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Understanding the Food Energy Water Nexus

Through the food and energy lens

# AUTHOR

Manisha Gulati

# ABOUT THIS STUDY

Food, water and energy security form the basis of a self-sufficient economy, but as a water-scarce country with little arable land and a dependence on oil imports, South Africa's economy is testing the limits of its resource constraints. WWF believes that a possible crisis in any of the three systems will directly affect the other two and that such a crisis may be imminent as the era of inexpensive food draws to a close.

WWF received funding from the British High Commission to establish a research programme exploring the complex relationship between food, water and energy systems from the perspective of a sustainable and secure future for the country. This paper is one of three summary papers based on nine reports in the Food Energy Water Nexus Study. The three summary papers are:

1. *Understanding the Food Energy Water Nexus: Through the food and energy lens:* Manisha Gulati
2. *Understanding the Food Energy Water Nexus: Through the energy and water lens:* Manisha Gulati
3. *Understanding the Food Energy Water Nexus: Through the water and food lens:* Tatjana von Bormann

# PAPERS IN THIS STUDY

1. *Climate change, the Food Energy Water Nexus and food security in South Africa:* Suzanne Carter and Manisha Gulati
2. *Developing an understanding of the energy implications of wasted food and waste disposal:* Philippa Notten, Tjasa Bole-Rentel and Natasha Rambaran
3. *Energy as an input in the food value chain:* Kyle Mason-Jones, Philippa Notten and Natasha Rambaran
4. *Food inflation and financial flows:* David Hampton and Kate Weinberg
5. *The importance of water quality to the food industry in South Africa:* Paul Oberholster and Anna-Maria Botha
6. *The agricultural sector as a biofuels producer in South Africa:* Alan Brent
7. *Virtual water:* James Dabrowski
8. *Water as an input into the food value chain:* Hannah Baleta and Guy Pegram
9. *Water, energy and food: A review of integrated planning in South Africa:* Sumayya Goga and Guy Pegram

# ABOUT WWF

The World Wide Fund for Nature is one of the world's largest and most respected independent conservation organisations, with almost five million supporters and a global network active in over 100 countries. WWF's mission is to stop the degradation of the Earth's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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For further information please contact: Tatjana von Bormann at [tvbormann@wwf.org.za](mailto:tvbormann@wwf.org.za) or Manisha Gulati at [mgulati@wwf.org.za](mailto:mgulati@wwf.org.za)

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## SUMMARY

The connection between food and energy systems has become the subject of intense debate. On the one hand, there is a view that low crop yields in Africa may be attributed to low energy inputs in agriculture, compared to capital-intensive and highly subsidised agricultural systems in developed countries (Folberth et al. 2012). On the other hand, the connection between food and energy prices has become more relevant than ever in recent years, with the prices of both food and fuel rising and falling more or less in tandem. The food price spikes of 2008 and 2010 were each preceded by an increase in the prices of energy and related products. Specific to South Africa, energy prices have increased dramatically in recent years and food prices have seen above-average inflation.

Although energy prices and energy and food security are often perceived as separate challenges in South Africa, these are, in fact, highly coupled and interdependent problems. This is because energy is an important input in producing fertilisers and agricultural chemicals, growing crops, raising livestock and accessing marine food resources throughout the value chain in processing, packaging, transporting, storing and disposing food. Therefore, the stability, affordability and assurance of energy supply have a direct bearing on food prices and on food security for the poor.

Of course, it can be argued that the causes of food price inflation are numerous, complex and have many dimensions, both short- and long-term (Mason-Jones et al. 2014), and that energy prices are only one of these causes. However, the role of energy prices cannot be ignored. This is because the connection is not limited to energy being an input to food production and processing. First, there is a close link between food security and energy security because food security cannot be achieved unless people can afford the fuel with which to cook the food.

Secondly, there is bioenergy, which is being promoted as a way to increase energy security and support climate mitigation goals. Biofuel feedstocks can have a direct and an indirect effect on food supplies. If biofuels are produced from feedstocks that could have been used for food, then biofuels directly reduce potential food supplies. This reduction occurs even if the price of feedstocks increase, thus resulting in expanding supply, because the expanded feedstock supply will typically reduce the supply of other food crops. The resulting price increase from the reduced supply of food crops will induce farmers to plant more. Even if a feedstock is not directly used to produce biofuels, it can still affect food supplies because crops used for food and biofuel production compete for the same input factors, notably land. The concerns on this front have been heightened by the fact that practically all biofuels produced globally so far are produced from feedstocks that could be used for food or are produced on land that could produce food. An additional concern in a water-stressed country like South Africa, which experiences huge variations in the temporal and spatial distribution of rainfall, is that the main biofuel feedstocks require relatively plentiful water at commercial yield levels. Moreover, feedstock production for biofuels in water-scarce regions requires irrigation. This has significant impacts on water availability, particularly for food production. It is estimated that roughly 45 billion cubic metres of irrigation water were used for biofuels production, globally, in 2007 – about six times more water than was used for drinking (Howarth et al. 2009).

At the same time, there is a view that the use of food crops for the production of biofuels means that an increase in the crude oil price has a small impact on farm profitability. An oil price increase actually has a positive impact because of the link between the maize price and the oil price: internationally, ethanol is produced from maize. When the oil price increases, the maize price also increases. Although the cost of fuel, fertiliser and chemicals also increase as a result of the higher oil price, the increase in the maize price is greater, thus causing net farm income (NFI) to increase (BFAP 2008).

Thirdly, there is the aspect of food waste. Energy resources used in food production are wasted if the food ends up as waste. The disposal of food waste in landfills represents a further waste of resources, where food waste could be used as a source of energy, as animal feed or to make compost. Moreover, landfill disposal of food waste requires energy.

Finally, energy and food are also linked through their use of land and water. Trade-offs can arise at the local level where mining for extraction of energy sources such as coal competes with agriculture and livestock grazing or other traditional land uses. Trade-offs may also arise between agriculture and mining over access to water resources for the

extraction of energy sources . The concerns here relate to both the total amount of water used, especially when there are limited fresh-water resources, and the impact on water quality due to these mining activities.

The effective management of the interconnection between energy and food is, therefore, a crucial developmental challenge. In this context, this report seeks to summarise the interlinkages and interdependencies in food production from an energy perspective in South Africa and touches more broadly on implications within the Food Energy Water Nexus. It examines the scale of the problem to determine the immediate risks, as well as those that we may have more time to address. It identifies some of the steps towards a resilience-based, integrated framework, as well as the key stakeholders in the process. The aim is to foster a greater understanding of how these three systems interact in order to promote efficient, equitable and sustainable development.

## 1. DEFINITIONS

**Food security:** Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (StatsSA 2012).

**Food availability:** The availability of sufficient quantities of food of adequate quality (FAO 2006).

**Food access:** The ability to access the available food, including the economic, legal, political and social capacity for obtaining such access (FAO 2006).

**Stability:** Food security requires not only an existing ability to acquire and use food, but also a stability of supply and safety from risk (FAO 2006).

**Utilisation:** The capacity to safely and effectively utilise food, which includes having an adequate diet to maintain good nutrition, as well as non-food elements such as access to clean water and sanitation (FAO 2006).

**Food waste:** includes both food losses and food waste, that is, it includes all food originally intended for human consumption that is ultimately never consumed.

## 2. SCALE OF THE PROBLEM

### 2.1 ENERGY AS AN INPUT IN THE FOOD VALUE CHAIN

Energy profiles for six food products – maize, potatoes, apples, chicken, milk and fish – that provide the energy intensity of the food product at three points in the value chain, reveal varied energy-use patterns between the farm, food-processing and retail stages of the value chain for the different foods. With the exception of dairy, where energy use is relatively evenly spread across the value chain, there is a general tendency for energy use to be concentrated at the earlier stages of the value chain, particularly before the farm gate (Mason-Jones et al. 2013). It can be interpreted that energy use is highest at the farm stage, albeit to a lesser degree in foods requiring cold-chain distribution. By contrast, an analysis of price development across the value chain for these six food products indicates that the price contributions of different value-chain stages do not appear to be proportionally related to their energy intensity – price contributions to final retail price tend to be more equally spread across the value chain or weighted towards the latter stages of the value chain (Mason-Jones et al. 2013).

For example, in the case of maize, about three-quarters of the life-cycle energy is consumed before the maize leaves the farm gate. This energy contributes only about 12% to total farm costs and the farm-gate price makes up less than

half of the retail price (Mason-Jones et al. 2013). Similarly, in the case of fish, the fuel use of fishing vessels dominates energy use along the value chain (Mason-Jones et al. 2013). However, this stage holds the smallest share in the final retail price and the processing stage makes up about half of the retail price. It may be logical to conclude that the cost of on-farm energy use is diluted by the other on-farm costs, and then further diluted by the mark-ups of subsequent value-chain stages. As a result, despite representing the bulk of life-cycle energy use, the on-farm energy use has limited influence on the retail price.

*Prima facie*, it can be concluded that energy prices do not drive food prices and an energy price increase should not be expected to induce a proportional increase in food prices (Mason-Jones et al. 2013). In fact, for some foods such as those that are not heavily processed or refrigerated, a fairly large energy price increase may translate to only a limited price increase at retail level (Mason-Jones et al. 2013). This conclusion is also supported by the fact that, in the context of South Africa's open economy, the extent to which energy prices would influence food prices at the commodity level is limited by market dynamics. Beyond this limit, higher local energy prices would translate into an increase in imports to substitute local production of food or fertiliser (Mason-Jones et al. 2013). On the other hand, low local energy prices in the context of high international energy prices would not contain prices beyond these limits, but would lead to greater exports of local production with higher returns to producers (Mason-Jones et al. 2013).

Nevertheless, the role of energy prices as a driver of food prices cannot be ignored completely. Statistics indicate that, although the primary agriculture sector in South Africa consumes only 3% of total electricity generated in the country and this consumption has risen at 3% per annum between 1999/2000 and 2010/11, the rise in electricity prices by over 24% since FY 2007/08 is having a severe impact on the agricultural sector. Between 2009/10 and 2010/11, the annual electricity bill for the agricultural sector increased by 26%. In the case of commodities such as maize, which accounts for the largest share of the national basic food basket – it is the staple diet of the poor in South Africa and the country's largest unprocessed agricultural export by volume – the cost of electricity as a percentage of other variable costs has been rising steadily over time (Gulati et al. 2013). Similarly, analyses of costs involved in the production of animal feed indicate that electricity costs have recently risen exponentially (Mason-Jones et al. 2013).

Furthermore, trends in oil and fertiliser prices indicate that rising oil prices in recent years have led to increases in fertiliser prices. The South African fertiliser industry is fully exposed to world market forces, given the completely deregulated environment of this sector, with no import tariffs or government-sponsored measures. Moreover, South Africa is a net importer of potassium and imports approximately 40% of its nitrogen requirements (Mason-Jones et al. 2013). This implies that domestic fertiliser prices are severely impacted by international oil prices, as well as shipping costs.

The abovementioned trends clearly indicate a causal link between energy prices and the costs of energy inputs to food production. These trends, viewed in tandem with the finding that the share of on-farm costs in the final retail price determination is rather small despite the significant energy costs at farm level, that is to say, the farmer is a price taker, seems to suggest that farmers are bearing the brunt of rising energy prices. In other words, rising energy costs, of course along with other input costs, are putting pressure on farm profitability and resulting in lower returns on investment (ROI).<sup>1</sup>

Analyses obtained from Potatoes South Africa indicate that increases in fuel and electricity prices, along with higher wages in the environment of lower market prices for potatoes, have led to a significant reduction in ROI at the farm level. Potatoes South Africa estimates that the fuel price increase of more than 40% since the beginning of 2012 has resulted in the total fuel cost increase of more than R340 000 for the typical farm. Consequently, the Net Farm Income (NFI) decreased by the same amount. It also estimates that the 16% rise in electricity costs from 2013 would lead to an increase of R79 000 in the electricity costs for 2013. As a result, the yearly average nominal farm ROI for the next six years would decrease to 1.6% compared to an ROI of 2.7% in a scenario without any major external shocks in 2013. It concludes that a typical potato farm would experience a negative cash flow from 2013 onwards, given the external price shocks in fuel and electricity (and labour). Analyses obtained from the National Agricultural Marketing Council

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<sup>1</sup> Return on investment (ROI) = Net Farm Income (NFI) divided by investment in land and machinery.

suggest similar findings in terms of reducing NFI as a result of rising electricity costs for the irrigation farming of wheat and maize in the Northern Cape.

It is important to note here that low domestic energy prices would not necessarily help farmers. Low domestic energy prices in the context of high international energy prices could fail to contain the prices of fertiliser or animal feed, because these inputs are traded on international commodity markets.

Finally it may also be useful to point out that energy and food price dynamics are difficult to disentangle. For example, the producer price index (PPI) for selected materials used in the food manufacturing process indicates that between March 2005 and March 2012 prices of plastic products increased by 82%, of tinplate by 85%, of Kraft paper by 34% and corrugated cardboard boxes by 36% (Jooste 2012). It is important to note that energy is a key component in the manufacturing of plastic bottles, paper and cardboard boxes. Although energy is not the sole input in the manufacturing of these materials and there is no surety of energy prices having been the sole driver of rising prices of these materials, it is possible that energy prices have played a role in driving up the costs of these materials.

## 2.2 COST OF COOKING ENERGY

Rising costs of energy also affect the cost of cooking and preparing food. Back-of-the-envelope computations indicate that if cooking a kilogram of maize meal, then at the maximum permitted retail price of paraffin in the country, cooking energy adds an additional cost of about 20% to the price of the maize meal (Mason-Jones et al. 2013). This suggests that the energy price could have a significant impact on the direct energy costs of food preparation.

## 2.3 ENERGY IMPLICATIONS OF WASTED FOOD

An estimated 10 million tonnes of food is lost to waste in some form or another across the food supply chain each year, from an estimated 31 million tonnes of food available (produced within South Africa and imported). With every tonne of wasted food, the energy involved in producing, processing and transporting it is also wasted. Although there is a lack of information specific to South Africa, the ballpark cost of this wasted energy, also known as the embedded energy wasted, can be pegged at approximately R1 billion. The issue of embedded energy wasted assumes more important proportions in view of estimates that the annual embedded energy loss through food waste is sufficient to power the City of Johannesburg for roughly 20 years.<sup>2</sup>

But this is not all. The disposal of wasted food requires energy. In South Africa, the majority of industrial and consumer organic waste ends up in a sanitary landfill, while organic waste at the farm level is disposed of on the farm or finds a use nearby (DEA 2012). Landfill activities require energy in the form of both electricity and diesel. Rough estimates indicate that the annual costs of electricity and diesel involved in landfilling the total post-agricultural food waste in the country amount to approximately R12 million and R27 million, respectively (Notten et al. 2013). In addition, the annual cost of diesel consumed in transporting this waste to landfills amounts to R232 million (Mason-Jones et al. 2013).

## 2.4 USE OF FOOD CROPS FOR ENERGY PRODUCTION

South Africa has adopted a biofuels strategy with the objective of achieving a 2% penetration level of biofuels, or 400 million litres per annum, in the national liquid fuels pool. This strategy mandates the crops that can be used for the production of biofuels: sugarcane and sugar beet for bioethanol, and sunflower, canola and soya beans for biodiesel. It excludes basic food crops such as maize in the light of food security concerns and other feedstocks such as *Jatropha*, given the possible impact on water resources. It is expected that, in view of the government's conservative approach to formulating the associated policies to protect food production, biofuels are likely to have a minimal impact on food

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<sup>2</sup> Based on the assumption that the average electricity use of Johannesburg is 5 000 MW per annum.

prices and availability, if placed in the context of large, global movements in the biofuels (and other agriculture) space (Brent 2014).

## 2.5 COMPETITION FOR LAND AND WATER

Coal deposits in South Africa coincide with the best agricultural land. Coal currently accounts for 77% of the total primary energy mix and 95% of the electricity-generation capacity in the country (Scholtz & Gulati 2013). Development plans for future electricity generation indicate that coal will still account for 65% of South Africa's electricity in 2030 (DoE 2011). A coal-based energy strategy could therefore directly conflict with food production.

A proportion of South Africa's coal reserves also overlap with areas of the highest rainfall in the country and the sources of major inland rivers. These areas are of critical national strategic importance from a water-security point of view. The mining of coal to realise a coal-based energy strategy could have an impact on the quality of these water resources, thus posing risks for food production in these areas.

Another possible trade-off for land could arise from the production of crops for energy generation, namely for biofuels. The country's biofuels strategy proposes that the targeted 2% biofuels scenario will require about 1.4% of arable land in the country. The strategy also provides for "new and additional" and "currently underutilised" land from the former homelands, estimated at 14% of arable land, to be brought into feedstock production for biofuels. Therefore, according to the target, the 2% biofuels scenario can be achieved without jeopardising food security.

However, this would be a simplistic view. The country has limited arable land. Only 13–14% of the total land available in the country is arable and, of this, only 3% is high-production land. Diverting 1.4% of arable land to the production of energy crops is therefore a subject for debate. Furthermore, given the global food shortages and the rise in food prices over the past few years, the use of arable land for biofuels could jeopardise food production in the future.

Moreover, the definitions of the different types of land to be brought under the production of energy crops are not transparent. Investigations into the agricultural area of QwaQwa in the eastern part of the Free State Province suggest that the types of land in this area that could be classified as "currently underutilised" include land owned by emerging black farmers, communal land and state-owned land (Letete 2009). The use of the first two types of land for growing crops for biofuels production is bound to conflict with food supply (Brent 2014). While the little produce that emerging farmers are able to achieve at the moment is currently being sent to regional silos that feed into the national food industry, the land used for communal subsistence farming is vital for survival in these communities and, in many cases, the community cannot afford to use it for anything else (Brent 2013).

In the case of water resources, it is believed that biofuels may not put pressure on these resources, so from a water perspective they pose a limited risk to food production at national level. Studies suggest that (Jewitt et al. 2009), given current information and based on climatological drivers only – and not soil, pests and other factors – only sweet sorghum and sugarcane have the potential to use more water than the dominant, native vegetation types; although sugar beet needs further investigation. It is therefore deemed unlikely that biofuels production, overall, under rain-fed conditions, will change the current burden on the national water resources (Brent 2014). The same could be said of biofuels production under irrigated conditions, in particular, where new irrigation developments are planned that do not support this production given the government's conservative approach to biofuels to protect food production (Brent 2014).

However, the impact of biofuels production at smaller spatial scales, and in times of drought, could be significant at a local level (Brent 2013). Given that 10% of the total arable land in the country is irrigated and agriculture consumes 60% of the national water supply in South Africa, which is a water-stressed country, the use of water for growing energy crops should be a subject of debate in the context of food security. Nevertheless, it is understood that the risks posed by biofuels in terms of land and water resources, in relation to food production, are lower than those arising from the current practices of the agricultural sector (Brent 2014).

### 3. IMMEDIATE RISKS

The contributions of different stages in the value chain to the final retail price vary considerably among different foodstuffs, with no evident relation to energy intensity or energy prices. But this should not be taken to mean that rising energy prices pose no risks to food security. Rising energy prices will affect food security, either through affordability of food and fuel to cook the food or through the supply of food.

The limited transmission of energy prices into retail prices means that it is the farmers and fisheries that are affected more directly by increased energy costs. There is a huge price discrepancy between the prices that farmers get for their products – at the National Fresh Produce Market (NFPM) level – and the eventual retail prices (Jooste 2012). This is largely due to stakeholders along the agrifoods value chain adding ever-increasing input costs (Jooste 2012). This means that farmers cannot easily pass on higher energy-related costs to the consumer and have to absorb these costs themselves. This may be interpreted to mean that energy prices do not pose a risk to food security in the short term. But the reality is different. Farmers face considerable financial pressure and competition from imported produce.

In order to maintain productivity and efficiency, farmers, particularly large commercial farmers, make adjustments to inputs by way of substitutions. Since electricity and fuel inputs have no substitutes, it is more likely that these farmers would increase mechanisation, thereby substituting technology for labour. Mechanisation enables them to maintain productivity and efficiency, and to manage higher wage costs. However, small farmers may not be able to invest in mechanisation or manage the pressure of lowered profitability.

On the one hand, the reduced profitability and competitiveness of farmers could affect investment in the agricultural sector and ultimately result in a decline in domestic production. Suboptimal investment in agriculture will hinder the agricultural sector's ability to produce sufficient food in general and certain commodities in particular. This poses a risk to food security in the country from the food-supply perspective.

On the other hand, energy prices along the value chain do make a substantial contribution to the final price of food. For example, in the case of maize, energy contributes almost 20% to the final price. So a large energy price increase of the order seen in the electricity price hikes since 2007 would be expected to drive up retail food prices considerably. At the same time, energy price hikes are increasing the cost of materials used in the food-manufacturing process. With food contributing to 30% of household spending for the lowest-income groups in the country (StatsSA 2012), energy price increases could affect the affordability of food and threaten food security for the lower-income groups. The increased energy-related cost of cooking could represent an added burden to this category of consumers and place further pressure on food affordability for the poor.

Risks to food security also remain on the biofuels front. In the business-as-usual approach the production of biofuels, is one of the most water-intensive ways to produce energy and, based on South Africa's water context, needs to be considered very carefully as an option. Moreover, though the provisions of the country's biofuels strategy are intended to safeguard food security, there is nothing in the strategy to prohibit farmers from substituting food crops with energy crops. If farmers find a good price for energy crops or if the market prices for the non-food crops identified in the biofuels strategy go up, there would be a natural inclination to shift towards these crops. As more land is used to produce energy crops, less land would be available for other crops. This could result in increasing prices for food crops that have to compete for the same land. Thus, biofuels do pose risks to food security by way of price hikes and/or potential shortages in the supply of some food crops.

In addition, there could be serious challenges over water allocation between the energy and food sectors. The energy needs of the country continue to grow. Water is a prerequisite for energy production, although different energy options have different levels of water intensity. With a significant portion of these needs being met by coal-fired power stations, the water requirements for energy production could be high. With South Africa being a water-scarce country, which experiences huge variations in the temporal and spatial distribution of rainfall, any future physical scarcity of water could require trade-offs for water allocation between energy and food. These trade-offs could be strongly influenced by the contributions of the energy and the agricultural sectors to the South African economy. Agriculture contributes only about 3% to GDP, while the energy sector uses only 2% of water but contributes about 15% to GDP. However, the value of agriculture to the South African economy cannot be considered through GDP alone. A water allocation between the energy and agricultural sectors would become a dilemma because both sectors are important for the generation of employment, equity and development of the rural economy.

Finally, the absence of evident links between energy intensity and energy prices at different stages of the food value chain and retail price determination indicates the importance of other factors in determining retail prices. The role of these factors needs to be examined. Discussions with stakeholders indicate that the level of competition at the food retail level in the country is one of the most important factors that determine food prices.

## **4. SECONDARY CONCERNS**

Inadequate investment in the agricultural sector and reduced productivity would inevitably reduce employment in this sector, endangering incomes and further impacting on food security. It would also affect the ability of this sector to earn foreign exchange and provide jobs, and finally to play its rightful role in rural development, poverty elevation and economic growth. OECD studies suggest that agricultural growth can be four to six times more effective in reducing poverty than growth in the non-agricultural sector (Joubert 2011). The studies also suggest that continued growth in the agricultural sector is required to complement non-agricultural sector growth (Joubert 2011). Moreover, if protecting this sector necessitates that all the costs that are currently being absorbed by farmers are passed on to the consumer, there would be negative implications for the country's food security because consumers might not be able to afford the food.

Another concern is the production of energy crops for biofuels. There is limited clarity on how quickly global crop production for biofuels can increase. If the global agricultural output does not grow adequately and fails to keep pace with the growth in demand for energy crops, it is possible that biofuels could contribute to higher food inflation.

As long as biofuels production competes for resources with food crops, the concerns about food security will persist. This is because prices in food markets, despite many government interventions, are influenced substantially by changes in market supply and demand, and market supply in turn is strongly influenced by the prices and availability of various inputs: land, water and fertiliser (FAO 2008). However, not all food items would be affected in the same manner. The magnitude of impacts will vary and depend on several factors such as the expansion in the global output of the concerned crop, advancements in energy and biofuels technology, and energy policy.

## **5. RECOMMENDATIONS/POSSIBLE APPROACHES/TOWARDS A RESILIENCE-BASED INTEGRATED FRAMEWORK**

From a food-security perspective, the dynamics between energy and food mean that the affordability of food needs to be maintained and improved; and the long-term viability and competitiveness of the agricultural sector needs to be assured.

Interventions that focus on energy prices in an attempt to contain food inflation would appear to be relatively indirect in their effects. Their influence on retail prices would be diluted by other cost components and be potentially undermined by interactions with international markets. Since consumers in the lower-income groups are the intended beneficiaries of such an action, more direct support might be more appropriate. The direct energy costs to households also need to be considered, as these could prove to be as significant as the effects transmitted through the retail pricing of food. This suggests that mechanisms such as the free basic electricity policy play an indirect, but nevertheless targeted, role in supporting food-insecure households.

Given that the current practices of the agricultural sector overshadow the risks of biofuels, the conservative policy approach to biofuels should be extended to the agricultural sector as a whole to minimise these risks. Also, the tendency to focus on integrated cropping, thereby extending the productivity of the agricultural system – with biofuels – should be enhanced. This would then buffer food production against global volatile prices, the major influence on local food prices. Such an agrarian transformation of the agricultural sector – with related benefits to rural communities – would increase the availability of biomass in general.

There is an urgent need to examine the manner in which rising energy costs, among other input costs, are affecting farmers and the ROI in agriculture. Demand growth for agricultural products over the coming decades will put tremendous pressure on the natural resource base (Potatoes South Africa and BFAP 2013). Ensuring food security, eradicating hunger and enabling rural development will require a significant increase in agricultural investment. The higher the ROI, the more investments will flow into agriculture (Potatoes South Africa and BFAP 2013). The government needs to create the legal, policy and institutional environments that will enable investors (farmers) to respond to market opportunities (Potatoes South Africa and BFAP 2013).

In the case of food wastage, the obvious response to reducing waste and saving the embedded energy wasted would be to target those food commodities and stages of the food value chain that contribute the most to food wastage and its associated costs. There are significant opportunities for energy recovery from wasted food.

At present, there is no specific legislation promoting one application of organic waste over another, and the National Organic Waste Composting Strategy, which aims to divert organic waste from landfill sites for composting, is careful to recognise that composting is only one of a suite of possible options for the use of organic waste (DEA 2012). Energy recovery is therefore only one possible application of food waste. Composting is a well-established alternative, as is the use of food waste as animal feed, especially at the early stages of the value chain, for example, milk returns fed to pigs.

Currently food waste is governed by both waste management regulations and energy policy, making the navigation of the policy and regulatory frameworks especially complex. Therefore, measures need to be taken to simplify and align waste management policy and regulation, as well as government documents guiding and governing the potential use of food waste as an energy source. At the same time, efforts need to be made to improve the data on waste flows. These measures would allow the reuse options of organic waste, including energy applications.

Finally, research can play a significant role in preparing policy responses to build food-security resilience in view of the links between food and energy systems. The scope for future research includes better understanding of energy costs at each stage of the value chain and their role in determining retail food prices. This should be coupled to a more comprehensive investigation of the economics of food production and food supply in South Africa.

Further research is also needed to see how biofuels can play a complementary role to food and environmental systems. Currently, biofuels are being evaluated from the perspective of being in competition with the food and environmental systems (Lynd & Woods 2011). Biofuels production and the policies used to support its development can relate both positively and negatively to each of the four dimensions of food security, namely availability, access, utilisation (nutrition) and stability (HLPE 2013). In addition, biofuels, being bioenergy, provide opportunities for both energy and food security for the poor through access to modern energy sources and increased food productivity (Brent 2013). This new dimension creates a better understanding of multiple benefits that can be gained if bioenergy and food systems are handled as integrated systems that depend on and complement each other.

An appreciation of the relationships and causal impact and feedback links between biofuels and food systems (HLPE 2013) is therefore necessary and needs to be performed at national and local level.

## 6. A CALL TO ACTION: TARGET AUDIENCES

### 6.1 GOVERNMENT

The sheer importance of the energy issue for food security gives it strategic status. Moreover, energy is a major element in the competitiveness and sustainability of the country's farming sector. The government is central to this process because a market mechanism alone would not support the critical social elements of both access to and affordability of food (Baleta & Pegram 2014).

- National Treasury: government priorities are governed by fiscal policy and job creation.
- Department of Energy (DoE): formulates energy policy.
- Department of Water Affairs (DWA): trade-offs for water between energy and food production.
- Department of Trade and Industry (DTI): determines import tariffs that, although constrained by numerous trade agreements, could help to support farmers and protect poor consumers.
- Department of Agriculture, Forestry and Fisheries (DAFF): manages agricultural extension services.
- Competition Commission: ensures that pricing is competitive throughout the value chain.
- National Planning Commission (NPC): ideally placed to play a key leadership role in developing integrated planning approaches that can deal with these multivariant interrelationships in an explicit way.
- National Energy Regulator (NERSA): determines energy prices.
- South African Reserve Bank: determines monetary policy, which impacts inflation and exchange rates.
- Department of Social Development: responsible for social welfare via the South African Social Security Agency.

### 6.2 STATE-OWNED ENTERPRISES AND BUSINESS

A dialogue that can draw in all the big water users such as Eskom and the coal-mining industry and include industry associations representing growers, food producers, retailers and associated unions may help to unlock necessary innovations and mitigation strategies. Involvement of the private sector would be key to promoting energy-sustainable agriculture: improve the energy efficiency of food production and distribution by shifting from energy-intensive industrial agricultural techniques to less intensive methods such as drip irrigation, non-synthetic fertilizers and no-till crop management, and using more efficient machinery and equipment; by reducing food processing and packaging; by promoting decentralisation of food production and by improving the efficiency of food transportation.

### 6.3 ACADEMIA AND CIVIL SOCIETY

Civil society is important in driving societal change and participation must also be sought from historically marginalised voices. A dialogue framework that hosts business and government must also provide a forum for grassroots civil society to articulate their views and discuss what the interconnected resource risk means to them in terms of their livelihood, jobs and well-being. Academia can play a role in further research that enables a more complete understanding of energy costs at each stage of the food value chain and their role in determining retail food prices, and a more comprehensive investigation of the economics of food production and supply in the country.

Civil society and academia can also articulate the reasons for a change in thinking about ecosystem services. By creating a forum in which people can speak out, it might be possible to get the government to understand that taking action on environmental issues is what the people want, at all levels of society.

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To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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