

Research Application Summary

**Managing Agriculture Risk through Commodity Exchanges: An opportunity for Zimbabwe and other emerging economies**

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**Abstract**

Zimbabwe is an agro-ecological area and its economy is backed by agriculture. Managing agricultural activities is important as this will impact positively on the country's gross domestic product (GDP). There are risks associated with agricultural risks such as production and marketing. Tobacco farmers in particular are losing millions of dollars from contractors, buyers and microfinance companies who would have loaned them some monies for inputs among others. The same applies to animal farmers as they lost animals due to various diseases, drought as a result climate change. Animal and crop productivity in Zimbabwe is being affected by prolonged dry spells, pests and diseases. For farmers, there is need for fair pricing models considering risks in agriculture. The aim of the paper is to assess the adoption of mathematical methods and derivative markets by farmers and investors in agricultural products. A situational analysis on the adoption derivative markets by farmers, investors and agricultural stakeholders among others in Zimbabwe was done. Random sampling methods was used in selecting respondents in Zimbabwe. From the survey, it was noted that most of the farmers, investors and stakeholders are not using mathematical models or derivative markets in their pricing and contracting decisions. The study recommends that the government in partnership with the Ministry of Agriculture should train or sensitise people on the benefits of agriculture derivative markets.

Keywords: Agriculture, derivative market, volatility, Zimbabwe

**Résumé**

Le Zimbabwe est une zone agro-écologique possédant une économie reposant sur l'agriculture. La gestion des activités agricoles est importante car elle possède un impact positif sur le produit intérieur brut (PIB) du pays. Il existe des risques associés aux aléas liés à l'agriculture tels que la production et la commercialisation. Les cultivateurs de tabac, en particulier, perdent des millions de dollars à cause d'entrepreneurs, d'acheteurs et de sociétés de micro-finance qui auraient dû leur prêter de l'argent pour des intrants, entre autres. Il en est de même pour les éleveurs car ils perdent des animaux à cause de diverses maladies, de la sécheresse en raison du changement climatique. La productivité animale et végétale au Zimbabwe est affectée par des périodes de sécheresse prolongées, des ravageurs et des maladies. Pour les agriculteurs, il est nécessaire de disposer de modèles de tarification équitables tenant compte des risques liés à l'agriculture. L'objectif de cet article était d'évaluer l'adoption des méthodes mathématiques et des marchés dérivés pour les agriculteurs et investisseurs des produits agricoles. Une analyse de la situation sur l'adoption des marchés dérivés par les agriculteurs, les investisseurs et les acteurs du secteur

agricole entre autres a été réalisée au Zimbabwe. Des méthodes d'échantillonnage aléatoire étaient utilisées pour sélectionner les répondants. D'après l'enquête, il a été noté que la plupart d'agriculteurs, d'investisseurs et des parties prenantes n'utilisent pas de modèles mathématiques ou marchés dérivés dans leurs prises de décisions de tarification et de passation de marchés. L'étude recommande que le gouvernement, en partenariat avec le ministère de l'Agriculture, forment ou sensibilisent la population sur les avantages des marchés dérivés en agriculture.

Mots clés : Agriculture, marché dérivé, volatilité, Zimbabwe

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## Introduction

Over the years, agriculture has increasingly asserted itself as one of the key socio-economic endeavours for mankind. In agriculture, decisions are made in an environment characterised by a myriad of indeterminacies. For the purpose of this paper, an indeterminacy is conceptualised as an agriculture-related phenomenon, factor or process whose future state or value cannot be established with absolute precision. An example of such phenomenon is the total amount of rainfall received, within a clearly defined geographical locality during a specified season. The uncertainties inherent to the natural and man-made circumstances are the major drivers of risk in agriculture. According to Huirne *et al.* (2000) and Ruud (2005) 'Risk is inescapable in life but it is, however, not to be too afraid of'. This is so because; return is the compensation that an investor is rewarded with for taking on risk.

Every practitioner in agriculture must assume some carefully assessed level of risk if they expect to reap profits from their business activity. The old adage "High risk, high return" is also applicable to farming business. From an investment perspective, one of the primary responsibilities for a farmer of any category is to manage agricultural risk. Now, risk management entails identifying sources of events that may negatively affect future returns, quantifying the impact of such occurrences and taking appropriate measures to mitigate, or possibly eliminating, the effects of these possible adverse developments. In general, the major sources of risk in agriculture are: production, marketing, financial dynamics, institutional and human. The following subsections examine each of these classes of risk in detail with respect to Zimbabwe.

**Production Risk:** This category of risk encompasses volatility of returns due to, *inter alia*, variability of weather conditions from season to season, nature and intensity of disease incidence and availability of efficient agricultural technology and other inputs. In Zimbabwe, the vagaries of unfavourable weather conditions, resulting from climate change, have constituted the greatest single contributor to the aggregate production risk in agriculture. The worst affected parts of the country are agro-ecological Regions IV and V, where increasingly frequent severe droughts and high temperature spells (approximately 1 in every 5 years), erratic rainfall, prolonged mid-season dry spells and delayed on-set of rain season are the major culprits. In recent years, cyclones and floods have also had their share in causing grief to the agriculture sector as they accounted for destruction of crops, livestock and wildlife in a number of seasons. For a more detailed and technical treatment of the adverse impact of weather risk on agricultural activities and returns in Zimbabwe, the reader is referred to [Zimbabwe: Agriculture Sector Disaster Risk Assessment. (2019). World Bank Group] and (Huirne *et al.*, 2000 and Ruud, 2005)

Pests and diseases constitute noteworthy production risk in Zimbabwe since they affect both animals and crops. A good example is the incidence of the armyworm in the 2018-2019 seasons. The pests significantly reduced yield from maize and other crops. Ageing or inadequately service equipment may not perform to the expectation of the farmer. Several farmers in Zimbabwe

depend on shared or rented equipment. The timely availability of such a resource has always been a cause for concern to the farmer in question. In a number of cases the quantum and/or expertise of the human resource base have not met the minimum threshold for smooth operations at various agriculture value chain levels.

**Marketing risk:** Marketing risk is driven by the evolution of commodity prices and costs factors of production. The cost of input factors (e.g labour, seeds, chemicals, fuel) and the selling price of farm products are a function of market dynamics. In principle, demand and supply forces are beyond the control of an individual farmer. The 2019 Zimbabwe tobacco auction season was initially characterised by market illiquidity and dimly subdued price offers by buyers. This prompted tobacco sellers to threaten withdrawal of the golden leaf from the market. The government of Zimbabwe later intervened to help resolve the crisis. The current world paradigm shift is that countries and regional economic blocs manage market risk through an active and professionally supervised ecosystem of stakeholders that includes financial institutions (banks, insurance companies, and building societies), commodity exchanges, stock exchanges and derivative markets. The advantages of such a developed networked market include efficient information flow leading to fair price discovery, enhanced market liquidity, stability in prices of products and reliable supply of input factors agriculture sector.

**Other forms of Risk:** Financial risk is inherent to situations where farmers need to finance their operations through debt instruments. In some cases lenders may not be willing, due to perceived or real circumstances, to provide the funds. Future interest rates may be a trap for farmers. Lower than anticipated prices, or poor yields due to drought, may induce failure to generate adequate returns to pay back the loan is a common aspect of financial risk in farming business. For institutional and human risk, refer to (Huirne *et al.*, 2000 and Ruud, 2005) .

### **Risk Management Strategies**

The world over, agricultural risk management has been a pivotal function of every player in the farming business. In Zimbabwe, irrigation systems of varying capacities have been developed to mitigate the effects of drought, delayed onset of rain season and prolonged midseason dry spells. The Tugwi-Mukosi Dam, located in the dry southern part of the country, was commissioned in 2019 to boost irrigation in that semi-arid agro-ecological region of the country. Over the years, the application of biotechnology resulted in the development of new plant and animal breeds that resist or tolerate the impact of climate change-induced harsh weather conditions. In 2019 the Chinhoyi University of Technology, embarked on a national cattle breeding programme aimed at restocking the national herd with breeds that cope with current climatic realities. The Government of Zimbabwe and the Non-Allied Movement Science and Technology Center (NAM S and T), through the Great Zimbabwe University, are in the process of establishing a Center of Excellence in Dryland Agriculture. The Center will be located in Chivi District which happens to be one of the perennially dry parts of Zimbabwe. The Center will augment efforts of other institutions and organisations such as ICRISAT, Makhoholi Research Center and Matopo Research Center and sister universities to build integrated risk management strategies. Institutional and government initiatives have been implemented to assist farmers manage market and financial risk. For example, the Command Agriculture programme, which caters for both crop and animal production, has already yielded fruits by directly increasing nation returns in the agriculture sector. The economic bloc can leverage on the experience of South Africans whose economy is already home to a vibrant derivative market for agricultural commodities and other underlying assets.

Zimbabwe's economy is largely supported by agriculture. Zimbabwe has a total land area of

over 39 million hectares and 33.3 million of these hectares are used for agricultural purposes. This shows that Zimbabwe is into agriculture. If the risk in agriculture (both crops and animals) is high then it leads to poor performance and as a result the economy suffers. Investors need to know the risks associated with investing into agriculture so it is important to have models that quantify the impact risks in agriculture. Derivative markets can act as the breeding ground for policy formulation. For farmers, there is need for fair pricing models considering risks in agriculture. Agreements between farmers and agricultural loan providers need to be assessed for optimal decision making purposes. Currently there are no or limited agricultural derivative markets that are being used by farmers, investors and agricultural stakeholders in assessing the risks associated in agricultural productivity in Zimbabwe and surrounding countries.

Tobacco farmers in particular are losing millions of dollars from contractors, buyers and microfinance companies who would have loaned them some monies for inputs among others. The same applies to animal farmers as they lost animals due to various diseases, drought as a result of climate change. Animal and crop productivity in Zimbabwe is being affected by prolonged dry spells, pests and diseases. All these are signs of risks associated with agriculture products. It is the aim of the paper to illustrate the importance of derivative markets in agriculture. The markets can be used for optimal pricing and decision making when it comes to contracts. Investors, farmers and contractors may use the information on the markets in their efforts to manage agricultural risks. It is hereby recommended that the Southern Africa Development Community (SADC) establishes a regional Derivative Market as a strategic move to manage various forms of agricultural risk and thereby increase the sector's GDP in the respective member states.

According to Tsetsekos and Varangis (2000), Derivative markets create an atmosphere conducive to better risks transfer enhanced public information, and lower transaction costs. This implies that derivative markets lead to market transparency which is something vital in the agriculture sector. Derivatives act as financial and investment management instrument for emerging markets (Schwegler, 2010) and Zimbabwe is not spared. Gemech *et al.* (2011) noted that farmers may derive significant positive payoffs from derivative markets through efficient allocation of resources to their production.

Economic instability and climate change among others have adverse effects on agriculture productivity. Uncertainty about agriculture productivity due to various factors could significantly reduce investors' willingness to take risks, including banks' ability and willingness to lend as well as the willingness and ability of firms to invest in agriculture. With derivative markets, banks, investors and farmers will be able to access useful information.

## **Materials and methods**

A situational analysis was done. A random sampling method was adopted in picking the farmers, agriculture investors, agriculture stakeholders and the government among others. Questionnaires were distributed and interviews were conducted as a way of gathering data. Most of the questions asked were biased towards the adoption of mathematical methods and agriculture derivative markets in pricing agriculture productivity, deciding types of investments in agriculture as well as contacting. All ethical issues were observed. The use of mathematical models such as the Autoregressive Conditional heteroscedasticity (ARCH) Generalised Autoregressive Conditional heteroscedasticity (GARCH) models by Engle (1982), Bollerslev (1986) and Taylor (1986), which are capable of modelling agricultural volatility which is something useful to investors were asked. The GARCH model can be used to test for the effect of Zimbabwe's agriculture derivative on the agriculture volatility.

The ARCH model is denoted by:

$$\sigma_t^2 = \omega + \sum_{i=1}^q \alpha_i e_{t-i}^2 \quad (1)$$

where  $\omega$  and  $\alpha_i$  are model parameters. The GARCH model is represented by the formula:

$$\sigma_t^2 = \omega + \sum_{i=1}^q \alpha_i e_{t-i}^2 + \sum_{j=1}^p \beta_j \sigma_{t-i}^2 \quad (2)$$

where  $\omega > 0, \alpha \geq 0, \beta \geq 0, (\alpha + \beta) < 1$  and the constant variance is denoted by  $\omega$ . The GARCH family of models are fitted under the assumption that the model residuals follow a normal, GED and Student's t distributions.

### Data analysis and results

A quantitative approach was used in the data analysis, after coding responses from the collected questionnaires. A general observation from the Zimbabwean farmers was that they are not using agriculture derivative markets in their operations even on decing making processes. They are just using judgemental methods which lack scientific basis hence they are losing a lot of money.

### Conclusion

A survey on the adoption of agriculture derivative markets by farmers, agriculture stakeholders, investors among others was done. A quantitative approach was done. Results from the study indicated that most farmers and investors are not aware of agriculture derivate markets, hence they are using traditional methods in their operations. Losses encountered by farmers are due to unavailability of informative information that can be accessed through mathematical models or derivative markets. The government together with the Ministry of Agriculture should establish agriculture derivative markets and ingage farmers and investors about derivative markets. Oprimal decisions can be achieved through the use of agriculture derivative markets.

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