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TESTING A PROFIT MARGIN HEDGING MODEL AS A PRICE RISK-MANAGEMENT SOLUTION FOR CROP FARMERS IN SOUTH AFRICA

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ABSTRACT

Risks inherent in the agricultural environment are often complex and include a combination of risks such as production risk (weather), market risk (uncertain prices), technological risks (new production techniques), price risk (changes in input and output prices) and institutional risk (changes in policies). Also, farmers experience personal and financial risks, which relate to cash flow and the ability of the business to generate sufficient profit. Literature shows that crop farmers manage price risk to fulfil the end-values of security, feeling good and operating a viable and competitive business. A profit margin hedging approach could effectively be used as a price risk management strategy. Although certain other agricultural industries are using profit margin hedging as a risk management strategy, not much is known of the usage and success of this strategy in crop farming. A gap in research exists where an effective plan combines the various components into an effective crop risk management strategy. It is also evident that a gap in practice exists where all the components identified in the literature are not combined into a working model to do better price risk management on a daily basis. Consequently, this study aimed to test the performance of such a new profit margin hedging (PMH) model, with and without using put options as a pre-harvest strategy, against the performance of a control group. The study was conducted in the Free State Province in South Africa. Data for eight (8) seasons of a group of ten farmers were obtained from a bureau service. The data was analysed using the software suite Jamovi 1.0.7.0. Independent t-tests were used to compare the profitability of the new PMH model to the control group. Statistically, significant differences were reported between the groups. The study found both a significant improvement in profitability and a stabilising effect on profitability when using a profit margin hedging approach. This study proposes that crop farmers can operate more viable and secure businesses by utilising a profit margin hedging model.

Key words: agriculture marketing, crop farmers, price risk management, profit margin hedging

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INTRODUCTION

In the agricultural industry, crop farmers are facing the problem of how to successfully manage price risk. Literature suggests that focusing on effective risk management strategies can help farmers with a better planning approach, contributing to an increased sense of security and farmer welfare [1]. Unpredictable circumstances, financial pressure and uncertainty about the future are significant stressors for farmers worldwide [2]. In South Africa, farmers barely recovered from the worst drought recorded in 30 years [3] when La Nina's rains caused flooding and a call was made for a national state of disaster towards the end of 2021 [4]. Amidst navigating through such stressors, farmers must plan efficiently and operate viable businesses [1]. Literature indicates that hedging is a sound approach to protect farmers against business risk, unpredictable events as well as price fluctuations [5]. Some studies suggest that profit margin hedging as a price risk management strategy could effectively determine the time to sell crops [6]. In a study among dairy farmers, profit margin hedging especially assisted in maintaining viable businesses [7]. Literature indicates that other industries, such as pig farming [8], the dairy industry [9] and cattle feedlots [10], are utilizing profit margin hedging strategies to manage their business risks. Similarly, in the milling industry, maize or wheat price are fixed while the miller has a forward contract on the supply of maize or flour [11]. The same applies to the soybean crushing industry, which is famous for locking in the crushing margins [12].

Although these studies apply profit margin hedging as strategy in other agricultural sectors, no such studies could be found in the crop production sector where profit margin hedging has been modelled and tested in practice. This study aimed to suggest a solution for the price risk management problem in the crop production sector by providing evidence of the effectiveness of using a novel profit margin hedging (PMH) model. The following research objectives flow from the introduction:

- To determine whether a new profit margin hedging (PMH) model using put options as a pre-harvest strategy will significantly outperform the profit of the control group; and
- To determine whether a new profit margin hedging (PMH) model, without using put options as a pre-harvest strategy, will significantly outperform the profit of the control group.

Farmers risk most of their working capital producing crops in the agricultural sector, often making emotional decisions [13]. Various publications report the risks inherently involved with crop farming and the possibility of experiencing loss as a

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farmer [2]. It is essential to consider why crop farmers do price risk management, namely, to fulfil the end-values of security and operating a viable and competitive business [1]. A combination of risk management strategies [13] is often utilised to manage risks in farming, such as production management, income risk management and price risk management [14].

Since the onset of financial markets, hedging has been proposed as the primary risk management tool for farming businesses [15]. Hedging is defined as a strategy intended to lessen investment risk using put options or futures contracts [15]. Hedging involves locking in profits with the purpose of reducing the volatility of a portfolio by reducing the risk of loss [7].

Kee and Kenyon [8] indicate that “profit margin hedging is the simultaneous hedging of inputs and outputs of a production process”. In a study profit margin hedging gave the highest expected utility to producers, and it was important to manage yield risk in the pre-harvest phase of a season [16].

Proactive marketing plans are essential for crop production. Literature suggests different elements that should be included in a crop marketing plan, such as financial goals, cashflow needs, price objectives, storage capacity, anticipated production and capacity to take a risk [17]. An environment with many risks can easily lead to emotional decisions. A solid crop marketing plan should not only lead to better decision-making, but also assists in managing and reducing emotions that are often obstacles in the way of good decision making [17]. Crop marketing plans should be flexible enough to accommodate the unique needs of farmers, as well as prioritise their geographic characteristics, cost structure, production potential and risk propensity [18]. Addressing uniqueness is a common theme for both the concepts ‘crop marketing plan’ and ‘profit margin hedging’ and therefore these approaches should be incorporated into the basic design template of a crop price risk management platform. A basic design template should include a grouping of all the relevant variables, such as tested in the current study.

Currently, there is a gap in the literature of research failing to provide an effective plan to combine the various components into an effective crop risk management strategy. It is also evident that a gap in practice exists where all the components identified in the literature are combined into a working model to do better price risk management on a daily basis. Consequently, this study aimed to test the performance of such a model.

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MATERIALS AND METHODS

The study was conducted in the Free State Province in South Africa. Ethics approval was received from the Ethics Committee of the Faculty of Economic and Management Sciences with approval number NWU-01270-21-A4 for the study. Data of eight consecutive seasons of a group of 10 farmers were supplied by a bureau service. The data were anonymous and in the form of the averages for each season for the crop white maize. The open-source software suite Jamovi 1.0.7.0 was used to analyse the data [19]. Yuen's test was conducted to determine the significance of the results and effect size for the difference in the means [20]. Robust tests, such as Yuen's test, were recommended as an alternative solution for t-tests rather than using the non-parametric tests. In the case of this study, bootstrapping was used, which remains a powerful method, particularly for the small sample sized data, as was the case in this study.

Model description

The profit margin hedging (PMH) model that was tested in this study integrates the components of crop price risk management, as identified in the literature, into a platform. The new PMH model consists of three sections: 1) a crop marketing plan, 2) marketing cycles and 3) an algorithm. A crop marketing plan [17, 18] defines all the variables of each season, for example "break-even cost". The variables of each season in the crop marketing plans are updated when change occurs during a season, and as one of the variables, it is also important that every season's basis should be regularly updated and the profit recalculated [17].

An important factor determining the success in crop marketing plans is human capital [21]. By having experts joining their crop marketing teams, smaller and emerging farmers can reduce the cost of learning how to use derivative tools and improve their crop marketing plans [18].

A crop marketing plan consists of marketing cycles [22-24]: A marketing cycle constituted the time a user needed to sell a certain percentage of a season's total harvest when the profit goals were reached.

In each marketing cycle, an algorithm using profit margin hedging [6,8,16] as its core logic mechanism, continuously calculated profitability as the live market price and other variables of a crop marketing plan changed during a marketing cycle. In the process, suggested transactions were generated for the uncertain (pre-harvest) [17, 25] and certain (post-harvest) [17] phases of a season's crop marketing plan.

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This price risk management strategy for crop farmers therefore suggests selling some of their crop when the current futures price (adjusted for basis risk and commissions) is equal to or higher than their crop marketing plan's lowest profit goal [7].

Literature suggests that a pre-harvest strategy is not complicated if the basic assumptions such as break-even cost, planned harvest yield and the correct crop marketing tools are realistic [25]. There is a clear need to guide crop farmers to identify the marketing tools to be used in making hedging decisions [21]. In addition, using the correct crop marketing tools, such as put options, in the pre-harvest period is advisable. This can be left to expire if the market price rises above its strike price, or if the final harvest yield is lower than the planned harvest yield and all the contracts cannot be honoured. Hedging in the pre-harvest phase of a season is important because it increases the profitable crop pricing opportunities of farmers [17]. Studies on South African rainfall patterns suggested that the average harvest yields of the previous ten years (seasons) should be used as planned harvest yield for the pre-harvest strategy, thereby addressing the problem of uncertain harvest yields. Using a time period shorter than 10 years to calculate a planned harvest yield can be erroneous since it may include only a wet or a dry cycle, contributing to uncertainty [26]. The problem with using the correct planned harvest yield was also identified in other studies [16,17], indicating that adding yield risk reduces the advantage of profit margin hedging.

A crop marketing plan should have clear exit strategies and clear criteria for quick and easy decision-making stating how much and at what price transactions must be done. Thereby allowing crop farmers to make instant decisions on specific criteria as to when to sell or hold. When calculating an exit strategy during the post-harvest phase of a season, it is vital to account for the storage costs of a crop, thereby avoiding holding a crop in storage for too long [17]. A simulation algorithm can help farmers to better understand the practical applications of forward pricing.

A study on position sizing showed that it was advisable not to risk (hedge) more than 6% on average of the total harvest of a season when a season's profit goal was met [24]. The implication is that this principle divides a marketing season over many decision-making events, distributing the risk.

Literature emphasises the importance of focusing on the desired profit goal in a crop marketing plan [27]. Selling above a target price is shown to be an optimal strategy under a highly restricted target utility function where a producer has the

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same level of risk preferences above and below the target [23]. The new PMH model used in this study calculated a net profit based on the live market price by taking variables such as break-even cost, harvest yield and profit goals of a crop marketing plan into account [7]. A large body of evidence exists that shows the impressive ability of live financial markets to predict financial events of all types [28, 29]. It meant that crop pricing decisions were based on each farm's unique circumstances and risk propensity and linking it to a live futures market added to the accuracy of decisions [18].

RESULTS AND DISCUSSION

For this study, the production seasons of the control group and the new PMH model started on 1 September. Seasons ended when the total harvest was sold, and the new PMH model used the same area seeded of 500 hectares for each of the seasons in the study. The commodity used was the crop white maize (WMAZ) as it was traded on the Johannesburg Stock Exchange (JSE) Agricultural Derivatives Market [29]. The standard grading of the crop was WM1, and a standard contract size was 100 tons. The daily closing prices of the July contract month on the JSE were used [29]. July was chosen because it was seen as the price risk month when the harvesting processes of the control group were completed. On approximately the 20th of July of each season, the July contract month expired and then the planned harvest yields of the new PMH model were also changed to reflect the final harvest yields of the control group. When the total harvest for a season on the new PMH model was not yet sold by the end of July, the daily closing prices of the next contract month were used until the crop was fully sold. Marketing seasons were divided into marketing cycles of a week [22, 24], and this was the period allowed to do transactions when the model's profit goals were reached [23, 27]. Marketing cycles started on Mondays and ended on Sundays, with the trading days Mondays to Fridays.

To keep the new PMH model as authentic as possible, the simulation algorithm was allowed to run its course. With one exception, no user intervention was allowed. The only intervention was due to the severe adverse conditions experienced during the 2014/15 and 2015/16 seasons, which was accounted for by lowering the planned harvest yields of the new PMH model by a further 20% from the dates that the events occurred. The transactions concluded by the simulation were all done on the closing prices of marketing cycles, which were on Fridays.

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The planned harvest yield for each season was calculated by using the average final harvest yields of the control group for the ten preceding seasons (Table 1). For example, to calculate the planned harvest yield of the 2013/14 season, the averages of the final harvest yields from the control group for the previous ten seasons 2003/04 to 2012/13 were used.

The ideal profit goal of 30%/ha for the 2013/14 season was the average net profits of the control group for the previous five seasons 2008/09 to 2012/13. The position sizing [24] at the ideal profit goal was set at 5% of the total harvest, which had to be sold in the week when the ideal profit goal was reached. The lowest profit goal was set at 33% below the ideal profit goal and amounted to 20%/ha. This was the profit level where the model started doing transactions. The position sizing at the lowest profit goal was set at 1% of the total harvest. The lowest and ideal profit goals were kept the same throughout the study period (Table 1).

When seasons started, the deliverable harvest was set at 0% [21, 30]. When harvesting started, it was increased to 25%, being the percentage of the total expected harvest of which delivery can be guaranteed to buyers. On completion of the harvest, it was made 100%, meaning that the total harvest (date, grade and quantity) can be guaranteed to buyers.

For this study the hedging instruments used during the uncertain pre-harvest phases of seasons were at the money put options. The Black-Scholes Option Pricing Formula was used to calculate the weekly average cost of the money put options on the JSE daily closing prices. This average cost was then used when buying at the money put options in the following week. The certain harvest marketing instrument used to sell the crop was fixed priced contracts. It was for that part of the season when delivery (date, grade and quantity) could be guaranteed to buyers.

Other inputs used by the new PMH model were the location differentials (similar geographic area to the control group), handling fee and storage cost for every season in the study (Table 2).

The total break-even costs for each season of the control group included their directly attributable costs, overhead costs, as well as foreign factor costs such as interest, leases and management (Table 3). It did not include the owners' salaries. Before using the total break-even cost in the new PMH model, the marketing and storage costs of the control group were first subtracted. This was done because

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the simulation algorithm of the new PMH model calculated its own marketing and storage costs to arrive at its net profit.

As stated in the research objectives, two approaches were compared to the control group, namely a simulation of the new PMH model with the use of put options as a pre-harvest strategy, and a simulation of the new PMH model without the use of put options as a pre-harvest strategy.

When not using a put option pre-harvest strategy, it took on average two months longer to complete a season's marketing (Table 4). The new PMH model using a put option pre-harvest strategy generated an average net profit of 41%/ha. The model not using the put option pre-harvest strategy generated an average net profit of 47%/ha (Table 4). These were substantial performances compared to the average of 22%/ha of the control group (Table 3). There was also a stabilising effect; while the new PMH model outperformed its ideal profit goal of 30%/Ha as stated, the average net profit of the control group decreased from its 30%/ha over the previous five seasons (Table 1), to 22%/ha over the study period (Table 3).

It must be considered that some farmers could have started selling their old harvests in time to finance the costs of their new seasons. It is possible that the control group was under cashflow pressure to sell their harvests earlier than the new PMH model had to, since cashflow is essential. The new PMH model had already sold on average 48% of its total harvest at harvest completion when using a put option pre-harvest strategy, and 25% when not using a put option pre-harvest strategy. Respectively 73% and 67% of total harvests were sold four months after the harvests were completed (Figure 1). (This information was not available from the control group.)

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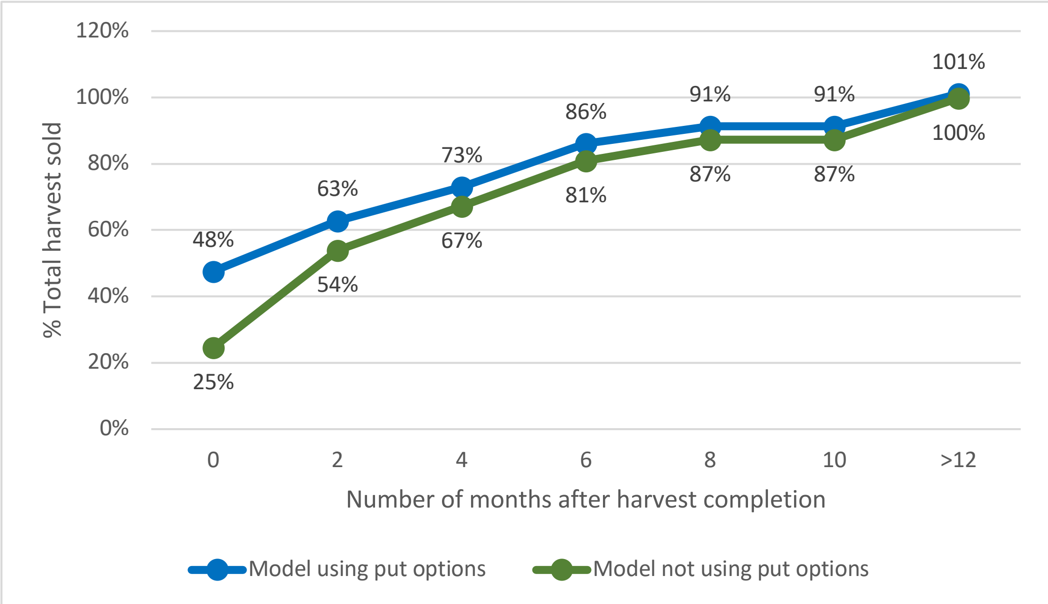
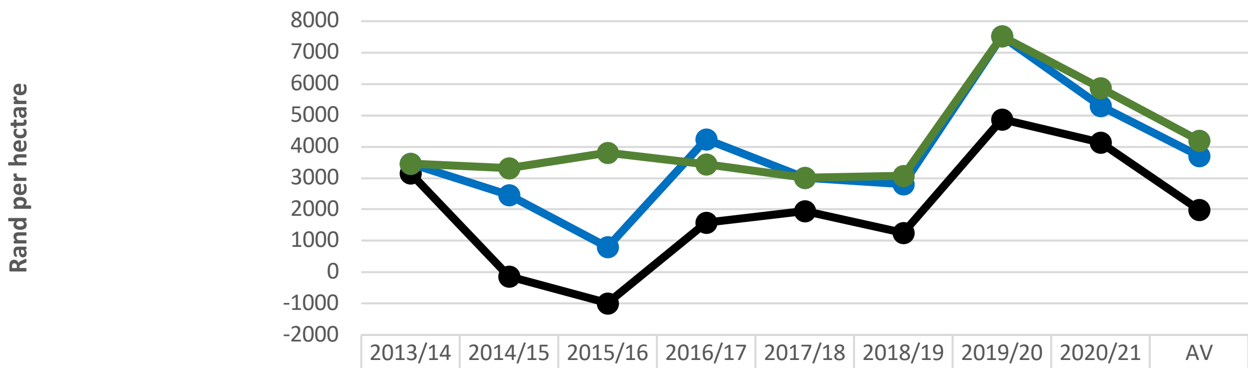


Figure 1: Average percentage of total harvest sold by the new PMH model

Descriptive statistics

Figure 2 shows the net profit comparison of the new PMH model to the control group from Tables 3 and 4.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	AV
Anonymous control group	3154	-134	-984	1588	1956	1251	4874	4142	1981
Model using put options	3465	2451	798	4231	3011	2800	7518	5303	3697
Model not using put options	3457	3316	3798	3438	3011	3078	7518	5864	4185

Figure 2: Net profit comparison of the new PMH model to the control group

Over eight consecutive seasons (2013/14 to 2020/21), the anonymous control group was profitable with an average net profit above break-even cost of R1 981 (Figure 2), and in two of the eight seasons (2014/15 and 2015/16), the anonymous control group reported losses. In comparison, with the new PMH model using put

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options as a pre-harvest strategy, the model generated an average net profit above break-even cost of R3 697 (Figure 2), outperforming the control group on average by R1 716 or 87% per hectare per season. With the new PMH model not using put options as a pre-harvest strategy, the model had an average net profit above break-even cost of R4 185 (Figure 2), outperforming the control group on average by R2 204 or 111% per hectare per season. Neither of the two new PMH model approaches reported any losses.

Independent sample t-tests

In the next section the robust descriptive statistics are specified (Table 5), and the statistical significance of the profitability was calculated using robust independent sample t-tests (Tables 6 and 7). The interpretation rule as for Cohen's d was used, namely d-values of 0.2, 0.5 and 0.8 correspond to small, medium and large effect sizes, respectively, which show the effect sizes (ξ) (for trimming levels on 0.00). The M-estimator was reported from Yuen's t-test. M-estimators determined outliers and applied adjustments for it. This held several advantages for the reporting of the data, such as down-weight rather than exclude observations and avoiding over- or under-trimming the data [20].

The results of the new PMH model with the use of put options as a pre-harvest strategy were compared to the control group (Table 6). The findings from Yuen's t-test indicated that the new PMH model (with the use of put options) performed statistically significantly better than the control group. Considering that the sample size was relatively small, it was acceptable to consider significance at $p < 0.10$, a medium effect size was reported ($p = 0.093$; $\xi = 0.566$).

The results from the new PMH model without the use of put options as a pre-harvest strategy were compared to the control group (Table 7). The findings from Yuen's t-test indicated that the new PMH model (without the use of put options) performed statistically significantly better than the control group with $p < 0.01$, and close to a large effect size ($p = 0.003$; $\xi = 0.741$) was reported.

In the 2014/15 and 2015/16 seasons the impact of adverse weather conditions on the planned harvest yields (Table 1) were more severe than expected. The planned harvest yields were lowered by 20% to compensate for the adverse events, but the final harvest yields (Table 3) were eventually lower than the 20% downward compensation of the planned harvest yields. For the model using put options as a pre-harvest strategy, this resulted in a lower profitability than expected for the two seasons (Figure 2). These events were good illustrations of the importance of conservative estimations of pre-harvest yields. Adding unnecessary yield risk reduced the advantage of profit margin hedging [16,17]. Even though put options were expensive to use, not conservatively estimating the pre-harvest yields in the 2014/15 and 2015/16 seasons were one of the main reasons why the model using put options as a pre-harvest strategy, was less profitable than the model not using put options as a pre-harvest strategy. The model using put options as a pre-harvest strategy had the benefit of longer marketing periods with more profitable hedging opportunities, from a price risk management perspective this made it a more sound approach. Put options are practical risk management tools, even though no guarantees can be given. Whether themselves or with support, it is advisable that farmers should at least try to trade an option [33].

CONCLUSION

The study found both a significant improvement in profitability and a stabilising effect when using a profit margin hedging approach. Integrating the components of crop price risk management into a platform allows a crop farmer to make more informed decisions on a daily basis. This approach assists farmers in maintaining a more profitable and viable business, especially amid the inherent risks in the agricultural environment. This study showed that crop farmers should have their crop marketing plans tailored to fit the unique circumstances of their farms.

The results of this study are valuable to crop farmers, traders, financiers and all other parties involved in the crop production supply chain. Crop farmers cultivating a large variety of crops, even in countries outside South Africa, commercial farming, and emerging operations, may benefit from applying the new PMH model. It is expected that with time and a larger sample, an even more evident effect could be expected.

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Institutional review board statement: Ethics approval was received from the Ethics Committee of the Faculty of Economic and Management Sciences with approval number NWU-01270-21-A4.

Data availability statement: The data used in the study are available from a controlled access repository.

Conflicts of interest: The authors report that DG developed the novel PMH model. He has disclosed those interests fully and ensured that the data in this study were analysed by an objective third party to manage any potential conflicts.

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Table 1: Calculation of the planned harvest yields and the profit goals

Variables	2013 /14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Planned harvest yields (Ton per hectare)	4.90	5.03	4.89	4.76	4.88	4.91	4.83	4.92
Ideal profit goal (%/ha)	30%	30%	30%	30%	30%	30%	30%	30%
Lowest profit goal (%/ha)	20%	20%	20%	20%	20%	20%	20%	20%

Table 2: Seasonal costs (Rand per ton excluding VAT)

Variables	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Location differential on 200 km (rand per ton)	201.29*	211.88	197.06	193.53	209.18	221.29	238.00	243.65
Handling fee (rand per ton)	39.75	43.00	41.85*	45.00	48.00	54.57	57.03	62.37
Location differential + handling (rand per ton)	241.04	254.88	238.91	238.53	257.18	275.86	295.03	306.02
Daily storage costs (rand per ton per day)	0.59	0.64	0.66*	0.71	0.76	0.86	0.91	0.98

Source: [29, 32] *Estimated values where values were not available

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Table 3: Data from the control group

Variables	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	AV
Net profit above total break-even cost (R/ha)	3154	-134	-984	1588	1956	1251	4874	4142	1981
Net profit % above total break-even cost (%/ha)	42%	-2%	-12%	18%	22%	13%	49%	42%	22%
Final harvest yield (Ton/ha)	6.10	3.10	2.90	6.30	5.90	4.90	6.40	5.60	5.15
Total break-even cost (R/ha)	7586	7960	8385	8593	8882	9328	9908	9980	8828
(-) Crop marketing and storage costs (R/ha)	81	85	90	80	82	76	79	141	89
(=) Total break-even cost for new PMH model input (R/ha)	7505	7875	8295	8513	8800	9252	9829	9839	8739
Average area seeded (ha)	1543	1372	412	1054	1254	1687	1372	1547	1280

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Table 4: Results from the new PMH model

Variables	Model	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	AV
Net profit above break-even (R/ha)	With Put	3465	2451	798	4231	3011	2800	7518	5303	3697
	Without Put	3457	3316	3798	3438	3011	3078	7518	5864	4185
Net profit % above break-even cost (%/ha)	With Put	46%	31%	10%	50%	34%	30%	76%	54%	41%
	Without Put	46%	42%	46%	40%	34%	33%	76%	60%	47%
Marketing completion date	With Put	01Mar 2015	31Jan 2016	31Jul 2016	17Mar 2019	16Dec 2018	04Aug 2019	18Oct 2020	15Aug 2021	-
	Without Put	15Mar 2015	14Feb 2016	04Dec 2016	14Jul 2019	16Dec 2018	26Jan 2020	18Oct 2020	03Oct 2021	-
Marketing completion after harvest (months)	With Put	7	6	0	20	5	13	3	1	7
	Without Put	8	7	4	24	5	18	3	2	9

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Table 5: Robust Descriptives

Value	Group	Mean	SE
Profit with put options	Control	1981	712
	Model	3697	717
Profit without put options	Control	1981	712
	Model	4185	575

Table 6: Robust independent sample t-test with put options

Value		t	df	P	ξ
Profit with put options	**Yuen's test**	1.70	14.0	0.111	0.566
	Yuen's bootstrapped	-1.70		0.116	
	M-estimator*	-1716		0.093	

Note: *Mean estimator used; For bootstrapping 1 000 draws were used

Table 7: Robust independent sample t-test without the use of put options

Value		T	df	P	ξ
Profit without put options	**Yuen's test**	2.41	13.4	0.031	0.741
	Yuen's bootstrapped	-2.41		0.039	
	M-estimator*	-2204		0.003	

Note: *Mean estimator used; For bootstrapping 1 000 draws were used

REFERENCES

1. **Nyman R** Farmers preferred end-values related to their use of forward contract [thesis]. Sweden: Swedish University of Agricultural Sciences, 2015.

2. **Fennell KM, Jarrett CE, Kettler LJ, Dollman J and DA Turnbull** Watching the bank balance build up then blow away and the rain clouds do the same: A thematic analysis of South Australian farmers' sources of stress during drought. *J Rural Stud.* 2016; **1(46):** 102-110. https://doi.org/10.1016/j.jrurstud.2016.05.00

3. **Mogoatlhe L** South Africa repeals State of Disaster for drought. Here's why it's a 'grave concern' for farmers. Global Citizen 2020 Jul 21. Retrieved from https://www.globalcitizen.org/en/content/south-africa-drought-national-crisis-farmers/ *Accessed January 2022.*

4. **Sguazzin A** SA's heaviest rain on record brings crop damage, floods and a lush green Karoo. News24 2022 Jan 25. Retrieved from https://www.news24.com/fin24/economy/sas-heaviest-rain-on-record-brings-crop-damage-floods-and-a-lush-green-karoo-20220125 *Accessed January 2022.*

5. **Šperanda I and Z Tršinski** Hedging as a business risk protection instrument. Ekonomski vjesnik: Econviews Review of Contemporary Entrepreneurship, Business, and Economic Issues. 2015; **28(2):** 551-565.

6. **Kim HS, Brorsen BW and KB Anderson** Profit margin hedging. Am J Agric Econ. 2010; **92(3):** 638–653. https://doi.org/10.1093/ajae/aap038

7. **Fernandez-Perez A, Frijns B, Gafiatullina I and A Tourani-Rad** Profit margin hedging in the New Zealand dairy farming industry. *J. Commod. Mark.* 2021; 100197. https://doi.org/10.1016/j.jcomm.2021.100197

8. **Kee D and DE Kenyon** Hog Profit Margin Hedging: A Long-Term Out-of-Sample Evaluation. Paper presented at NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Illinois, USA. 1999. Retrieved from: http://www.farmdoc.uiuc.edu/nccc134 *Accessed November 2021.*

9. **Strydom D and M Venter** Understanding the Maize Maze. *The Dairy Mail* 2014 Sep 1; **21:** 48–53.

10. **Ramey HM** Cattle Feeding Hedging and Cash Margin Analysis [dissertation]. Colorado: Colorado State University, USA. 2022.

11. **Sihlongonyane LN** Evaluating the prospect to hedge maize price risk against the Johannesburg Stock Exchange Commodity Derivatives Market prices: The case of Eswatini [dissertation]. Pretoria: University of Pretoria, South Africa. 2021.

12. **Nordier JP** Identifying possible misspecification in South African soybean oil future contracts [dissertation]. Pretoria: University of Pretoria, South Africa. 2021.

13. **Kahan D** Managing risk in farming. FAO. 2013. Retrieved from: https://www.fao.org/3/i3229e/i3229e.pdf *Accessed March 2022.*

14. **Financial Glossary.** Hedging. Available from: https://financial-dictionary.thefreedictionary.com/hedging *Accessed January 2022.*

15. **Geyser M** The Short and Long of Future Markets: Safex, Grain Hedging, Speculation. Kejafa Knowledge Works; *Krugersdorp*. 2013: 35-43.

16. **Kim HS, Brorsen BW and KB Anderson** Profit Margin Hedging. Paper presented at NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Chicago, Illinois, USA. 2007. Available from: https://legacy.farmdoc.illinois.edu/nccc134/conf_2007/pdf/confp14-07.pdf *Accessed January 2022.*

17. **Usset E** Five Common Mistakes in Grain Marketing. Paper presented at Farmers Conference, Minnesota, University of Minnesota, USA. 2020.

18. **Ueckermann EM, Blignaut JN, Gupta R and J Raubenheimer** Modelling South African grain farmers' preferences to adopt derivative contracts using discrete choice models. *Agrekon* 2008; **47(2):** 222–239. https://doi.org/10.1080/03031853.2008.9523798

19. **The Jamovi project** [computer program]. Jamovi version 2.2. 2021.

20. **Wilcox RR** Introduction to robust estimation and hypothesis testing. 3rd ed. Academic Press, Amsterdam. 2011.

21. **Jordaan H and B Grove** Factors affecting maize producers' adoption of forward pricing in price risk management: the case of Vaalharts. *Agrekon* 2007;**46(4):** 548-565. https://doi.org/10.1080/03031853.2007.9523786

22. **Groskopf J** Developing a grain marketing plan in 5 easy steps. 2017. Cropwatch 2017 Oct 6. Available from: https://cropwatch.unl.edu/2017/developing-grain-marketing-plan-5-easy-steps *Accessed February 2022.*

23. **Kim HS** Making grain pricing decisions based on profit margin hedging and real option values [thesis]. Oklahoma: College of the State University, USA. 2008.

24. **Ginyard J** Position-sizing Effects on Trader Performance: An experimental analysis [thesis]. Sweden: Uppsala University, 2001.

25. **Venter MM, Strydom DB and B Grové** Stochastic efficiency analysis of alternative basic grain marketing strategies. African Association of Agricultural Economists (AAE) conference, Bloemfontein, South Africa. 2012.

26. **Malherbe J, Landman WA and FA Engelbrecht** The bi-decadal rainfall cycle, Southern Annular Mode and tropical cyclones over the Limpopo River Basin, Southern Africa. *Clim. Dyn.* 2014; **42(11):** 3121–3138. https://doi.org/10.1007/s00382-013-2027-y

27. **Massey RE** Crop marketing plan. Agricultural MU Guide. 1999; G600:1-4. Available from: https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/60852/g00600.pdf?sequence=1 *Accessed January 2022.*

28. **Bown AN, Ortmann GF and MAG Darroch** Use of maize marketing alternatives and price risk management tools by commercial maize farmers in South Africa. *Agrekon* 1999; **38(3):** 275–301. https://doi.org/10.1080/03031853.1999.9523555

29. **Ray R** Prediction Markets and the Financial "Wisdom of Crowds". *J Behav Financ*, 2006; **7(1):** 2–4. https://doi.org/10.1207/s15427579jpfm0701_1

30. **Woolverton AE and ME Sykuta** Do income support programs impact producer hedging decisions? Evidence from a cross-country comparative. *Appl Econ Perspect Policy*. 2009; **31(4):** 834–852. https://doi.org/10.1111/j.1467-9353.2009.01469.x

31. **Johannesburg Securities Exchange (JSE).** Daily market closing prices. Available from: https://www.jse.co.za/trade/derivitive-market/interest-rate-derivatives-market/agricultural-derivitives Accessed December 2021.

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32. **Senwes.** Seasonal storage and handling tariffs for maize and grain sorghum. Available from: http://www.senwes.co.za. *Accessed February 2022.*

33. **Potter B** FarmProgress. Trade an option, USA. 2022. Available from: https://www.farmprogress.com/farm-progress-events/11-great-takes-2022-summit/gallery?slide=5 *Accessed February 2022.*