaging and also storage (Hodges & Toivonen, 2008). Peppers are very known vegetables not just of their color and taste, but the nutritional value contains within. The levels of Vitamins C, phenolic

compounds and carotenoids are increased when they're fully develop or matured enough. Moreover, peppers grown under an organic culture which had a higher Vitamin C, henolic and carotenoid rather than those grown under conventional culture (Perez-Lopez et al., 2007).

Costs much expenses and loss of capital

Having a farm really needs money for finances. Due to the climate change, farmers revealed that they spent too much expenses than before and experienced losing their capital because of damaged crops due to the heat. This caused them some difficulties in producing more harvests. Thus, their finances were also affected.

The increase of temperature has brought negative response in the global yield in which the annual income for crops nationwide has reduced 5 billion dollars per year since 1981 until 2002 as stated by Lobell and Field (2007). Drought will be a problem to poor farmers because with this they might lost their investments for the crops in the farm and worse, they may go into a debt (Pandey et al., 2007). The use of pesticides to increase the productivity rate and destroy the pests in the farm has resulted in the increase of costs which affects the profit of the farmers (Wilson & Tisdell, 2001). Moreover, farmers who uses organic do not earn higher than the synthetic users, they who earns a high income had spent higher production expenses also thus both of them had a little profit for their hard work (Uematsu & Mishra, 2012).

Exhausting and tiresome

Due to the effect of climate change, it was discovered that farmers need to work hard to ensure that their crops will live even though it is dry season. They do many works to the point where they feel exhausted and tired. It can be reiterated by the mere fact they only earn a meager amount from their produce.

Working in the farm, farmers cannot avoid having an unfavorable body posture and with this, farmers experienced fatigue in the body especially in lower back and shoulders (Maeda et al., 1980). In relation to this, farmers are prone to having low back pain and musculoskeletal disorder because of the activities they do in the farms such as working with wrong body posture and doing physical work load like lifting and carrying loads (Solecki, 2011).

Plants will be dehydrated

Farmers revealed that too much heat brought by climate change, the plants will become dehydrated. Having not enough source of water, the plants cannot sustain nutrients needed by the plants thus it will become wither. A wide range of period having water deficit or the lack of water supply in the farm can cause drought stress and dehydration to the plants (Ingram & Bartels, 1996). In addition, some plants have a little capacity of dehydration tolerance and most of it die due to low water potential

(Oliver, Cushmad & Koster, 2010).

Ways farmers cope with Climate Change

Employ Waterworks

Water is essential for the growth and development of plant. It was discovered that during dry season, the farmers are doing waterworks to ensure that their crops stay alive even if there is no rain.

Having efficient supply of water can be the determinant in the farmers' crops yield and as for the resistance of the crops to drought and dehydration (Blum, 2009). Similarly, crop growth is strongly dependent on the moisture of the soil that was stored from the out-of-season rain and farmers improved and maintain it by doing water works (Condon, et al., 2002). Additionally, by doing water works through irrigation can help the plants develop and grow under different condition of the weather (Doorenbos & Kassam, 1979).

Wait for the assistance from the government

Farmers revealed that the effect of climate change cannot be easily coped up if doing it alone. The reason why farmers rely on the assistance from the government and also join in association in which they can received help. Investments by government and donors are undoubtedly the best way to finance risk assessments and start-up prices for market development. Government support wherever the government is in the type of premium subsidies. Paying a certain amount of total insurance premiums can very well hamper adaptation by encouraging households to maintain or increase investment in unsustainable livelihoods.

A less distorting structure of government support in progress is to divide the hazard into a moderately severe layer of business and a particularly severe social layer. Regardless of whether investments are built by governments and donors to support insurance markets, they should be carefully considered in light weight of their chance prices as adaptation desires outweigh current levels of funding (Collier et al., 2009). Contrary to governmental views, their programs are usually viewed in an unfavorable manner, and therefore there is a demand to evaluate the effectiveness of export programs also facilitate as a result of the ways in which customized businesses generate user awareness. There is evidence of a lack of understanding between government and small business on the role and value of existing export programs facilitate the small sample base.

Future programs must reflect on the wishes of the small bourgeois \$64,000 and recognize their entirely different stages of development, variable periods of overseas involvement and export expertise (Albaum, 1983). Some government payments to farmers also translate into financial gain for merchants offering inputs from seed, fertilizer, machinery, and alternative production. Lenders benefit from enhanced farm borrowers ' reimbursement capacity and reduced risk on portfolios of farm loans.

As native economic multipliers create ripple effects from the additional income across the agricultural community, alternative indirect benefits accrue (McCabe, 2001). Government plays a vital role in fostering smallholders ' CF in the Asian country of recent fruit and vegetables (FFV). Indeed, the program event (Contract Farming Program), effective management technique, and strong player engagement, as well as strong government support. They are thought-out because they are the strongest tools to facilitate the economic process and to raise the living standards of farmers in Asia (Baqtayan et al., 2017).

Different means employed by farmers to ensure crop yield

Applying Fertilizer to the plants

Plants need nutrients in order for it to grow and have a good quality products. It was revealed that farmers used fertilizer in replenishing the nutrients found in the soil which will be absorb by the plants that will result to a healthy production. The farmers applied fertilizer because it has a strong potential for building an adaptive food system in the face of vacillation.

Also farmers used synthetic fertilizer, to facilitate the process of the growth their crops, so that they can acquire higher yields or they can gain profit to their crops (Scialabba & Müller-Lindenlauf, 2010). Fertilizer are useful and important to our crops. It improve crop productivity and also restore soil fertility (Mwangi, 1996). The use of fertilizer is an effective, efficient and ensuring it has a good production. It also increase soil aggregation (Ahmad et al., 2016).

Using chemicals

Synthetic and new products are available in the market to ensure that the plants are being protected against pests, insects and fungus. The farmers revealed that they use such chemicals to ensure that there are no hinder in growth of their plants. Using such chemicals will also ensure high production of crops. Farmers are continue using chemicals in their farm to increase their agricultural productivity.

Even though, chemicals are harmful in humans' health, still they used chemicals to reduce the number of pest assaulting to their crops (Wilson & Tisdell, 2001). Farmers are now depends on synthetic chemicals to protect their crops from pest and insects (Chandler et al., 2011). Most farmers applied chemicals to manage the growth of their crops and to control the pest and weeds that competing with crops (Magahud & Dimaano, 2005).

Using Waterworks

Water is essential for the plants and necessary for the improvement of its growth. It was discovered that farmers are doing waterworks to ensure that the crops will result a good and bountiful harvest. Water is the most important element needed by humans in growing their crops to ensure food security and sustainability.

Water is now quickly becoming critically short object for

humans and for crop production (Waraich et al., 2011). The government implement programs specially in terms of implementing an irrigating system which can help in tolerating the plants to grow better (Abdel – Azim, Allam, 2005). Irrigation serve as self-insurance, irrigating farmers using too much water volumes that's why it can improve the difference of outcome (Foudi, & Erdlenbruch, 2011).

Implications for Practice

Farmers especially the new ones can use the result of the study to enable them to become aware on the challenges that they may encounter due to the effects of climate change. They may also know that climate change is a serious matter in which farmers can experienced failure due to the unpredictable weather patterns, bad harvest, slow growth of crops due to high temperature, the quality of fruits is affected, spending much money to the expenses and loss of capital, exhaustion and tiredness and dehydration of plants.

To cope with the challenges brought by climate change farmers may have a water-pump to do the waterworks in order for the plants to stay alive and fight against too much heat and drought during dry season. Farmers may also ask the government or any associations for assistance in solving the problems in their corresponding farms.

To ensure crop yield, farmers can apply fertilizers like Potassium or potash, Urea and Yara which is available in the markets to ensure that the plants can get enough nutrients needed for better growth and development. They may also use chemical such as pesticide, insecticide and fungicide specifically Malathion and Dithane to combat against the pests and insects and ensure that there is no hinder for the growth of their plants thus, it may result to a good quality production. Moreover, farmers may also do waterworks in order for the plants to stay healthy that may result to a bountiful harvest.

CONCLUSION

It has been noted that the farmers are one of the most vulnerable because of climate change. They played a significant role in feeding billions of people of this planet. Without them, there could have widespread famine that we could experience. Indeed, the government must have to intervene to help them cope with the challenges that they are currently facing.

The impact of COVID-19 pandemic showed to have a detrimental effect on the harvest of the farmers. As well, the on-going conflict between Ukraine and Russia added to the cost of grains. As an engineer, educator, and a school president, I can say that we have the most important role in order to help our farmers. Their problems will also be ours. We cannot say that we are not part of it. Thus, this study is a eye-opener that we have to walk hand-in-hand in combatting climate change.

REFERENCES

Ahmad, A. A., Radovich, T. J., Nguyen, H. V., Uyeda, J., Arakaki, A., Cadby, J., ... & Teves, G. (2016). Use

- of organic fertilizers to enhance soil fertility, plant growth, and yield in a tropical environment. *Organic Fertilizers-From Basic Concepts to Applied Outcomes*, 85-108.
- Albaum, G. (1983). Effectiveness of government export assistance for US smaller-sized manufacturers: some further evidence. *International Marketing Review*.
- Alcamo, J., Dronin, N., Endejan, M., Golubev, G., & Kirilenko, A. (2007). A new assessment of climate change impacts on food production shortfalls and water availability in Russia. *Global Environmental Change*, 17(3-4), 429-444.
- Ayeri, O. S., Christian, V. R., Josef, E., & Michael, H. (2012). Local perceptions and responses to climate change and variability: *The case of Laikipia District, Kenya. Sustainability*, 4(12), 3302-3325.
- Baqutayan, S. M., Mohamad, R., Azman, R. R., & Hassan, N. A. (2017). The implementation of contract farming of fresh fruits and vegetables (FFV) for smallholders in Malaysia: government roles and initiatives. *J Sci Technology & Innovation Policy*, 3(1), 1-8.
- Chandler, D., Bailey, A. S., Tatchell, G. M., Davidson, G., Greaves, J., & Grant, W. P. (2011). The development, regulation and use of biopesticides for integrated pest management. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1573), 1987-1998.
- Collier, B., Skees, J., & Barnett B. (2009). Weather index insurance and climate change: Opportunities and challenges in lower income countries. *The Geneva Papers on risk insurance- issues and practices*.
- Condon, A. G., Richards, R. A., Rebetzke, G. J., & Farquhar, G. D. (2002). Improving intrinsic water-use efficiency and crop yield. *Crop Science*, 42(1), 122-131.
- Defiesta, G. & Rapera, C. (2014). Measuring Adaptive Capacity of Farmers to Climate Change and Variability: Application of a Composite Index to an Agricultural Community in the Philippines. *Journal of Environmental Science and Management*, 17(2), 48-62.
- Doorenbos, J., & Kassam, A. H. (1979). Yield response to water. *Irrigation and drainage paper*, 33(257).
- Escarcha, J. F., Lassa, J. A., Palacpac, E. P., & Zander, K. K. (2020). Livelihoods transformation and climate change adaptation: The case of smallholder water buffalo farmers in the Philippines. *Environmental Development*, 33, 100468.
- Etikan, I., & Bala, K. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal*, 5(6), 00149
- Feola, G., Lerner, A. M., Jain, M., Montefrio, M. J. F., & Nicholas, K. A. (2015). Researching farmer behaviour in climate change adaptation and sustainable agriculture: Lessons learned from five case studies. *Journal of Rural Studies*, 39, 74-84.
- Foudi, S., & Erdlenbruch, K. (2011). The role of irrigation in farmers' risk management strategies in France. *European Review of Agricultural Economics*, 39(3), 439-457.
- Gallagher, S. (2012). What Is phenomenology?. In *phenomenology* (pp. 7-18). Palgrave Macmillan, London.
- Gehart, D. R., Ratliff, D. A., & Lyle, R. R. (2001). Qualitative research in family therapy: A substantive and methodological review. *Journal of Marital and Family Therapy*, 27(2), 261-274.
- Hirpha, H. H., Mpandeli, S., & Bantider, A. (2020). Determinants of adaptation strategies to climate change among the smallholder farmers in Adama District Ethiopia. *International Journal of Climate Change Strategies and Management*.
- Hodges, D. M., & Toivonen, P. M. (2008). Quality of fresh-cut fruits and vegetables as affected by exposure to abiotic stress. *Post-harvest Biology and Technology*, 48(2), 155-162.
- Howden, S. M., Soussana, J. F., Tubiello, F. N., Chhetri, N., Dunlop, M., & Meinke, H. (2007). Adapting agriculture to climate change. *Proceedings of the National Academy of Sciences*, 104(50), 19691-19696.
- Husserl, E., & Gibson, W. R. B. (1983). Ideas: general introduction to pure phenomenology. New York: Collier Books.
- Lasco, R. D., Habito, C. M. D., Delfino, R. J. P., Pulhin, F. B., & Concepcion, R. N. (2011). Climate change adaptation for smallholder farmers in Southeast Asia.
- Lobell, D. B., & Gourdji, S. M. (2012). The influence of climate change on global crop productivity. *Plant Physiology*, 160(4), 1686-1697.
- Magahud, J. C., & Dimaano, N. G. B. (2015). Extent, methods and determining factors of pesticide application in irrigated rice areas of the Philippines. *IAMURE International Journal of Ecology and Conservation*, 15(168).
- McCabe, J. T. (2003). Sustainability and livelihood diversification among the Maasai of northern Tanzania. *Human Organization*, 62(2), 100-111.
- Maeda, K., Okazaki, F., Suenaga, T., Sakurai, T., & Takamatsu, M. (1980). Low back pain related to bowing posture of greenhouse farmers. *Journal of human ergology*, 9(2), 117-123.
- Oliver, M. J., Cushman, J. C., & Koster, K. L. (2010). Dehydration tolerance in plants. In *Plant stress tolerance* (pp. 3-24). Humana Press.
- Pandey, S., Bhandari, H.S., & Hardy B. (2007). Economic costs of drought and rice farmers' coping mechanism: a cross-country comparative analysis. *Int. Rice Res, Inst.*.
- Perez-Lopez, A. J., del Amor, F. M., Servano-Martinez, A., Fortea, M. I., and Nunez Delicado, E. (2017). Influence of Agricultural practices on the quality of sweet pepper fruits as affected by the maturity stage. *Journal of the science of Food and Agriculture of the science of Food and Agriculture*, 87(11), 2075-2080.
- Porter, J. R., & Semenov, M. A. (2005). Crop responses to climatic variation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1463), 2021-2035.
- Rosegrant, M., Perez, N., Pradesha, A., & Thomas, T. (2015). The Economywide Impacts of Climate Change on Philippine Agriculture. Routledge.

- Scialabba, N. E. H., & Müller-Lindenlauf, M. (2010). Organic agriculture and climate change. *Renewable Agriculture and Food Systems*, 25(2), 158-169.
- Simelton, E., Quinn, C. H., AntwiAgyei, P., Batisani, N., Dougill, A. J., Dyer, J., ... & Stringer, L. C. (2011). African farmers' perceptions of erratic rainfall. Centre for Climate Change Economics and Policy (No. 73). Working Paper.
- Simelton, E., Quinn, C. H., Batisani, N., Dougill, A. S., Dyer, J.C., Fraser, E. D., ... & Stringer, L. C. (2013). Is rainfall really changing? Farmer's perceptions meteorological data, and policy implications. *Climate and Development*, 5(2), 123-138.
- Skees, J. R. (2001). The bad harvest. *Regulation*, 24, 16.
- Solecki, L. (2001). Low back pain among farmers exposed to whole body vibration: a literature review. *Medycyna pracy*, 62(2), 187-202.
- Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and applications*, 5, 147-158.
- Uematsu, H., & Mishra, A. K. (2012). Organic farmers or conventional farmers: Where's the money?. *Ecological Economics*, 78, 55-62.
- Varadan, R. J., & Kumar, P. (2014). Indigenous knowledge about climate change: Validating the perceptions of dryland farmers in Tamil Nadu.
- Waraich, E. A., Ahmad, R., Ashraf, M. Y., Saifullah, & Ahmad, M. (2011). Improving agricultural water use efficiency by nutrient management in crop plants. *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science*, 61(4), 291-304.
- Wilson, C., & Tisdell, C. (2001). Why farmers continue to use pesticides despite environmental, health and sustainability costs. *Ecological economics*, 39(3), 449-462.
- Yoshida, S. (1981). Fundamentals of rice crop science. *Int. Rice Res. Inst.*.
- Yoshida, S., & Parao, Ft. (1976). Climatic influence on yield and yield components of lowland rice in the tropics. *Climate and Rice*, 20, 471-494.