IMPACT ANALYSIS OF FOOD POLICY RESPONSE ON HOUSEHOLD FOOD SECURITY: THE CASE OF SOUTH AFRICA'S MAIZE SUBSECTOR

by

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1. Introduction

The phenomenon of increasing food prices within South Africa reflects the current reality of the global food market. According to reports from the World Bank, World Food Program and United Nations, a wave of food price inflation is moving through global markets, leading to what some have termed a "silent Tsunami" of hunger. Since the turn of the century global wheat prices have increased by 200%, while overall food prices have risen by 75% (World Bank, 2008a). According to the United Nations Food and Agriculture Organization (FAO), of the 36 countries in crisis, 21 are in Africa. Of these, the worst hits are those highly dependent on imports of basic staple grains such as maize, rice and wheat (World Bank, 200b).

In regards to South Africa, despite being a surplus maize producer, rising global commodity prices has translated into increasing food processing, transportation and distribution costs. The domestic commodity market is adjusting to a new equilibrium, which is attended by increased food price volatility particularly among staple food goods. For example, within South Africa, the average retail price for a 5 kg bag of maize meal fell 3% from December 2004 to December 2005, but rose nearly 23% from December 2006 to December 2007 (Figure 1).

Figure 1: South African Retail Prices of Selected Maize Meal Products

Maize is a dominant grain crop in South Africa. In 2000 approximately 98% of rural consumers and 71% of urban consumers consumed maize on a daily basis (Steyn & Labadarios, 2000). For low-income consumers, with an estimated income of about US$1 per person per day, maize represents as much as 66% of their daily energy intake (Oldewage-Theron, et. al., 2005).

In the light of rising food prices as well as increasing energy costs, the South African government has responded by expanding existing social protection programs as well as implementing economy-wide macro-policies (World Bank, 2008c). One such policy is the recent commitment of the Department of Agriculture to increase budgetary spending on agricultural development to boost local production (National Food Summit, 31 July 2008).

Despite the governments proactive response, very little is known about the actual impact of the various policies on household food security. The overall objective of this study is to quantify the possible income and nutritional impact of the recent commitment by the Department of Agriculture to increase budgetary spending on agricultural development. To accomplish the objective three levels of models were utilized. The first is a large-scale partial equilibrium model developed by the Bureau of Food and Agricultural Policy (BFAP). The model has the capacity to generate a 10-year outlook for a range of commodity prices under a set of macro-economic and policy assumptions, given world commodity price projections. This model was used to generate an outlook for maize grain under two possible future scenarios; the first is the baseline scenario where it is assumed no additional government investment in the agricultural sector takes place, the second allows for the impact of an investment within the maize subsector large enough to boost local maize production by 15% above the baseline projections. To link the grain sector to the maize meal down-stream market, a simplified specification of price transmission was utilized. From this model, the long-run propensity (LRP) was used to determine the long-run change in retail prices as a result of projected wholesale maize grain prices. These retail price projections were then used to estimate the impact on household expenditure as well as nutritional in-take patterns by utilizing household-level survey data.

2. Methodology

2.1 Maize Grain Price Projections

Forecasting economic time series remains an important component of economic study. Models used to forecast economic variables fall into two broad categories; those based on either explicit behavioral assumptions; or on extrapolating observed trends and patterns (Voormen, 1991). In terms of behavioral models, future movements in a variable are predicted by relating a set of explanatory variables in a casual framework. For example, prices are typically hypothesized to be determined simultaneously by supply and demand conditions (Voormen, 1991). The BFAP sector model is a behavioral model consisting of a simultaneous system of demand and supply equations. It is a stochastic multi-commodity partial equilibrium model that incorporates regime-switching modelling techniques to accommodate various equilibrium pricing conditions. All the commodities included in the BFAP sector model are simulated within a closed system of equations, thereby accounting for the dynamic interactions between various industries (see Figure 2). This implies, for example, any shocks in the livestock sector are transmitted to the grain and oilseed sector and *vice versa*. The model incorporates the most important elements of demand and supply and solves for a market-clearing (equilibrium) price. Once an exogenous shock is imposed in the model, the model solves for a new equilibrium where total demand has to equal total supply and a new price is formed.

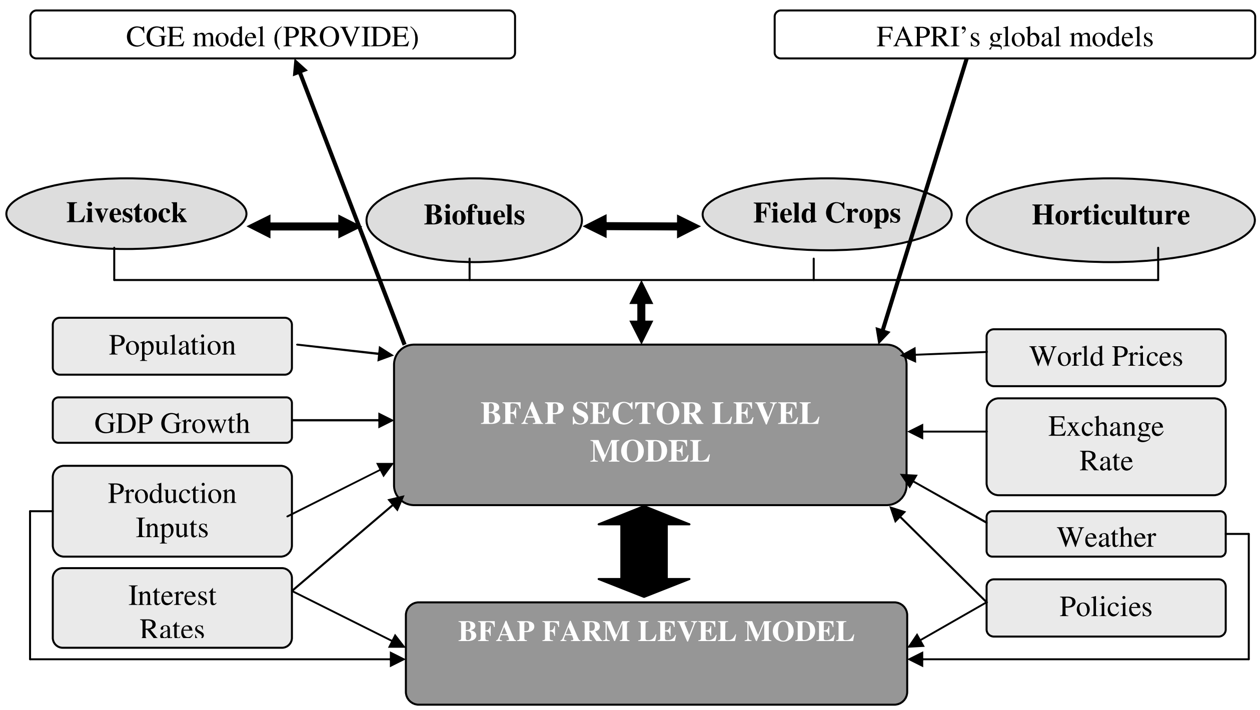

Figure 2: BFAP modelling framework

Within this study, the BFAP sector model was applied to generate upstream wholesale maize grain prices under two possible future scenarios. The first serves as a baseline projection while the second assumes a 15% increase in the overall production of maize grain within South Africa due to increased public funding within the sector.

2.2. Retail Price Model

Vertical price transmission has been the subject of numerous agricultural economic studies (Gardner, 1975; Brorsen et al., 1985; Heien, 1980; and Wohlgenant, 1985). Many of these studies have focused on testing for asymmetry in a wide variety of agricultural markets (Appel, 1992; Boyd and Brosen, 1988; Hahn, 1990; and Engle and Granger, 19987). These econometric models have ranged from the Wolffram-Houck specification, which assumes no cointegration between the analyzed variables, to the error-correction model proposed by Engle and Granger (1987) when cointegration exists between price series at different levels of the supply chains.

To link the upstream wholesale maize grain prices with retail maize meal prices, a simplified price transmission model was used, where the response of retail prices to changes in wholesale maize grain prices was estimated using a rational distributed lag model, given by the following equation:

$$\Delta LnP_{r,t} = \alpha_0 + \beta_1 \Delta LnP_{w,t-1} + \beta_2 \Delta LnP_{w,t-2} + \alpha_1 \Delta LnP_{r,t-1} + \nu_t \qquad (1)$$

where Pr refers to the retail price of maize meal measured in Rands per ton, P_w the wholesale price of maize grain, and t is the current time period. Unlike Engle and Granger (1987), an error-correction term is not included in the model since there was no evidence of cointegration between retail and wholesale prices. In testing for cointegration the t-statistic on the lagged predicted error term was above the critical-value of -3.78 regardless of whether testing in levels or logs. However, the first differenced variables for cointegration were tested and found to be cointegrated at the 5% level of significance; indicating a long-run relationship between the change in wholesale prices on changes in retail maize meal prices. To determine the appropriate lag-length truncation of the independent variable, which was found to be two, both the AIC and BIC selection criteria were used. In this model the Long-run Propensity is given as:

$$LRP = (\beta_1 + \beta_2)/(1-\alpha_1) \qquad (2)$$

This measure indicates the long-run change in retail prices due to a permanent 1% change in wholesale prices. In order to project the annual average retail maize meal prices for 2008/2009 marketing year, the forecasted percentage change in wholesale maize grain prices, as generated from the partial equilibrium model was multiplied by the LRP.

When Ordinary Least Squared method of estimation is applied to equation (1), it was found that the price transmission model exhibited both serially correlated error terms and heteroskedasticity (non-stationary error variances). In order to correct for this, the model was estimated by OLS with standard errors robust to both serial correlation and heteroskedasticity.

2.3 Household Expenditure and Nutritional In-take

The potential impact of maize meal inflation on South African households was estimated using survey data compiled by the Bureau of Market Research (BMR) (Martins, 2006). The BMR data-set consists of household survey data on annual maize meal expenditure patterns, disaggregated by the universal Living Standard Measures (LSM[1]) within three metropolitan areas in South Africa (see Table 1). These include; Gauteng, the Cape Peninsula and the Durban metropolitan areas.

Table 1: Overview of the LSM market segments

	LSM group									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Share of South African adult population (%)	6.1	12.2	12.6	14.9	13.5	14.4	7.8	5.7	6.7	6
Average income (Rand/household/ month)	1003	1210	1509	1924	2674	4400	6880	9304	12647	19974
Estimated maize meal expenditure (R/household/month for 2006)	307	264	329	317	319	195	89	118	68	85

Source: The South African Advertising Research Foundation (SAARF), Bureau of Market Research

[1] The South African Advertising Research Foundation (SAARF) developed a market segmentation tool - the Universal Living Standard Measures (LSM) - based on the socio-economic status of an individual or group (SAARF, 2007). LSM 1 represents the lowest income group while LSM 10 represent the highest (SAARF, 2008a).

To account for the impact of changing maize meal prices on households' expenditure levels, the own-price elasticity of demand was utilized. In general, consumer expenditure on maize meal is found by multiplying price and quantity demand. Any change in price will impact overall expenditure through two opposing effects; the price itself (price effect) as well as through its related impact on quantity demand (quantity effect). The net effect would depend on relative size of each. Table 2 below summarizes the price and quantity effects of rising maize meal prices on expenditure.

Table 2: Price and Quantity Effect of Rising Maize Meal Prices

Year	Price Effect	Quantity Effect		Net Effect
	% Δ in P_r[2]	**Own-price Elasticity of Demand**	**% Δ in Q_d**	**% Δ in Expenditure**
2006/07	29.0%	-0.2	-5.8%	23.2%
2007/08	5.4%	-0.17	-0.9%	4.5%
Baseline_08/09	3.6%	-0.18	-0.6%	2.9%
Alternative_08/09	0.2%	-0.18	0.0%	0.2%

Source: NAMC Food Price Monitoring, BFAP 2008 Baseline

The net effect on expenditure was then used to estimate the impact on household monthly expenditure on maize meal disaggregated by LSM groupings.

Food security implications of rising maize meal prices on poor consumers were explored through a nutritional perspective. According to the National Food Consumption Survey (Steyn & Labadarios, 2000) maize porridge is dominant among the five most widely consumed food items in South Africa. Table 3 presents a summary of these foods and their typical energy contributions.

[2] Refers to actual year-on-year inflation figures: March 2006 to March 2007 – 29 percent; April 2007 to April 2008 – 5.4 percent. Projected 'baseline' inflation: May 2008 to May 2009: 3.58 percent. Projected inflation with increased agricultural output scenario: 0.22%.

Table 3: The five most widely consumed food items in South Africa

Food type:	**Share of South African adults consuming item:**	**Average – South African adults:**		**Average – Low-income consumers:**	
		Typical portion size[1]:	Energy value[2]:	Typical portion size[3]:	Energy value[2]:
Maize porridge	56.4 %	761.5g	3465kJ	532.0g	2420kJ
Brown bread	51.5 %	152.0g	1566kJ	150.0g	1545kJ
Sugar	77.0 %	31.4g	486kJ	22g	341kJ
Tea (bags)	61.9 %	±5g	50kJ	±2.5g	25kJ
Fresh full cream milk	34.9 %	212.7g	623kJ	56g	164kJ

[1] *Source: Steyn & Labadarios, 2000*
[2]*: Sources: Danster eat al, 2008; Wolmarans et al, 2005 ; Medical Research Council, 1999.*
[3] *Source: Oldewage-Theron et al, 2005*

The analysis was based on the typical maize porridge portion size for low-income consumers as described by Oldewage-Theron, et al (2005) and the assumption was made the 'typical' portion size values applied to the period (March 2006). Since the reduction of portion sizes is a likely food coping strategy for poor households (Kruger, et al , 2008), the potential energy loss associated with reduced portion sizes (due to more expensive maize meal) was estimated for the time periods 2006/2007, 2007/2008 as well as for the projected inflation period up to mid-2009. To determine the reduction in portion sizes, the quantity effect of changing maize meal prices was utilized.

3. Data

3.1 BFAP sector model

The data that was required to construct the commodity balance sheet for maize was obtained from the South African Grain Information Services (SAGIS), while the source for wholesale maize grain prices was the South African Futures Exchange (SAFEX).

3.2 Retail Price Model

Retail maize meal prices were obtained from the market intelligence firm A.C. Nielsen. The sample period for both wholesale and retail prices ranged from January 2004 to December 2007.

4. Results

4.1 Scenarios

This study presents two possible future scenarios on the contribution of maize meal to daily energy requirements. The BFAP baseline 2008 presents one possible outlook of commodities markets over the next ten years under a certain set of assumptions and macro economic projections. These projections include the world prices, the exchange rate, interest rates, rainfall, economic growth and policies. The baseline scenario can be regarded as a benchmark outlook for maize grain prices given the current trends in local and international commodity markets. For the alternative scenario it is assumed that government's strategy to boost local production of maize is successful and that local production of maize grain increases by 15%. The BFAP sector model was used to simulate the percentage deviation of the projected maize grain price from the baseline.

4.2 BFAP Sector Model results

Table 4 presents the baseline scenario for the white maize industry in South Africa as published in the BFAP baseline 2008.

Table 4: Baseline Scenario for the South African white maize industry

	2008	2009	2010	2011	2012	2013	2014
				thousand tons			
Production	6,771	5,840	6,009	5,829	5,956	5,804	6,043
Feed consumption	827	845	709	712	738	749	775
Human consumption	3,863	3,770	3,758	3,721	3,722	3,672	3,650
Ending stock	1,501	1,581	1,736	1,737	1,797	1,762	1,830
Exports	1,150	1,025	1,268	1,276	1,315	1,299	1,431
Imports	0	0	0	0	0	0	0
				R/ton			
SAFEX price	1810	2019	1960	2171	2154	2372	2459

Important to note, for the purpose of this study the maize grain price and consumption were only projected for the period April 2008 – April 2009 (Table 4).

Table 5 presents the alternative scenario for the South African white maize industry. This future scenario was simulated by inducing an increase in local production of 15 percent. Therefore, production in 2009 increased from 5.84 million tons in the baseline scenario to 6.69 million tons in the alternative scenario. The increased production causes the maize grain price (SAFEX price) of white maize to decrease from R2019/ton to R1823/ton, a 9.7% drop, in 2009.

Table 5: Alternative Scenario for the South African white maize industry

	2008	2009	2010	2011	2012	2013	2014
				thousand tons			
Production	6,771	6,694	6,926	6,730	6,877	6,699	6,979
Feed consumption	827	866	746	752	782	793	821
Human consumption	3,863	3,838	3,799	3,766	3,770	3,721	3,702
Ending stock	1,501	1,901	2,227	2,308	2,420	2,399	2,489
Exports	1,150	1,470	1,934	2,010	2,093	2,087	2,247
Imports	0	0	0	0	0	0	0
				R/ton			
Average SAFEX prices	1810	1823	1836	2028	1995	2204	2277

4.3 Retail Price Model Results

In order to link the grain sector to the maize meal down-stream market, a simplified price transmission model, Equation (1), was estimated by OLS with standard errors robust to both serial correlation and heteroskedasticity. Table 6 summarizes the estimated coefficients and t-statistics.

Table 6: Estimated Retail Maize Meal Price Equation, January 2004 – December 2007

Explanatory Variable	Coefficients
$\Delta LnP_{r,t-1}$	0.0597
	(0.042)
$\Delta LnP_{w,t-2}$	0.1653
	(0.055)**
$\Delta LnP_{r,t-1}$	0.2912
	(0.1234)*
Constant	0.0004
	(0.006)
Long-run Propensity	0.3177
R-squared	0.3359
Number of Observations	45

Note: **=significant at the 1% level; *=significant at the 5% level

The table shows the coefficient on the $\Delta LnP_{r,t-1}$ is not statistically significant, indicating within the model, changes in wholesale prices have no contemporaneous effect on retail prices. This result is not surprising since there exists a four-month lag period between maize grain and maize meal prices due to the milling industries pricing strategy (Meyer, et. al., 2005) However, the variable of interest here is the LRP. This measure implies a permanent one percentage increase in the change of wholesale maize grain prices increases the change in retail maize meal prices by 0.31 percent. The estimated LRP coefficient was found to be significantly different from zero at the 5% level.

The LRP coefficient was used to determine the long-run change in retail prices as a result of projected wholesale maize grain prices generated by the BFAP sector model. Table 7 summarizes the results.

Table 7: Projected maize meal retail price inflation

BFAP sector model				
			Change: 2008 – 2009	
Maize grain prices (SAFEX price)	2008	2009		
	R/ton		Absolute	Percentage
Baseline	1,810	2,019	209	11.55%
Scenario	1,810	1,823	13	0.71%
LRP coefficient = 0.31				
Maize meal prices			**% Increase 2008 – 2009**	
Baseline Scenario			11.55% * 0.31 = 3.58%	
Alternative Scenario			0.71% * 0.31 = 0.22%	

Given the estimated LRP coefficient, retail maize meal prices are projected to increase 3.58% under the baseline scenario and virtually zero (0.22%) under the alternative scenario for the period April 2008 to April 2009. This projected maize meal inflation is significantly lower than the year-on-year maize meal inflation rate of March 2006 to March 2007 (29%) and somewhat lower than the year-on-year maize meal inflation rate of 5.4% for April 2007 to April 2008. Thus the projected maize meal inflation rates are minimal (even without increased government investment in the agricultural sector) compared to the inflation rates in preceding years.

4.4 Impact of Maize Meal Inflation on Household Expenditure and nutritional status

The retail price projections, presented in Table 7, were used to estimate the impact on household expenditure as well as nutritional in-take patterns by utilizing household-level survey data. Figure 4 illustrates consumers' additional spending due to historical maize meal inflation from March 2006 to March 2007 and from April 2007 to April 2008 as well as the projected maize meal prices for 2008/2009.

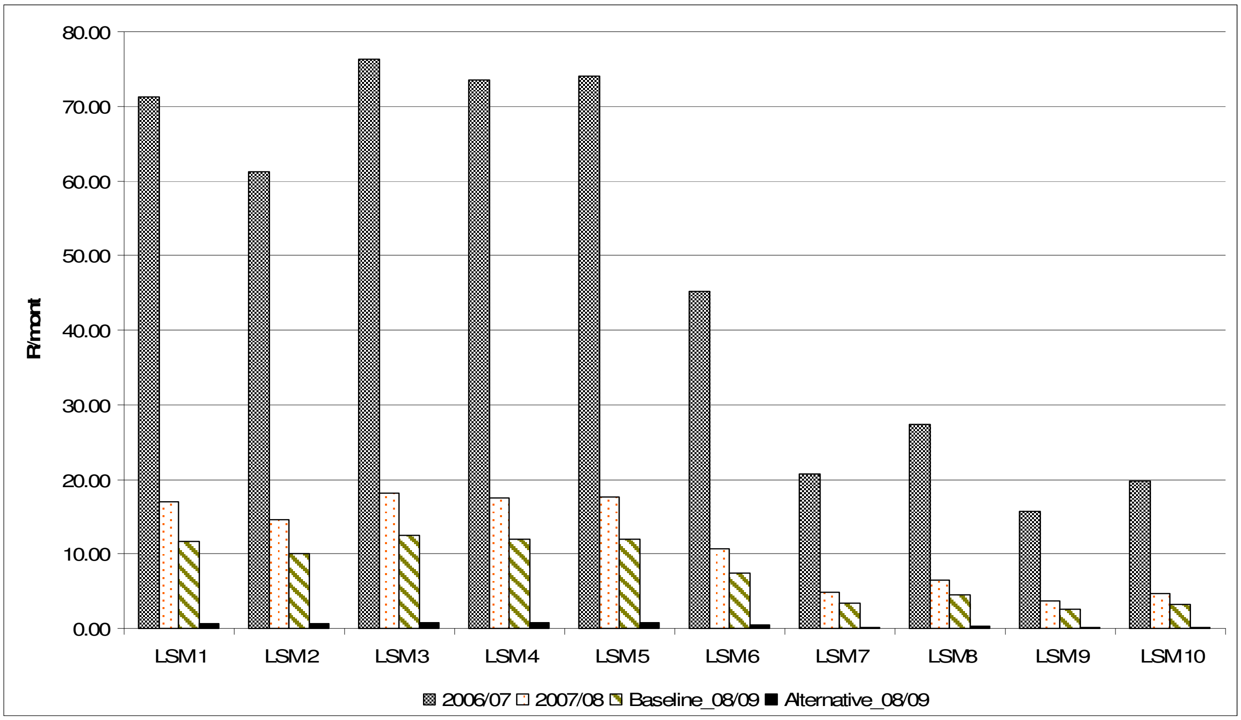

Figure 4: Consumers' estimated additional spending on maize meal due to inflation

Given a 29% year-on-year maize meal price inflation rate, the largest increase in expenditure across all income groups occurred in the 2006/2007 period. In absolute terms, households in LSM groups 1 through 5 experienced the largest additional spending during this time period. For instance, expenditures on maize meal increased by R71 per month for households within LSM 1, while LSM 5 realized a R74 per month increase in spending. These estimated increases in maize meal expenditure create a 6.3% increase in households' monthly income devoted to maize meal for the LSM 1, while LSM 5 realized a 2.5% increase in the monthly income devoted to maize meal purchases.

Most notably, when the impact of the alternative maize meal price projections on household expenditures are estimated and compared to the baseline, it is clear with government investment in the sector, consumers additional spending on maize meal will be negligible. For instance, given the projected maize meal price inflation of 3.58% under the baseline assumption, household expenditures on maize meal are estimated to increase on average, approximately R11 per month for households within LSM 1 through LSM 5 groupings. However, under the alternative scenario of increased government investment to the sector, which increases production, the estimated increase in maize meal expenditure for households within the same category amounts to an average R0.71 per month. For households whose largest share of income is devoted to maize meal, this difference can have a significant nutritional impact.

Table 8 presents a summary of the potential nutritional implications of maize meal inflation in South Africa for the period March 2006 to April 2008, as well as for the two potential future projections. It is important to take into consideration that the BFAP sector model presents the aggregate shifts in national human consumption of maize. This implies that no distinction is made between the various income levels of households. For the purpose of this study only the lowest income households are taken into consideration. In many cases these households already do not have sufficient income to meet their daily dietary requirements. It can thus be assumed in the "worst case" scenario, they face an inelastic own price elasticity with respect to food. In other words, if maize meal prices increase by 3.58%, household quantity demanded of maize meal will decreases by more than 3.58%. To estimate the changes in quantity of maize meal consumed, the price elasticities of demand, as generated by the BFAP model were used (see Table 2). The nutritional impact of this decrease in maize meal consumption is summarized in the table below.

Table 8: Nutritional implications of maize meal inflation

Product:	**Scenario:**	**Portion size:**	**Contribution to daily energy needs[3]:**
Maize[4] porridge (cooked)	March 2006 – March 2007	501.1g	22.8%
	April 2007 – April 2008	496.5g	22.6%
	Baseline Scenario: April 2009	493.3g	22.5%
	Alternative Scenario: April 2009	496.3g	22.6%

[3] Compared to minimum energy needs for an adult male – 10,000kJ/day.
[4] Based on reference portion size as specified by Oldewage-Theron et al, 2005.

In general, the analysis shows despite rising food prices, maize meal portion sizes remain relatively constant across all time periods. Given the role of maize meal as a staple food for low-income households, this income is not surprising. What is important to note, is under the alternative scenario, with a negligible increase maize meal prices (0.22%), portion sizes are projected to remain constant between 2008 and 2009.

5. Conclusion

Low-income maize meal consumers have relatively inelastic demand for maize meal. When faced with volatile and increasing prices their one option is to postpone or reduce their purchase of non-staple foods, such as meat and dairy products, which are rich in vitamins and minerals (Bouis, 2008). This study has found if government investment in the maize sector is successful, and results in a 15% increase in production; it could potentially mean cost-savings of approximately R10 per month for the lowest income households. Although not substantial, this cost-savings could increase in consumption of non-staple food items as meat and diary, which are rich in minerals and vitamins. However, further study, which would allow for the substitution effect among food items within the consumer basket, could further quantify the overall nutritional impact of the proposed government policy.

In view of the urgency of the current food crisis it becomes critical to evaluate and assess the effectiveness of national agricultural policy in addressing and/or mitigating household food security. The empirical results in this paper suggest that government's recent commitment to increase budgetary spending in agriculture could have limited impact to alleviate undernourishment of the poor. When the conditions of the baseline scenario (benchmark) are carefully analysed, it becomes clear even without the additional government investment in agriculture, South Africa is projected to have surplus maize stocks and remain a net exporter into the future. Local maize grain prices are, thus, trading closer to export parity levels and the impact on local prices due to higher local production levels will not be dramatic. However, it is important to note that the comparative outcome is dependent on the baseline scenario against which an alternative is analysed. A further rise in input costs or severe weather conditions could change the baseline scenario completely, causing a policy to boost local production to prove very effective.

REFERENCES

Bouis, H., (2008). Rising Food Prices Will Result in Severe Declines in Mineral and Vitamin Intakes of the Poor. Harvestplus, Consultative Group on International Agricultural Research (CGIAR), Washington, D.C.

Bureau for Food and Agricultural Policy (2008). "The South African Agricultural Baseline, June 2008", Launched on 5 June 2008, Pretoria.

Diebold, F.X. (2004). Elements of Forecasting. South-Western, United States.

Kruger, R., Schönfeldt, H.C. & Owen, J.H. (2008). Food-coping strategy index applied to a community of farm-worker household in South Africa. Food and Nutrition Bulletin, Volume 29, no. 1, pp.3-14.

Martins, J.H. (2006). Total household cash expenditure in South Africa by Living Standard Measure (LSM) group and product, 2005. Research report no. 347, Pretoria: Bureau of Market Research.

Medical Research Council (MRC) (1999). *SA Food Composition Tables of 1999.* MRC: Cape Town.

Organization for Economic Co-operation and Development (OECD), 2008. Food Outlook Outlook 2008. Paris, France.

SAARF (2007). *SAARF Segmentation Handbook* - Based on AMPS 2006 and AMPS 2007a. Johannesburg: South African Advertising Research Foundation.

SAARF (2008a). *SAARF Trends 2003 - 2007*. Johannesburg: South African Advertising Research Foundation, February 2008.

SAARF (2008b). Data on trended LMS by Race. Based on AMPS 2001, 2002, 2003, 2004, 2005, 2007. Personal communication with Claire Milne, Technical Support Executive at SAARF.

Voormen, H. (1991). A Short-run Forecasting Model for Nitrogen Fertilizer Prices. Agribusiness, Vol. 7, No. 6. United States.

World Bank, 2008a. High Food Prices – A Harsh New Reality.
http://econ.worldbank.org/WEBSITE/EXTERNAL/EXTDEC/0,,contentMDK:21665883~pagePK:64165401~piPK:64165026~theSitePK:469372,00.html

World Bank, 2008b. The Effects of High Food Prices in Africa – Q&A. http://web.worldbank.org.

World Bank, 2008c. Country Policy Responses. http://www.worldbank.org/html/extdr/foodprices/