Demand-led market opportunities for farmers in the high value product sector in South Africa: Demand elasticities for selected vegetables

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Market information is indispensable in facilitating marketing of agricultural produce, particularly fresh produce given its high perishability. The purpose of this study was to estimate South African consumers’ demand for vegetables. Demand for six vegetables was analysed via a multi-stage budgeting system, using data from the Household Expenditure Survey and the 2010 edition of the Abstract of Agricultural Statistics. The estimated demand elasticities show that the demand for all vegetables increases with rising per capita income. Most of the vegetables were found to respond substantially to changes in their own prices and in the direction as expected with estimated negative own-price elasticities.

Keywords: Vegetables, South Africa, multi-stage budgeting system, demand elasticities, market access.

JEL Classification: D12, Q11

INTRODUCTION

South Africa has a dualistic agriculture sector with a well-developed commercial sector comprising about a declining 37 000 farmers in 2014 from 46 000 in 2006 occupying 86% of the total agricultural land and 300 000 small-scale farmers occupying the remaining 14% which is mostly marginal lands in the former homeland areas (Groenewald, 2014; Vink and van Rooyen, 2009; Ortmann and King, 2006).

Linking farmers to markets in South Africa has occupied centre stage among both public and private sector endeavours to create a commercial and vibrant rural economy through the development of smallholder farmers. For a long time, endeavours aimed at farmer development in South Africa have focussed on technical assistance to farmers, that is dispensing agronomic and mechanisation advice to farmers. While the improvement in technical know-how and its attendant improvement of productivity are important, they do not form a sufficient precondition to successfully integrating smallholder and previously marginalised farmers into the mainstream economy. Recently there has been a growing realisation that linking farmers to markets is an important and integral part of migrating smallholder farmers up the development ladder thus addressing imbalances of past policies and fostering a more egalitarian society. Most smallholder farmers in South Africa are located in marginal agriculture lands in the previous homelands (Vink and van Rooyen, 2009; Statistics South Africa, 2002), thus they largely produce vegetables, which are considered to be high value products (HVPs), because they can be produced intensively on small plots. Moreover, smallholder growers in South Africa have been found to be efficient producers of vegetables as measured by technical efficiency (Mkhabela, 2005). Mkhabela (2005) found smallholder vegetable producers in Msinga, in the northern KwaZulu-Natal province, to be technically efficient, with an average efficiency score of 86%.

Coupled with the suitable disposition of smallholder farmers to produce HVPs, the health benefits of increased consumption of vegetables are clearly documented in the literature (Block et al., 1992; van Duyne and Pivonka, 2000; Dallongeville et al., 2010;
Gustavsen and Rickertsen, 2006) and this is expected to bolster the demand for vegetables as consumers become more health-conscious. However, cognisance must be taken of findings that the consumption of vegetables for health reasons is largely a consideration of consumers who already have adequate levels of calorie intake. Block et al. (1992) indicated that the health benefits of eating vegetables accrue from reduction in the incidence of various forms of cancer, as well other ailments such as stroke, heart disease, and obesity. However, although the per capita consumption of vegetables is showing an increasing trend, it is still low in South Africa, particularly among low-income consumers. But the per capita consumption of vegetables in South Africa is expected to rise in response to improved standards of living and growing health concerns among consumers (Arshad and Hameed, 2007). There is also the emergence of research to promote healthy eating as a means of increasing market access for smallholder farmers in South Africa (Mkhabela, 2011).

The overall increase in the per capita consumption of vegetables has largely been due to increases in the overall consumption of potatoes, tomatoes, carrots, onions, cabbages, and cucumbers. Economics theory postulates that own price, prices of closely related products and per capita income are major determinants of demand for any particular commodity (Ferris, 2005; Tomek and Robinson, 1985). However, there are recognised factors in the vegetable sector that mitigate against this straightforward relationship postulated by economic theory. For example, Chiew (2007) identified that there is poor dissemination of price information for vegetables and that this has often been recognised as the prime cause of ineffective production planning, which, in turn, leads to wide fluctuations in prices. Market information is important in facilitating a functioning marketing system from production downstream along the value chain. The purpose of this study is therefore to estimate the South African consumers' demand for vegetables in order to identify those vegetables that are likely to be profitable, especially for smallholder farmers. Specifically, this study estimates demand elasticities in terms of income and price elasticities for six major vegetables.

The importance of demand elasticities is their value in identifying those vegetables that are in demand and those vegetables whose quantities demanded respond positively to increases in income and price. Mergenthaler et al. (2009), for instance, stated that knowing the income elasticity of demand for products purchased could help supply chain actors to better adjust to changing consumer preferences in the process of economic development. Greater understanding of the demand for vegetables would be helpful in assessing the quality of South African diets. It also has implications for future agricultural trade, particularly as there are concerted efforts to link smallholder farmers to markets in order to make smallholder farming commercially viable. Furthermore, many aspects of economic policy formulation and strategic industry planning in the food sector require estimates of food demand elasticities (Ulubasoglu et al., 2010). This view was further buttressed by Menezes et al. (2008) who stated that empirical evidence on consumers' behaviour is very important in the formulation and analysis of economic policy.

**LITERATURE REVIEW**

The demand for vegetables has been studied extensively in developed countries but there is a paucity of literature on the demand for fresh produce, particularly vegetables in developing countries, including South Africa. For example, You et al. (1997) studied the demand elasticities for eight major vegetables at retail level in the United States of America with the Almost Ideal Demand System (AIDS), using annual data for the period from 1960 to 1993. They found that the demand for eight major vegetables was generally inelastic with respect to changes in own prices, and cross-price effects for most fresh vegetables were negligible. Few studies have attempted to examine the demand elasticities of fresh produce particularly in Africa and even less so for South Africa. Mergenthaler et al. (2009), for example, lamented the paucity of recent demand analysis studies that look specifically into household demand for food products from modern, high-value chains in developing countries. The limited information on such an important subject is considered a knowledge gap because such information about economic demand parameters is instructive for projections of future trends (Mergenthaler et al., 2009).

Most studies that look at the demand elasticities of agricultural products have used estimated expenditure elasticities as proxies for income elasticities, which does not conform to the hypothesis in Engel's law. Under Engel’s law, as income rises, the proportion of income spent on food falls, even if actual expenditure on food rises (Engel, 1857). Thus, the income elasticity of demand for food must be less than 1.4. One of the results of rising consumer incomes is to reduce the consumers’ share of income spent on food. Normally, expenditure on food does not increase at the same pace as income, so according to Engel's law, the ratio of expenditure on food to income falls with rising income (Kohls and Uhl, 1998).

Radam et al. (2005) estimated expenditure elasticities for 20 types of fruits in South East Asia by using the Working-Leser functional form. The study found that star fruit (Averrhoa carambola) had the highest expenditure elasticity (1.104) while jackfruit (Artocarpus heterophyllus or A. heterophylla) recorded the lowest expenditure elasticities (0.225). However, Bryne and Capps (1996) argued that the Working-Leser functional form inherently imposes restrictions on the elasticity values.

Furthermore, none of the above studies censored zero consumption in the data, which might have led to
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It can be observed from Figure 1 that potatoes were by far the most important vegetable type in South Africa in terms of consumption and have shown an upward trend from approximately one million tonnes in 1982 to about two million tonnes in 2008. Tomatoes and onions are the second and third most commonly consumed vegetables in South Africa, respectively.

Figure 2 shows the trends in the producer price indices for horticultural, field and animal food products from 1982 to 2009. The figures are real values in year 2005 terms. The producer price index for horticultural produce, which included vegetables, saw a steady increase during the period under investigation. However, the increase between 2000 and 2009 was steeper, showing that fruit and vegetables were becoming more expensive in South Africa.

DATA AND ESTIMATION PROCEDURES

The fresh vegetable demand system to be estimated consisted of potatoes, tomatoes, cabbages, carrots, butternuts, beetroot, lettuce, and onions. Annual data on South African per capita domestic consumption and retail prices for these eight fresh vegetables over the period 1998 to 2009 were used. Data sources included the Abstract of Agricultural Statistics, 2010 (DAFF, 2010) and Income and Expenditure of Households, 2005/2006 (StatsSA, 2008). These eight vegetables represented 80% of the total per capita fresh vegetable consumption on the retail quantity base over the observed period, as shown in Figure 1. Figure 1 shows the consumption (demand) trends, as proxied by the quantities sold, of 12 fresh vegetables in South Africa between 1982 and 2009. A number of fresh vegetable varieties were excluded from the demand system due to lack of information about retail prices and quantities sold.

This study utilises data from the Abstract of Agricultural Statistics (AAS) obtained from the South African Department of Agriculture, Forestry and Fisheries (DAFF, 2010). The data includes quantities demanded (consumed) and prices from 1982 to 2009. Another source of data that was used was the Income and Expenditure Survey of 2005/06 (Stats SA, 2008) which provided household consumption expenditure data and household size. The large dataset is ideal as it provides higher degrees of freedom, which is particularly important for estimating demand elasticities.

On the basis of the economic model, a three-stage utility maximisation is assumed to simplify the construction of the decision-making process for South African households in connection with expenditure on vegetables. Various recent studies (Blundell et al., 1993; Fan et al., 1995; Gao et al., 1997; Tiffin and Tiffin, 1999; Dey, 2000) have used the multi-stage...
budgeting framework in estimating the demand functions for disaggregated commodity groups, thus justifying the economic model chosen for this study. In the first stage, a household makes decisions on how much of their total income is to be allocated for food consumption, conditional on household characteristics and the consumption of non-food goods (expenditure). Following Blundell et al. (1993), the specific functional form used in the first stage can be written as:

$$\ln(M^h) = \alpha + \beta_1 \ln(S^h) + \beta_2 \ln(N^h) + \beta_3 \ln(Y^h) + \beta_4 Y^h + \sum_{i \in Z} \beta_i Z$$ (1)

where $M^h$ is food expenditure, $S^h$ is price index for food, $N^h$ is non-food expenditure as proxy for price index for non-food, $Y^h$ is per capita total expenditures (incomes), and $Z$ is a vector of demographic variables that include household size and a dummy variable of urban.

As equation (1) is an outcome of utility maximisation problem, it must observe homogeneity of degree zero in prices and income. The restriction is evaluated at the sample mean and can be stated as:

$$\beta_1 + \beta_2 + \beta_3 + 2\beta_4 \ln y^h = 0$$ (2)

In the second stage, the household allocates a portion of food expenditure for consumption of vegetables and other commodity groups. The natural approach would be to include purchase of food in the right hand side as a repressor. This raises the second major problem, which is simultaneity, given that such purchasing decisions are endogenous. To address this, the predicted rather than actual value is used as a repressor.

This instrumental variable approach has been estimated by Blundell et al. (1993) and in other studies (Fan et al., 1995; Gao et al., 1997; Tiffin and Tiffin, 1999; Dey, 2000) via Tobit regression. The estimating equation for stage 2 is expressed as:

$$\ln(EG^h) = \theta_0 + \theta_1 \ln(PG^h) + \theta_2 \ln(M^h) + \theta_3 \ln(\hat{M}^h) + \theta_4 S^h + \sum_{i \in Z} \theta_i Z$$ (3)

where $EG^h$ is aggregate expenditures on vegetables, $PG^h$ is price index of aggregate vegetable group, $\hat{M}^h$ is the predicted value of $M^h$ from stage 1, $S^h$ is the price index for the $i$th food group, and $Z$ is a vector of demographic variables that include household size and a dummy variable of urban.

Then, a Probit regression is computed in order to estimate the probability that a given household consumes the individual vegetable in question. This regression is used to estimate the inverse Mills ratio for each household, which is used as an instrument in the second regression. IMRs are also incorporated into the model to correct the possible bias created by the presence of zero consumption (Heien and Wessels, 1990).

In the third stage, the household allocates the aggregate vegetable group expenditure between different vegetable items. Denote the set of food items on the demand side as DF. For $i$th DF, the quadratic version of AIDS is (Blundell et al., 1993):

$$S_i^h = \gamma_0 + \sum_{j \in DF} \gamma_j \ln P_j^h + \gamma_1 \ln \left[ \frac{EG^h}{ST^h} \right] + \gamma_2 \ln \left[ \frac{EG^h}{ST^h} \right] + \gamma_3 \cdot BMR_i^h + \sum_{i \in Z} \gamma_i Z$$ (4)

where $S_i^h$ is the expenditure share of the $i$th vegetable item in the aggregate vegetable group expenditure, $P_j^h$ is the price of the $j$th vegetable item, $IMR_i^h$ is the estimated value of inverse Mills ratio, and $ST^h$ is an approximation of the AIDS price index, is computed as:

$$\ln ST^h = \sum_{i \in DF} S_i^h \ln P_i^h$$ (5)
Utility maximisation requires that parameters of equation (4) comply with homogeneity of degree zero in prices, symmetry of the Slutsky matrix, and the adding up restriction (budget shares sum to 1). These restrictions are expressed as follows:

\[ \sum_j \gamma_{ij} = 0, \quad i, j \notin DF \]  

(Homogeneity) \hspace{1cm} (6)

\[ \gamma_{ij} = \gamma_{ij}, \quad \gamma_{i1} = \gamma_{1j}, \quad \gamma_{2i} = \gamma_{i2}, \quad i, j \notin DF \]  

(Symmetry) \hspace{1cm} (7)

\[ \sum_i \beta_0 i = 1, \sum_i \beta_1 = \sum_i \beta_2 = 0; \quad i \notin DF \]  

(Adding up) \hspace{1cm} (8)

For \( i, j \notin DF \), let \( \epsilon_i^h \) be the own- and cross-price elasticities, \( \eta_i^h \) the income elasticity of food type \( i \), \( \eta_0^h \) be the elasticity of food type \( i \) to food expenditure, and \( \eta_i^h \) the elasticity of food expenditure to income. Therefore, following Blundell et al. (1993), the elasticities are:

\[ \eta_i^h = \beta_1 + 2 \beta_2 \ln \gamma^h \]  

(9)

Aggregate vegetable group expenditure to total expenditure:

\[ \eta_{ij}^h = \left( \theta_2 + 2 \theta_3 \ln M_i \right) PFD_i^h \]  

(10)

\( \text{ith vegetable item to aggregate vegetable expenditure:} \)

\[ \eta_{ij}^h = \left[ \gamma_1 + 2 * \gamma_2 \ln \left( \frac{\hat{E}G_i^h}{P_i^h} \right) \right] \]  

(11)

Income elasticity of \( \text{ith food item:} \)

\[ \eta_i^h = \eta_i^h / \eta_i^h \]  

(12)

The Marshallian measure of price elasticity:

\[ e_{ij}^h = \frac{\gamma_i^h}{S_i^h} \left[ \gamma_1 + 2 * \gamma_2 \ln \left( \frac{\hat{E}G_i^h}{P_i^h} \right) \right] S_i^h - k_{ij} \]  

(13)

where \( PFD_i^h \) is the probability aggregate vegetable group, and may be estimated from the sample proportion, \( k_{ij} \) is the Kronecker delta which is unity for \( i = j \), otherwise zero.

RESULTS

Table 1 presents the parameter estimates of the food expenditure function. Noteworthy is the square term of the per capita income variable, which is significantly different from zero. This result shows that the food expenditure function is non-linear and a quadratic term is appropriate for use in the remaining analyses. The coefficient of household size is negative and insignificant.

The implication of the negative finding is that there is a negative relationship between household size and expenditure on food and this is counter-intuitive. However, for South Africa, this is hardly surprising as most poor households have large families and wealthier families have fewer members, thus the latter group can afford to spend more on food as they tend to procure more expensive food, including luxurious goods. The average household size for non-poor households in South Africa is 3.1, significantly smaller than that of poor households at 5.1 (Statistics South Africa, 2014; p. 52). Furthermore, Statistics South Africa (2014) reports that on average, non-poor households spent R14020 on food and non-alcoholic beverages while poor households spent R25 348 in 2011.

The coefficient for food price index of 0.2035 was significant at the 5 % level of significance, implying that as the price of food increases households will spend more on food as the same amount of food now costs more. Such a relationship between expenditure on food and food price supports the theory that food, by and large, is a necessity and people still have to eat whether food is expensive or not. However, it is expected that as food prices increase, after a certain point poorer households will begin to reduce their consumption of food as they struggle to satisfy non-food expenditure, such as school fees. The estimated food expenditure elasticity with respect to total income is 0.4346 and the high R-square signifies that the independent variables chosen are representative of reality because they sufficiently explain the dependent variable, which is per capita food expenditure.
Table 2. South African fresh produce expenditure function

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.3728</td>
<td>0.2806**</td>
</tr>
<tr>
<td>Ln (price of cereals)</td>
<td>-0.1511</td>
<td>0.3328</td>
</tr>
<tr>
<td>Ln (price of meat)</td>
<td>-0.0608</td>
<td>0.1894</td>
</tr>
<tr>
<td>Ln (price of milk and eggs)</td>
<td>0.5600</td>
<td>0.3047</td>
</tr>
<tr>
<td>Ln (price of fruit and vegetables)</td>
<td>0.7631</td>
<td>0.1850**</td>
</tr>
<tr>
<td>Ln (price of fruit and vegetables)²</td>
<td>0.1431</td>
<td>0.0199**</td>
</tr>
<tr>
<td>Ln (price of beverages)</td>
<td>0.1183</td>
<td>0.0950**</td>
</tr>
</tbody>
</table>

Adjusted R-squared: 0.99

**Significant at the 5% level of significance; ²Denotes a squared term

Table 3. Estimated parameters of the QUAIMS vegetable demand system, South Africa, 1998-2009

<table>
<thead>
<tr>
<th>Variable</th>
<th>Potatoes</th>
<th>Tomatoes</th>
<th>Cabbages</th>
<th>Onions</th>
<th>Butternut</th>
<th>Beetrootsth</th>
<th>Carrots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.6307 (0.2497)**</td>
<td>5.1751 (0.6456)**</td>
<td>5.7637 (0.3916)**</td>
<td>4.3633 (0.5199)**</td>
<td>2.2628 (1.0020)**</td>
<td>2.3871 (1.0362)**</td>
<td>2.9719 (0.7859)</td>
</tr>
<tr>
<td>Ln (price of potatoes)</td>
<td>-0.4746 (0.0638)**</td>
<td>-0.1988 (0.1468)</td>
<td>0.2113 (0.0890)**</td>
<td>-0.0298 (0.1182)**</td>
<td>0.1740 (0.2453)</td>
<td>0.1189 (0.2187)**</td>
<td>0.1498 (0.1547)**</td>
</tr>
<tr>
<td>Ln (price of tomatoes)</td>
<td>0.3572 (0.0495)**</td>
<td>0.1732 (0.4766)**</td>
<td>0.3793 (0.2891)**</td>
<td>0.3577 (0.3838)</td>
<td>0.1339 (0.5089)**</td>
<td>0.1105 (0.6275)**</td>
<td>0.0136 (0.4748)**</td>
</tr>
<tr>
<td>Ln (price of cabbages)</td>
<td>-0.0612 (0.0552)**</td>
<td>0.0767 (0.1967)</td>
<td>-0.1186 (0.1193)**</td>
<td>0.0184 (0.1584)**</td>
<td>0.1279 (0.3499)**</td>
<td>-0.1029 (0.277)**</td>
<td>0.0170 (2058)**</td>
</tr>
<tr>
<td>Ln (price of onions)</td>
<td>-0.0832 (0.0391)</td>
<td>-0.2706 (0.0826)**</td>
<td>0.0005 (0.1979)</td>
<td>-0.4273 (0.6650)**</td>
<td>-0.3329 (0.1518)</td>
<td>-0.1752 (0.1198)**</td>
<td>-0.2254 (0.0876)</td>
</tr>
<tr>
<td>Ln (price of butternut)</td>
<td>0.0615 (0.0872)**</td>
<td>0.3371 (0.2635)</td>
<td>0.2434 (0.1598)**</td>
<td>0.2515 (0.2121)**</td>
<td>-0.6326 (0.4570)**</td>
<td>-0.1546 (0.3606)**</td>
<td>0.1105 (0.3093)**</td>
</tr>
<tr>
<td>Ln (price of beetroot)</td>
<td>-0.9051 (0.9321)</td>
<td>-0.1812 (0.1438)</td>
<td>-0.1813 (0.1438)</td>
<td>-0.0743 (0.1910)**</td>
<td>0.4164 (0.2824)**</td>
<td>-0.2576 (0.2320)**</td>
<td>0.1703 (0.1718)**</td>
</tr>
<tr>
<td>Ln (price of lettuce)</td>
<td>-0.7351 (1.1403)</td>
<td>-0.1221 (0.1241)</td>
<td>-0.1221 (0.1241)</td>
<td>-0.0607 (0.1648)</td>
<td>-0.0212 (0.1391)**</td>
<td>0.3895 (0.3284)**</td>
<td>0.2099 (0.2482)**</td>
</tr>
<tr>
<td>Ln (price of carrots)</td>
<td>-0.0007 (0.2735)**</td>
<td>-0.5753 (0.2131)</td>
<td>-0.5754 (0.2131)**</td>
<td>0.0140 (0.2830)**</td>
<td>0.3708 (0.5042)**</td>
<td>0.4228 (0.3984)**</td>
<td>-0.1454 (0.2746)**</td>
</tr>
</tbody>
</table>

Figures in parenthesis represent the standard error; **Significant at the 5% level of significance

Table 2 reports the estimates of the parameters of the vegetable expenditure function. The food expenditure variable and its square term are positive and significant. This suggests that the response of vegetable expenditure to changes in food expenditure is significant and non-linear. Evaluated at the sample mean, the vegetable expenditure elasticity with respect to food expenditure is 0.7632. The negative and significant household size shows that an increase in the size of the family would decrease the per capita expenditure on vegetables. Of interest, although not the focus of this study, are the prices of cereals and meat, which both had negative but insignificant coefficients. Cereals, especially maize, are the mainstay of the diet for the majority of South African and their negative coefficient indicates that people are likely to spend less on food when the price of cereals is high. A caveat to the preceding statement is that the coefficient was not significant at the 5% level of significance.

Table 3 presents the estimates of the parameters of the vegetable demand system. The square term of the per capita vegetable expenditure variable was significant in most of the vegetable types (except bulb and stem vegetables), indicating that the response of consumption of various types of vegetables to increases in expenditure on vegetables is non-linear. Most of the urban dummy variables (except leafy and salad vegetables) are significant in all the share equations. However, the sign differs in different equations, suggesting that preference patterns for various vegetable types vary between urban and rural. Vegetable expenditure elasticity for individual types of vegetables varies from 1.0172 for fruiting and flowering vegetables to 0.8972 for processed vegetables.

Table 4 presents the estimates of income elasticities of different vegetable and the income elasticities were estimated using the expenditure elasticities that were estimated from Stage 1, Stage 2, and Stage 3. The income elasticities vary across vegetable types. Income elasticities for potatoes (0.7072), tomatoes (0.3254), carrots (0.6098), and gem squash (0.4457) are inelastic, showing that these vegetables are normal and necessity goods. Lettuce (1.7373), onions (-0.6438), and butternuts (1.0967) exhibited elastic responses to demand. This suggests that preference patterns for various vegetable types vary between urban and rural.
changes in income. An unexpected finding is that of onions exhibiting income inelasticity. Onions form part of most dishes in South Africa and is especially used by poor households as it is believed that it improves the acceptability of the meal due to the aroma it gives during cooking and serving. This is an important finding suggesting that lettuce, butternuts, potatoes and carrots present the best investment option in terms of farmers’ production choices. These four vegetables can be considered to be high value products that are preferred by consumers as their incomes grow.

Lettuce is a salad vegetable and its consumption is expected to increase as consumers become more health-conscious and increase salad consumption in their daily diets. The consumption of potatoes is expected to increase as the overall consumption of vegetables increase because consumers tend to switch to “non-traditional” carbohydrate and energy sources as incomes increase. In South Africa, maize (maize meal) and rice are the most common starchy foods and potatoes are the most logical substitute. Furthermore, potatoes are more versatile as they can be consumed both at home and in many food-away from home dishes, such as chips (French Fries), potato wedges, mashed-potato, and salads, etc. Butternuts are an obvious substitute for pumpkin and these are smaller in size thus preferred by the increasing middle class and urban population.

Cabbages (−2.0149), pumpkin (−1.3362), cucumbers (−1.5292), hubbard squash (−1.6410), and onions (−0.6438) had elastic yet negative income elasticities. The implication of the negative elasticities is that as household incomes increase, the consumption of these vegetables decreases more than proportionate to the increase in income thus rendering them inferior products. Mostly poor people consume large amounts of cabbages in South Africa, particularly in rural areas (Mkhabela, 2011). Most people substitute butternuts for pumpkin as their income rises and families become smaller because pumpkins are normally large and thus cannot all be consumed before getting spoiled. Thus smaller families prefer butternuts to pumpkins, although the two are from the same vegetable family. An interesting observation is that of cucumbers having negative income elasticity, although being complimentary to lettuce which had positive income elasticity. However, a plausible explanation could not be found.

The next step was to look at the Marshallian own-price elasticities of the eight vegetables, evaluated at the sample mean as reported in Table 5. Most of the own-price elasticities of demand for individual vegetable types are inelastic ($\varepsilon_{ii} > 1$). The percentage change in quantity demanded is less than the percentage change in own-price. Potatoes (−0.0113), tomatoes (−0.0228), cabbages (−0.2270), beetroots (−0.2995), and lettuce (−0.07292) all had negative own-price elasticities and this means that an increase in the price of each of these vegetables will elicit a reduction in their demand (consumption), albeit less the proportionate increase in price. The only vegetable group that had positive own-price elastic of demand, although not significant (at the 5% level) was onions (0.089241). A plausible explanation is that onions are considered as a companion (complimentary) to most vegetable dishes, such as stir fries, stews and salads.

**CONCLUSIONS AND POLICY IMPLICATIONS**

Demand elasticities for eight vegetables, namely potatoes, tomatoes, cabbages, onions, carrots, beetroots, lettuce, and butternut were analysed using
data from various Abstracts of Agricultural Statistics collected and published by the Department of Agriculture, Forestry and Fisheries (DAFF) via a multi-stage budgeting system. In the first stage, a household makes decisions on how much of their total income (expenditure) is to be allocated for food and non-food goods. In the second, the household allocates food expenditure for vegetables and other commodities, and in the third stage, the household allocates the aggregate vegetable group expenditure between different vegetable items.

The estimated demand elasticities show that demand for all vegetables increases when per capita income rises. This result is consistent with the findings of other researchers – for example, Tey et al. (2007) in Malaysia and You et al. (1997) in the USA – who showed that food consumption patterns moved toward functional foods in response to income growth. Furthermore, all the vegetables were found to respond to changes in their own prices and in the directions as expected with estimated own-price elasticities all less than unity.

The results of this study have some important policy implications and these can be broadly divided into three categories, namely: 1) marketing, and linking farmers to markets 2) food security and poverty issues and 3) healthy eating.

Firstly, the identification of those vegetables that have elastic and high-income elasticities presents an opportunity of identifying marketing niches and vegetable crops with high potential returns for farmers, particularly smallholder farmers. Although return to farmer is a function of price and related costs (both production and marketing costs), the identification of vegetables income elasticities gives an indication of which products’ demand will continue to increase as households’ income increases. Such information can better inform farmers on how to allocate their future investment. The government, private and the non-governmental sectors in South Africa have numerous interventions aimed at fostering rural development and emancipating the poor from poverty, and agriculture has been identified as one of the most important sectors in achieving these elusive goals. Thus, focussing efforts – be they extension or marketing – on those vegetables with high demand elasticities would yield the highest returns per rand spent.

Secondly, South Africa has been trying to address poverty and its attendant food insecurity problems. Given that South Africa is considered food secure at national level but food insecure at the household level, it would be useful to identify to vegetable products that the South African consumer is demanding. Having identified the vegetables with high demand elasticities, the next step would be to identify policy interventions that could be used to increase the consumption of such vegetables by food insecure households. Possible policy instruments that could be used include subsidising the price of highly nutritious and energy-rich vegetables, such as potatoes thus offering an incentive to both producers and consumers. Furthermore, South Africa has a well-developed social grant system that reaches most poor households, which could be used to subsidise the consumption of vegetables through designating part of the grant for the exclusive purchase of vegetables. Such an intervention would not only address poverty and food insecurity but also address the issue of promoting healthy eating among the population of South Africa. It should be noted that the subsidies are mainly aimed at the consumers rather than subsidizing the farmers, per se. This approach is not unique to South Africa but has been used in a number of countries worldwide and does not result in market distortion.

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