

Effect of Climate Change Perception on Production and Identification of Adaptation Strategies: Case of Professional Poultry Farmers in Segou, Mali

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Abstract—This study analyzed poultry farmers' Climate Change (CC) perception and its effects on poultry production and identified the adaptation strategies in Ségou, Mali. The data collection was exhaustive, 72 registered farmers. Confirmatory factor analysis was used to analyze farmers' CC perception and Tobit model to determine its effects on production. The perception on "motivation" was rejected for nonconformity. The analysis showed noncollinearity and the Tobit model adequacy. The results showed a dominance of individual entrepreneurs and family businesses at 72% and 26% respectively. Among producers 96% heard of CC but 89% did not participate in any training. CC-related disasters affected 5% of farmers and only 3% received help. Innovation, finance, information and the perception of the effect of CC on mortality and loss of production influenced positively the production while the perception of the effects of CC on growth and development of animals influenced it negatively. Contrary to income from off-farm activities 2 socio-economic variables also positively affected production namely the number of children and the number of wives. The study recommends strong involvement of Malian authorities against the effects of CC through promotion of pro-environmental techniques and technologies, training, financial support to overcome disasters.

Index Terms—climate change, perception, adaptation, poultry farming, Likert scale, Tobit, factor analysis

I. INTRODUCTION

Mali is an excellent agricultural country thanks to its arable area of land as for its aquatic resources, fauna and flora. [1] The country also has a predominantly agricultural economy where agriculture far exceeds the other sector in terms of income and international trade

(Government of Mali, 2013). [2] Agriculture contributes nearly to 39% of GDP and 80% of employment created in Mali (Food and Agricultural Organization, 2017a). [3] The country has the highest number of heads in the ECOWAS (Government of Mali, 2018).

Poultry farming has been a rapidly expanding sector in recent years. [3] Performance in egg and broiler production reached 73% and 62% respectively (Government of Mali, 2018). [4] Otherwise considered to be the farmyard animals managed by women, poultry farming is now the envy of all types of entrepreneurs, large traders, retirees, civil servants and agriculture enthusiasts (Government of Mali, 2019). [5] It is an activity that contributes to household food security but also to the diversification of sources of incomes (United States Agency for International Development, 2018). The same source claims that the country has comparative advantage in the livestock sector remains untapped and underperforming for a variety of reasons, the most imminent of which is climate change.

[6] Nevertheless, poultry farming, which is one of Mali's most promising economic sectors, is hit hard by the adverse effects of climate variability (Food and Agricultural Organization, 2017b). [7] In fact, poultry are particularly vulnerable to Climate Change (CC) because they only tolerate a low range of temperature to maintain their peak of production (G. Adebisi, L. L. Oyeboade and I. I. Owosib, 2017). [5] These effects of climate variability are seen under different aspects but the results remain the same: increase in production costs and increasingly unbearable losses by the small producers who dominate this sector in Mali (United States Agency for International Development, 2018). Some animal diseases iterate and many others emerge. [8] The need for animals' food and sanitary treatment increases and the yield plummets (O. A. Alade, and A. O. Ademola., 2013).

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[9] The need for urgent action no longer makes doubt given the enormity of the socio-economic losses linked to the effects of CC at all levels of the value chain of the national economy (Food and Agriculture Organization, 2019). [10] It is even more remarkable among subsistence farming because they are the most sensitive to climatic shocks (Government of Mali, 2011). The Malian government has shown its commitment to the fight against CC and implemented strategies to improve the resilience of actors in the sector through various decisions and political reforms such as multilateral environmental agreements, national policy of the fight against CC, program of national adaptation action, strategic framework for growth and poverty reduction. [9] However, it turns out that poultry farming has not received the same support as other sectors such as irrigation, crop production and other livestock productions (Food and Agriculture Organization, 2019).

Producers make decisions about their environment based on their perception of the situation. Nevertheless, the perception of producers in the poultry sector is still less clear, thus hampering the progress made in this fight against the effects of the climate variability. This study aims to determine the perception of these actors on the effects of climate variability on the production of commercial poultry farming in the Ségou region in Mali.

The general objective of this study is to help make the right political decisions and improve the resilience of farmers in the face of this scourge in order to promote the poultry sector in the Malian economy. More specifically, the study aims to determine poultry farmers' climate change perception and its effects on production, expressed in its monetary value. It also plans to propose strategies to make the participation of these key players effective and efficient in the socio-economic development of the sector.

II. METHODOLOGY

The study was carried out in the city of Ségou, which is the main town of Ségou circle. It is at 240 km from the Malian capital city (Bamako) and located between 13th and 16th North latitude, 4th and 7th degree of West longitude. [11] The region is composed of 414 villages which occupy an area of 15,600 km² with a population of 696 135 inhabitants according to the last census (Institut National de Statistique, 2014). The same source estimates that primary activity occupies 84% of the working population, secondary 4%, tertiary 7% and services 5%. The climate is of 2 types: Sahelian in the North with a rainfall of 250-600 mm and Sudano-Sahelian in the South with 600-800mm. The vegetation is Sudano-Sahelian dominated by grasses.

The target population of the study is composed of poultry farmers registered with the platform of poultry farmers in the Ségou region, that is to say farmers working in the formal sector. The study made an exhaustive selection of the members of this platform in the city of Ségou and its urban areas are given the relatively small

number of poultry farmers. Data was collected using a questionnaire and through face to face with the 72 respondents. The data were analyzed using statistical analysis software: SPSS for descriptive statistics and Stata for inferential statistics. [12] Confirmatory factor analysis was used for the perception variables (expressed in five-point Likert scale) while the Tobit model was used for the independent variable which had only continuous and positive values (R. Moffitt, and J. F. McDonald, 2016).

III. DESCRIPTIVE STATISTICS

The statistical description focused on the average and the percentage. The analysis shows that the average age of the poultry farmers is 40 years. This is because commercial poultry farming requires relatively larger investment funds, which are generally not available to younger people. [13] This is similar to the findings in the studies of L. O. Saweda, I. Tasié, A. Sanou, and J. A. Tambo., 2019). The poultry business in the Ségou region according to the survey is mainly individual and family type at 72% and 28% respectively. Only 2% of poultry businesses emanates from a partnership between 2 people. Regarding associative life, only 12% of respondents belong to an association other than the poultry farmers platform. [14] This indicates a reduced networking between poultry farmers in the Ségou region, a situation that can affect the performance of their activities (A. Sanou, B. Osuntade, L.T. Saweda, and T. Reardon, 2017). The average years of experience of poultry farmers is estimated at 9 years. The reason for this is that commercial poultry farming, unlike traditional breeding where some producers inherit livestock from their parents or start at an early age, requires personal conviction and relatively higher means of investment. [15] These results are identical to those of T. Bidoli. and F. Issa (2011). Regarding the disaster experience, 95% of producers' say confirmed having experienced a disaster, 20% of which is attributed to heat stress and 11% to a devastating disease. Of these victims 97% said that they received no help. This shows the very great precariousness of the poultry business in Ségou. [9] This disengagement of the State from direct aid is almost common to all agricultural sectors in the country (Food and Agriculture Organization, 2019).

In addition, 85% of respondents affirmed that they do not have access to credit while 75% admitted having a secondary activity as a source of income. These secondary activities are mainly either commerce at 49%, or any other wage-earning activities at 23%. [13] It should be noted that these secondary activities allow some producers not only to do without credit but also to reduce the risk associated with poultry production as mentioned in 2019 by Saweda LT and his co-authors.

Regarding CC, 96% of poultry farmers concurred hearing about it. Television is by far the main source of information for them, 56%, followed by personal exchange (word of mouth) through its communication

network and radio at 22% and 11% respectively. The small portion of the population of poultry farmers who have never heard of climate change should not be overlooked, however, given the importance of this topic. On the other hand, 89% of poultry farmers reported that they have never attended a training on CC. reportedly, the few of the who participated in such a training did so only through a private organization or an NGO. [16] This absence of the state in the field of training for combating CC has been a persistent phenomenon for years (Organization for Economic Co-operation and Development, 2001).

IV. CLIMATE CHANGE PERCEPTION AMONG POULTRY FARMERS IN SEGOU

The rise in temperature is perceived as the first sign of CC in Ségou at 48% while the variability of the seasons and multiplication of epizootics (animal diseases) are perceived as a sign of CC by 30% and 9% respectively as shown in Fig. 1.

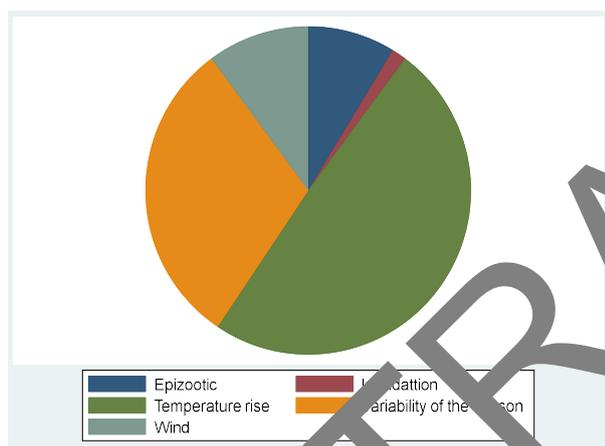


Figure 1. Farmers' CC perception.

V. CC ADAPTATION STRATEGIES AMONG POULTRY FARMERS IN SEGOU

The methods and means of fighting the drawback, several strategies are implemented by poultry farmers. These strategies are, among others, mulching the roof, frequently washing the henhouse with relatively cool water, changing periodically the water of the drinkers, refreshing the drinking water of the subjects by adding ice

in the drinkers or silting up the chicken coop terrace. Among the surveyed farmers, 64% of producers say they use strategies to reduce the temperature in the henhouse or heat stress in the animals. [15] Around 55% of producers claim to use a combination of strategies to combat the effects of CC as confirmed with T. Bidoli, and F. Issa, (2011).

The proposed strategies by poultry farmers to deal with the negative effects of CC are diverse. The popularization of knowledge on CC is proposed by 18% of producers, adaptation of henhouse and poultry activities by 24% and judicious choice of inputs is proposed by 20%. However, 27% of poultry farmers believe that it is only the State and its partners that can stem the adverse effects of CC on poultry farming and its related activities.

As far as the analysis of poultry farmers' perception of CC is concerned, it is carried out by using confirmatory factor analysis on the basis of the five-point Likert scale. [17] This method requires that the average of the selection indicators be between 1 and 5 as the Likert scale itself (R. B. Moralis, and G.C. Delaria, 2014). On this basis, one of the indicators used in this study, namely "Motivation for poultry farming" was dropped (see Table I).

[18] Cronbach's alpha was 0.71, greater than 0.53, within the acceptable value required for the validity of the test (E. Grau, 2009). [19] The KMO measure and Bartlett's test have been neglected due to the small sample size (72) and the exclusion of all elements of the target population from the surveys (L. Chan, and N. Idris, 2017). [20] Likewise, the value of VIF (Variance Inflation Factor) on continuous variables was 2.85 which is acceptable because it is less than 10 (R. Williams, 2015). This stipulates the absence of collinearity among variables as indicated in Table II. Since production is a continuous variable, the Tobit model was used and its fitness found to be statistically significant at 1%. [12] This significance confirms that the Tobit model is well suited for the variables chosen (R. Moffitt, and J. F. McDonald, 2016).

Analysis of the data showed that the innovation variable is statistically significant at 5%. This means that an increase in innovation by one unit leads to an increase in production by a coefficient of 0.2834. [21] Peasants' innovation, which is technical, organizational and social, is crucial for the performance and survival of African agricultural enterprises where producers are left to their own devices (H. Basquin, F. Charon, M. Cissokho, G. Le Gauyer, RH. d'Orfeuil, and JL. Vielajus, 2014).

TABLE I. AVERAGE SCORES OF POULTRY FARMERS' PERCEPTIONS OF CC

Variables of perception	Means scores	Margin of error
Information on CC	1.8604	0.1273
Role of poultry farming on CC	2.8141	0.2702
Effects of CC on animal growth and development	2.4075	0.1211
Effects on CC on animal health	2.2294	0.1393
Effects of CC on production loss	2.6627	0.46033
Motivation for poultry farming	22.6182	0.8699
Innovation to face CC	4.6520	0.31528

TABLE II. RESULTS OF COLLINEARITY ANALYSIS AMONG THE PERCEPTION ITEMS OF THE STUDY

Variables of perception	Information on CC	Role of poultry farming on CC	Effects of CC on animal growth and development	Effects of CC on animal health	Effects of CC on production loss	Motivation for poultry farming	Innovation to face CC
Information on CC	1.0000						
Role of poultry farming on CC	0.0133	1.0000					
Effects of CC on animal growth and development	0.0671	-0.3392	1.0000				
Effects of CC on animal health	0.4482	-0.0433	-0.0097	1.0000			
Effects of CC on production loss	-0.1823	0.2567	-0.1612	0.0739	1.0000		
Motivation for poultry farming	-0.0580	0.2895	-0.2696	-0.0111	-0.0211	1.0000	
Innovation to face CC	-0.1287	0.0289	0.2495	-0.4711	0.1739	0.4235	1.0000

Reliance on the information received about the CC has a positive influence on poultry production at 10% statistical significance. One unit increase on producer confidence in the information received will increase production by a coefficient of 0.3165. It is assumed that this information received is used in making well-guided decisions by poultry farmers in the region. Information is essential for any actor in the value chain, especially for producers. [22] It is used not only in the daily management of farms but also in the prevention of possible crises in the sector, prices, costs and other production factors (Douillet, and P. Girar, 2013).

The perception of the effects of CC on the growth and development of animals has a negative influence on production at 10% significance. That is, one more unit of this perception reduces production by -0.3834. The disease is a devastating phenomenon in poultry farming in the Ségou region. It is not uncommon for producers to abandon poultry operations after a disease ravaging the barn or during times when the risk of an epizootic in poultry is high such as during the hot period of the year. [23] S. Coulibaly, M. Siby, and B. Songoré, (2017) believe that the biggest obstacle to the development of poultry farming in M'pessoba and Mali in general is disease and its related effects.

Curiously, a positive correlation was observed between, on the one hand, the perception of the effects of CC on mortality and loss of production, and on the other hand, poultry production. For each unit increase in this perception, we observe an increase in production by a coefficient of 0.1084. It would seem that every economic loss serves as a lesson. As producers who lack adequate extension services learn from their mistakes. [21] H. Basquin, F. Charon, M. Cissokho, G. Le Gauyer, RH. d'Orfeuil, and JL. Vielajus, (2014) reported that in rural

Africa producers learn from their own mistakes or learn from those around them in general, however this allows producers to survive in an environment where everyone is left for themselves. [23] S. Coulibaly, M. Siby, and B. Songoré, (2017) in his studies on poultry farming in M'pessoba proved that the enormous loss favors traditional poultry farming where the risks are much more limited.

Perception, like any other psychometric tool, is subject to a series of latent variables that are more or less critical to fully expressing oneself. Thus, the number of children and the number of wives of producers positively affect production at 1% significance. This is explained by the dominance of the family or quasi-family type where children and women are used as labor. This family workforce is a source of opportunity in addition to the ideas that family members can provide to the head of the family who is also the head of the farm. [24] Food and Agriculture Organization and United Nations Development Program estimate that 85% of wealth generated in African agriculture comes from family labor. [24] This type of workforce is also one of the most effective means for family resilience, thus helping agricultural enterprises to overcome socio-economic and environmental obstacles (Food and Agriculture Organization and United Nations Development Program, 2016).

The gain from a secondary activity carried out by the respondents other than poultry farming negatively influences the level of production. This can be attributed to the fact that it is poultry farming which is rather a secondary source of income generation. [25] Trading or salary presents relatively less risk in terms of profit. S. B. Dieng, A. Houinato, M. R. B. Chrysostome, C. A. A. M. Issay, J. Hornick, A. Missouhou, (2013) note that in

addition to disease and bird mortality, production losses are a hindrance to the development of traditional and improved poultry farming. The author asserts that having more income is a favorable factor for the practice of poultry farming in rural areas.

VI. CONCLUSION

Poultry entrepreneurship in Ségou is dominated by the individual type and the family one. The heads of the farms are relatively young with relatively similar years of experience. Climate change is known to many of the town's poultry farmers, with television, word of mouth and radio as their source of information. Producers lack access to credit and training. It is poultry farming that is seen rather as a secondary income-generating activity by investors, who are mostly traders, salarieds and wage earners. The rise in temperature, the variability of the seasons and the multiplication of poultry epizootics are considered as the most palpable signs of CC. Innovation and reliance on the information received on CC have a positive influence on poultry production. Surprisingly, a positive relationship was also found between production and the perception of adverse effects of CC on mortality and product losses. On the contrary, a negative relationship is noted between income from off-farm activities and production, on the one hand, and between production and the perception of the effects of CC on the growth and development of animals. Only two socio-economic factors, including the number of children and the number of farm manager's wives, had also positively influenced poultry production.

VII. RECOMMENDATIONS

The study suggests that the political authorities become more involved in the fight against the adverse effects of CC on poultry farming through training producers, awareness raising and promotion of pro-environmental techniques and technologies. Access to credit and reliable information must be improved in order to allow commercial poultry farming to perform at its full potential.

CONFLICT OF INTEREST

The authors have no conflict of interest.

AUTHOR CONTRIBUTIONS

The literature review, preparing questionnaire and data analysis were done by Mahamadou Konte and they were improved by Boubacar Mariko. The data collection was done by a team trained by Boubacar Mariko and Mahamadou Konte.

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