Diverting grain from animal feed and biofuels

Can it protect the poor from high food prices?

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April 2013

Acknowledgements

We would like to thank the following people for their valuable comments and peer review.

Brian Wright – Professor and Chair, Department of Agricultural & Resource Economics, University of California, Berkeley, US

Wallace Tyner - James and Lois Ackerman Professor, Department of Agricultural Economics, Purdue University, Indiana, United States.

Further thanks go to Emily Darko, ODI, for researching and writing the case study on the Drought Water Bank in California

Finally, we are indebted to Helen Hynes and Angela Hawke for valuable assistance.

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UKaid
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This research was funded by UK aid from the Department for International Development. Its conclusions do not necessarily reflect the views of the UK Government.

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Abbreviations

AFMA	Animal Feed Manufacturers' Association
AHDB	Agriculture and Horticulture Development Board
AMEPA	Asociación Mexicana de Productores de Alimentos
AMIS	Agricultural Market Information System initiative
ASERCA	Support and Services for Agricultural and Livestock Trade (Paying Agency)
BCFM	Broken corn and foreign material
BFAP	Bureau for Food and Agricultural Policy
BRIC	Brazil, Russia, India and China
BSE	Bovine spongiform encephalopathy
CAP	EU Common Agriculture Policy
CCP	EU Energy and Climate Change Package
CDVI	Cuddy della valle index
CEC	Crop Estimates Committee
CEPEA	Comprehensive Economic Partnership for East Asia
CIF	Cost, Insurance and Freight (import parity price)
Codex	Codex Alimentarius Commission
CPI	Consumer price index
CVP	Central Valley Project
CY	Calendar year
DDG	Dried Distiller Grains
DDGS	Dried Distillers Grains with Solubles
DEFRA	UK Department for Environment, Food and Rural Affairs
DWR	California Department of Water Resources
EBITDA	Earnings before interest, taxes, depreciation and amortisation,
EISA	Energy Independence and Security Act
EPA	US Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO statistical database
FAS	Foreign Agricultural Service
FCR	Feed conversion ratios
FOB	Freight On Board (export parity price)
FPMC	Food Price Monitoring Committee
FSI	Organisation for Economic Co-operation and Development
FSU	Former Soviet Union
GIEWS	FAO Global Information and Early Warning System
GOM	Government of Mexico
HFCS	High-fructose corn syrup
ICC	International Association for Cereal Science and Technology
IFIF	International Feed Industry Federation
IFPRI	International Food Policy Research Institute
INEGI	Mexico's National Institute of Statistics and Geography
ISO	International Organisation for Standardisation
LDCs	Least Developed Countries
LIC	Low-income country
LMIC	Lower middle-income country
MENA	Middle East and North Africa
MIC	Middle-income country
MTBE	Methyl tertiary-butyl ether
MXN $	Mexican peso
MY	Marketing year
NAFTA	North American Free Trade Agreement
NAMC	National Agricultural Marketing Council (South Africa)
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development

OPEC	Organization of the Petroleum Exporting Countries
RBOB	Reformulated Blendstock for Oxygenate Blending
RED	European Union's Renewable Energy Directive
RFG	Reformulated gasoline
RFS	Renewable Fuel Standard
RIN	Renewable Identification Number
SAFEX	South African Futures Exchange
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (Mexico)
SAGIS	South African Grain Information Service
SASSA	South African Social Security Agency
SIAP-SAGARPA	Agrifood and Fishery Information Service of SAGARPA
SSA	Sub-Saharan Africa
SWP	California State Water Project
STUR	Stock to use ratio
TRQ	Tariff-rate quota
UMIC	Upper middle-income country
USDA	United States Department of Agriculture
USDE	United States Department of Education
VEETC	Volumetric Ethanol Excise Tax Credit
WASDE	World Agricultural Supply and Demand Estimates
WDI	World Development Indicators
WHO	World Health Organization
WM	White maize
WTO	World Trade Organization
YM	Yellow maize

Executive Summary

Context and background

The prices of cereals on international markets have become more volatile since 2007. The recent drought in the US Midwest pushed prices of maize and wheat up sharply in July 2012 drawing attention once more to the spectre of global price spikes. Higher prices of staples for poor and vulnerable people threaten hardship for those least equipped to deal with it.

One highly-touted way to deal with such volatility is to store more cereals, so that unexpected failures of supply or increases in demand can be met by releasing stocks, rather than having to ration cereals through sharply increased prices.

However, keeping more stocks is expensive, costing around US$15 per tonne per year. If we were then to stock another 70 million tonnes as insurance against the unexpected, it would cost more than US$1 billion a year. Yet in most years, the stocks would not be needed.

There is, however, an intriguing alternative. Of the 2,100 million tonnes of cereals produced annually, 800 million tonnes or more is used to feed animals or for industrial use, including distilling to biofuel, and the volumes of grains used for animals feed and biofuels have been increasing over the last decade. What if, when spikes threaten on world cereal markets, some of these grains were diverted to human use, temporarily, until the spike conditions passed by? Worldwide, had the equivalent of around 10% of feedgrains been diverted in this way in 2008, it may well have prevented the price spike.

This study explores this option, originally proposed by Brian Wright (Wright, 2009; 2011).

Key questions

An exploration of grain diversion must address certain questions.

- Could grains that currently go to livestock and factories be used for human food? Which grains are these?
- If grains were to be diverted, could this be done internationally, regionally, or only at country level?
- What policies would be used to divert grains?
- What compensation would need to be offered to the operators of animal feedlots, ethanol distilleries and other industries using grain? What would be the public costs of such a scheme?
- Are there other issues that need to be considered?
- How does grain diversion compare to other ways to tackle the problems caused by price spikes?

To answer these questions, we began by formulating a basic definition and some parameters of a grain diversion intervention that would:

- be a short-term intervention (spanning a maximum of six months, or until a price spike eased, whichever period was shorter)
- be a measure of last resort – a measure to be used in anomalous, crisis situations where lower-income populations face serious nutritional consequences due to the unaffordability of staple grains

- involve only the diversion of food-grade grain from the livestock or industrial sector
- make use of legislative instruments available to the government, carried out in a transparent and consultative manner, involving stakeholders from affected parties.

Approach and methodology

To find preliminary answers to these questions, we did the following:

- We checked **technical specifications** of grains used for different purposes.
- We reviewed statistics on **grain use** in different sectors (food, feed and industrial) and for different types of livestock.
- We looked at analogous schemes for the **diversion of irrigation water** to water for household use to see what instruments have been used and to what effect.
- We restricted our consideration to **maize** and **wheat**, as very little rice is used for animal feed or industry.
- We decided that, on the basis of early insights, there would be no incentive for countries to operate grain diversion as part of an international scheme. It is highly unlikely that US feedlot operators would idle their lots to help reduce grain prices on world markets to benefit poor and vulnerable people half way around the globe. Therefore, we focused on the possibility of diverting grains at **national** level, where the majority of the benefits and costs would be internal to one country and where a domestic scheme might be politically feasible. However, in some cases, a national scheme may have knock-on effects internationally, and we have highlighted where these occur and where they could benefit or prejudice the poor in other countries.
- To explore this in the case of animal feed, we took the cases of two developing countries large enough animal-feed operations for diversion to offer enough grain for humans, without completely closing the feedlots: **Mexico**, a net grain importer; and **South Africa**, a net exporter.
- In the case of biofuels, we looked at countries where the use of cereals for biofuel production is heavily concentrated— the **United States** (which uses over 30% of its domestic maize production for ethanol production) and the countries of the **European Union**. We focused mainly on the US for two reasons:
    - it uses larger volumes of grain for biofuels (particularly after the recent announcement by the EC of the intention to cap crop-based biofuels to 5% of transport fuel in 2020)
    - recent proposals have been submitted to the US Environmental Protection Agency (EPA) by the livestock industry in several states to switch off the use of maize for biofuels through a partial waiver of the mandate in order to take the heat out of the domestic maize price – an indication that a grain diversion scheme could support a domestic policy objective.

Key findings

The main points that we found were that:

Grain diversion can probably work technically…

At international level and in the countries studied, it was clear that most of the grain going to animal feed could be used for human food, although the higher level of moisture or broken grains may have implications for the length of time for which the grain can be stored.

However, this may be less the case at national level where technical specifications are less rigorous for particular parameters in feed and industrial grain (e.g., mycotoxins). There may also be distinct consumer preferences in different countries for different types of grains, e.g., white maize rather than yellow maize, so this would need to be looked at on a case-by-case basis.

The US State of California has used voluntary option contracts to persuade water users to switch water from fields to people — so we know that diversion can work. What was needed to make it work was a solid knowledge of the values of water and associated gross margins; a sense of the duration of the diversion; and an estimation of the total contract cost. What also helped was providing notice as far in advance as possible, ensuring that prices were adjusted to take into account inflation and having clear terms and conditions to provide security and flexibility.

The costs to governments of providing compensation for grain diversion appear to be lower than those of other comparable options, including existing support to farmers in the US and EU.

…but the impact of international trade and economics makes it a difficult option to implement in the case of animal feed and price-taking countries

When we looked at the two country cases for animal feed (Mexico and South Africa), we found a major obstacle. Both countries have reasonably open trade regimes and are price-takers on the international market, so reducing the domestic demand for grain – by cutting the domestic demand for animal feed – would not affect domestic price levels. Given market incentives, traders in South Africa would probably export the feed that was saved; Mexico would merely reduce its imports. Poor and vulnerable consumers in these countries would not see cereals prices fall. This is a major difference with the water diversion option in California, where water is not traded internationally. That said, in the case of South Africa, while the export of feed would not necessarily affect world prices, it could temporarily reduce prices in neighbouring countries that have a large number of poor.

… and complementary or alternative policies might be needed

Hence in both cases, grain diversion would only work if complementary trade management policies were deployed, which would not be a popular option. That would mean controlling grain exports for South Africa; and the extremely unlikely option of combining compulsory import quotas with export bans for the case of Mexico.

If trade restrictions were used, this would address much of the problem anyway, at least for South Africa, removing the need for further actions such as grain diversion. However, using restrictions such as trade bans to deal with the problem would have undesirable outcomes, including raising prices in South Africa's export markets in the region, disrupting regional markets and possibly reducing incentives for farmers to replant the affected grain. Therefore, the scope for using grain diversion would probably be limited to crisis situations[1] where action is deemed necessary and where there is a perceived need to ration demand to guarantee supply and reduce consumer prices.

In other situations, providing higher-value cash transfers may prove an adequate response to high prices. Both countries have established cash transfers for target groups of those at risk of extreme poverty. When cereals prices spike, existing payments could be increased, helping those who already receive transfers. Whether the reach could be broadened to capture people sliding into poverty because of the price rise is less certain, and will depend upon how quickly and robustly additional beneficiaries can be identified.

[1] For South Africa, this would likely be a situation in which global yellow maize prices are high and domestic maize supplies are very low.

It seems, therefore, that grain diversion would involve quite complicated policies, while simpler and more straightforward measures could achieve the policy objective of protecting those most vulnerable to higher cereals prices.

The large volumes of maize used for biofuels in the US make it more promising for lowering international grain prices…

What about the cases of the US and EU, which have more potential to influence world prices? Focusing on the US, the conditions look more promising for a grain diversion scheme as there is domestic support for some change (to lower prices for the domestic livestock industry) as well as sufficient volumes to deliver benefits for global food prices and the poor.

…but we need to look more closely at some possible constraints

Yet again, however, we need to look at the twists and turns in this. First, a grain diversion scheme would need to be coupled with flexible mandates to avoid penalties for failing to hit ethanol-blending targets.

Indeed, flexible mandates alone will not necessarily compel ethanol producers to stop making ethanol or stop refiners blending ethanol as long as the relative prices of maize and oil make it profitable to produce ethanol and keep it cheaper than oil: recent experience in the US has shown that more ethanol is being consumed than is mandated, despite the rise in the domestic maize price.

Voluntary contracts giving the option of switching maize out of biofuel production and providing financial incentives to do so, could provide the necessary encouragement to release maize for other uses. This would also have the benefit of encouraging less efficient producers with lower margins to drop out of production first.

But we can't stop there. If the option contracts have the desired effect of lowering maize prices, while oil (and ethanol) prices are unaffected, this would increase the profitability of ethanol production for remaining producers. If these producers have spare capacity, they could crank up production, increasing demand for maize and once again putting upward pressure on maize prices.

So, if the relative prices of oil and maize operate in favour of ethanol production and spare capacity exists, the scheme would need to be backed by complementary policy measures to work effectively. A variable tax could be placed on ethanol sales to close the gap between ethanol and oil prices, related to triggers such as the domestic maize ratio. Alternatively, limits could be placed on total maize use by the domestic ethanol industry, relating, for example, to the previous year's use.

Indeed, either of these schemes could probably function as a stand-alone policy option. However, voluntary option contracts would take the sting out of them.

Several other issues might also need to be taken into consideration.

- Oil refiners may not have unlimited flexibility to reduce their intake of ethanol. In the US, refiners are now using ethanol as an oxygenate to produce the high-octane petrol needed in many states. What costs are involved in reducing the amount of ethanol and could these be factored into compensation? How quickly could refiners change to using less ethanol?
- A measure taken up by individual producers and not applied across the board could have a negative impact on supplier reliability and client relations within the ethanol industry and appropriate solutions to this may need to be discussed with the ethanol industry.
- While a temporary diversion of grain away from biofuels would increase the availability of maize and wheat for other uses, livestock producers would face a reduction in the availability of Dried Distillers Grains with Solubles (DDGS) for livestock feed, which would need to be sourced elsewhere.

- Less ethanol production means more use of fossil fuels, unless replacement ethanol is imported, which could put upwards pressure on petrol prices.[2] This could be accentuated if the spike in food prices is linked to a rise in oil prices.

Policy implications

Our major conclusion is that grain diversion is unlikely to lower domestic prices in price-taking countries with relatively free trade. As such, the potential for this policy instrument to cushion poor and vulnerable people in developing countries against price rises in cereals is limited.

It might succeed in countries that have natural trade protection through high transport costs because they are landlocked. But few of these countries have substantial animal feed industries: most are poor countries where almost all cereals go to human use.

But this conclusion needs some qualification. These first-round analyses compare the effectiveness of policies by looking at what would be necessary if just one policy were to be adopted. In reality, policies can be combined to produce the intended outcomes. So, for example, when South Africa faces the threat of a spike to cereals prices, it could use grain diversion from beef feedlots to complement both increased cash transfers to protect the vulnerable in South Africa and possible export restrictions. However, the impact of export restrictions on the poor in neighbouring countries that rely on maize imports from South Africa would have to be looked at carefully before advocating this as a positive step forward.

In addition, in the case of a very large maize producer, such as the US with its significant use of maize for ethanol and where changes in production and exports have a major impact on global prices, the scheme could have some traction as long as it satisfies domestic policy objectives at the same time and if backed by complementary policies. If combined with flexible mandates, it could act as a sharper policy instrument than flexible mandates alone, while benefiting poor people in developing countries.

This is summarised in Figure ES1, which lays out the pathways for selecting potential candidate countries for grain diversion.

Reading the report

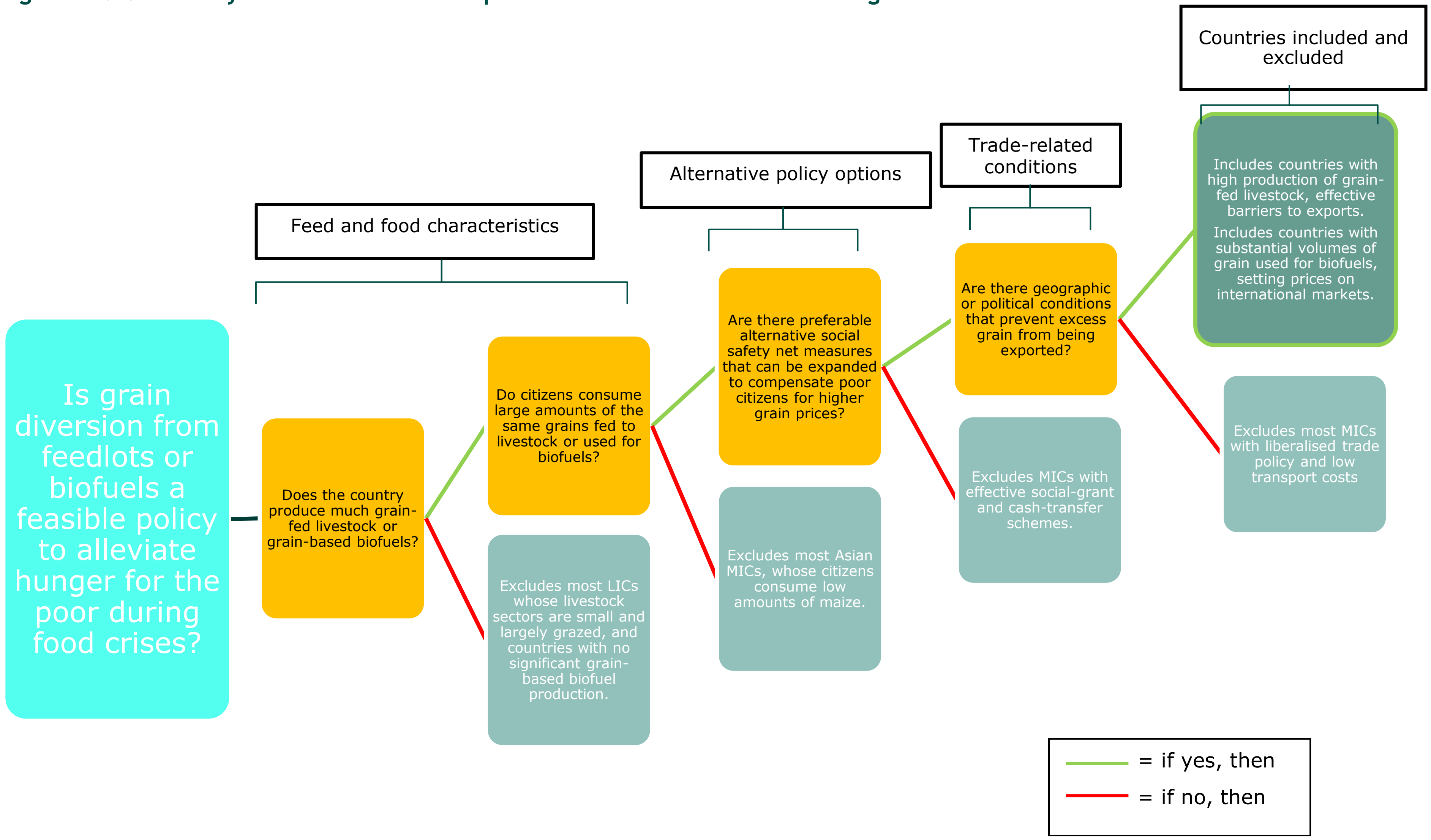
The main report has an introduction and six chapters that lay out in detail the information used to answer our key questions.

- Chapter 2 provides background on grain supply and use, and the technical specifications for maize and wheat used for different purposes. We also highlight California's experience of diverting water from irrigation to household use.
- Chapters 3 and 4 discuss the possibilities for diverting grain from animal feed at country level in Mexico and South Africa.
- Chapter 5 takes a closer look at the US and EU ethanol industries and the potential for switching maize or wheat out of ethanol production.
- The final section makes recommendations about whether such a scheme is workable, where it could work and under what conditions.

Annexes present more detailed information on specific issues raised in the main report.

[2] Assuming that OPEC does not increase production proportionally.

Figure ES.1: Pathways for the selection of potential candidate countries for grain diversion



1 Introduction

1.1 Context

The price spikes of 2007/08 and 2010/11, combined with the prospect of increased price volatility and rising real prices over the next decade, have triggered discussions about possible policy responses to limit price volatility or ensure access to food by the poor and vulnerable people most affected by these dynamics.

At the June 2009 World Grain Forum in St Petersburg, Brian Wright assessed two main possible policy interventions to address these issues (Wright, 2009):[3]

- Some, in the form of stocks and strategic reserves, would be designed to ensure minimum consumption levels for all. Wright concluded that these would be most effective at national, rather than international, level and that they should be used sparingly and targeted at specific groups.
- Other possible interventions, to reduce price volatility, involve price-band schemes and virtual buffer stocks whereby a (public) institution could take long-futures positions.[4] This would give players on the futures market an incentive to store grains, helping to create a buffer stock that could be released to the market at times of high prices.

- Experience, however, indicates that price-band schemes have not been effective, with prices tending to float either at the lower or upper limits of the band, and a risk of discouraging private storage and blunting the supply response to anticipated shortages.
- Virtual buffer stocks are risky and open to manipulation by market traders.

There are three main uses of key staples, such as maize and wheat: direct human consumption as staple foods; animal feed; and industrial use driven by biofuel consumption. The use of grains for biofuel production and animal feed has risen substantially over the last decade for two main reasons:

- biofuel production has been triggered mainly by the creation of demand for biofuels through fixed mandates and the increased profitability of production in the light of rising oil prices.
- the expansion of animal feed production has mirrored the rise in intensive animal production systems in both developed and developing countries.

Given this rise in the use of grains for biofuel production and animal feed, Wright proposed that governments could acquire grains from domestic producers of feed or fuel crops that could be switched to human consumption in the event of specified food crises. This could reduce price levels during price spikes and/or increase market access through the distribution of grains to those most seriously affected.

Alternatively, owners of large feedlots could be required to limit or stop production to reduce demand for feed grains when prices are high. While there may be some automatic market adjustment to higher grains prices, with some reduction in meat consumption and animal production depending on relative income and price elasticities for meat demand, this may not be sufficient to release adequate volumes of cereals to

[3] See Table A-1 in Annex A for a full presentation of the range of options being considered for dampening price spikes on national markets. This study does not assess the validity of the different options.
[4] Contracts to buy grain in the future at a pre-determined price.

dampen the increase in the price of grains for staple consumption. Additional incentives or actions may be needed to divert grains from animal feed to alternative uses.

Similarly, government biofuel mandates could be suspended or even revised to require diversion in crises. If, however, industrial demand is driven by inflexible statutory biofuels mandates, there is little scope to switch grain from biofuel production to other uses in the face of a supply shock.

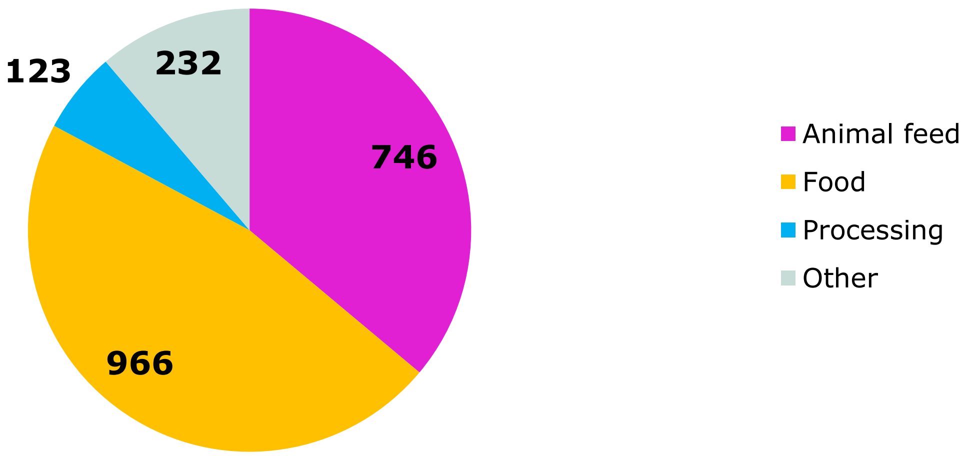
The operation would need to be similar to that used in some places, most notably California, for other key goods such as water. Here, irrigation is suspended to guarantee urban water supplies during droughts, and the non-essential use of electricity is interrupted when blackouts are imminent.

1.2 The advantages of a grain diversion option

As a way to head off price spikes, the grain diversion mechanism has the advantage of only requiring action when spikes threaten. There would be no need to hold costly physical stocks through many years of adequate supply and it could, therefore, be a cheaper option than holding stocks of cereals.

In addition, it would not necessarily require drastic action on the part of feed and biofuel grain users. Globally, the 2007/08 spike saw a shortfall in grain supply of around 70 million tonnes. This represented less than 10% of the amount of cereals that went to feed and distilleries in that year (Figure 1.1).[5] As such, grain diversion would not involve asking major industries to shut down but only to idle 10% of their capacity for probably a year at most, although this would vary from country to country and within each country.

Figure 1.1 Breakdown of major cereals for various uses globally, 2007 (million tonnes)



Source: Constructed with data from FAOSTAT.

Note: Rice in milled equivalent. ‘Other’ includes seeds and waste. Silage includes much non-grain vegetable matter, although made from corn plants, so feed use will appear exaggerated to some extent in terms of cereal suitable for human digestion.

[5] More than 40% of the 2.1 billion tonnes of cereals produced globally each year is used for animal feed and industrial distilling to ethanol. The USDA FAS projections for 2011/12 put cereals for feed use at 793 million tonnes, about 35% of the global projected production of 2.28 billion tonnes. Industrial use has also grown rapidly since 2007.

The idea would be to base grain diversion on voluntary participation by feed and industrial grain producers and users through agreed contracts that cover issues of compensation. This could be attractive to biofuel producers and animal feed manufacturers/livestock producers faced with the alternative of social unrest and potential threats to their stocks by hungry people (Wright, 2011).

1.3 Issues to consider

There are several issues to consider and resolve if such a proposal is to be workable.

- First, the technical aspects. Grain diversion assumes that cereals used for feed and fuel, principally maize and wheat, are substitutes for food. However, different qualities are usually specified for food and feed/industrial grains, which may make feed/industrial grain unpalatable or, at worst, unsuitable for human consumption. Some animal feed is consumed in the form of silage, whereby the whole plant is harvested then ensiled anaerobically – not something most humans would eat.
- Second: how to get firms to agree to divert their inventories of grains to millers or to idle production? This raises a series of other questions:
    - For governments, what policies might encourage this, including potential compensation (and its calculation)?[6] This requires insight into the economics of livestock/biofuel production or feed manufacturing.
    - Which contractual mechanisms would work best? For example, a call option with performance guarantees through sealed-bid auctions or other combinations of contingent contracts (Wright, 2011)?
- Third: what triggers could be used to ‘throw the switch’ of grain from feed/industrial use to human consumption, and how could cereals be moved from feed inventories to markets where rising prices threaten poverty and hunger or to specific target groups? This will depend partly on whether the key aim of the grain diversion mechanism is dampening price spikes or directing food to the most vulnerable. It could involve a trigger or exercise price or some measure of the needs of the target population (Wright, 2011). At a global level, this becomes combined with the politics: it is hard to imagine firms in OECD countries being willing to enter into these arrangements for the sake of hungry people in the Sahel.[7]

1.4 Aim of the study

Overall, more technical work is needed to establish the feasibility and potential application of grain diversion as a policy option. This study looks in greater detail at the issues that need to be raised and addressed for such a proposal to become workable.

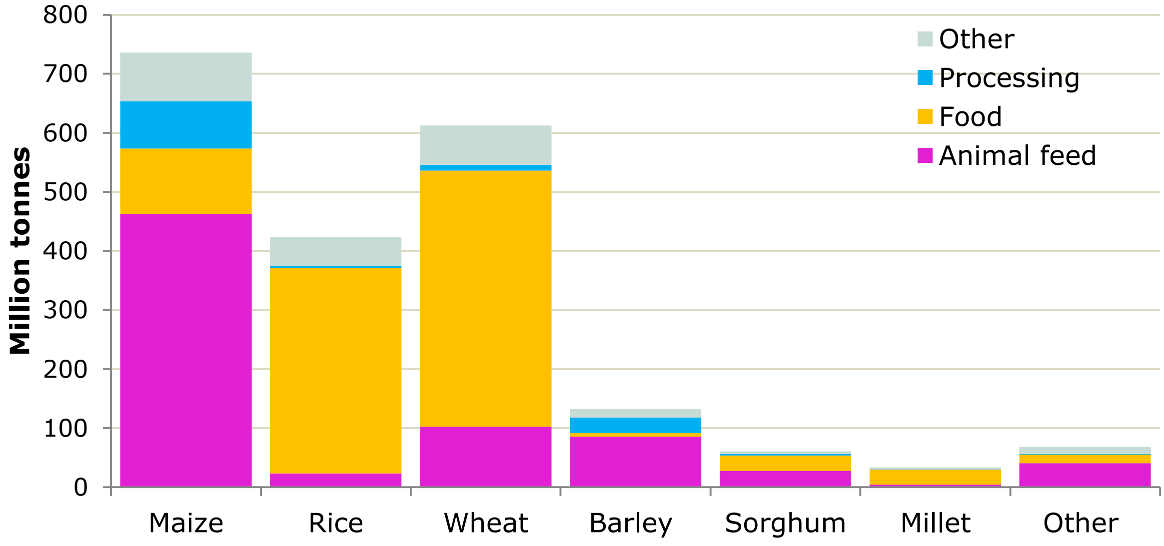
1.5 Focus of the study

Given the aim of grain diversion and the issues that it raises, this study focuses on five key variables.

[6] While detailed calculations may not be necessary, governments need to get a sense of the potential fiscal costs of this as a policy option and to assist effective pricing. However, a contract, *ex ante*, open for bids could establish a more accurate picture.
[7] Similar reasoning also generates export controls in periods of scarcity.

- First, the study focuses on **middle-income countries**, where the majority of poor and vulnerable people now live and where there is the greatest scope for diversion.
- Second, two cereals are seen as having the greatest potential for switching from animal feed/industrial use to human consumption: **maize** and **wheat**. As Figure 1.2 demonstrates, these two crops are the most widely consumed globally and both have a sizeable volume dedicated to feed or industrial use (processing),[8] particularly maize. Only small amounts of rice are used for feed and practically none for biofuel.

Figure 1.2 Breakdown of major cereals for various uses globally, 2007



Source: Constructed with data from FAOSTAT.

Note: Rice in milled equivalent. 'Other' includes seeds and waste.

- Third, in middle-income countries, the study focuses principally on the possibility of diverting maize and wheat from **animal feed**, rather than from biofuels, to human consumption. This is not because the use of cereals for biofuels worldwide is marginal. Indeed, industrial use of cereals has grown rapidly since 2007 and over 140 million tonnes are expected to be used for ethanol production in 2012. However, the use of cereals for biofuel production is concentrated heavily in the United States (which uses over 30% of its domestic maize production for ethanol production) and the European Union rather than in middle or low income countries.[9]
- Fourth, this study looks at the possibility of such a scheme being implemented at **national** level. Internationally, this proposal may be difficult, given the issues of motivation and compensation discussed above. However, in the case of diversion of grain from animal feed, these two problems become more tractable at national level, where those whose business is interrupted may suffer more direct consequences if their needs are not addressed (e.g., the food riots of 2008).

[8] This is predominantly for distillation to biofuels but also includes distillation to alcohol for humans

[9] If reported LDC plans for biofuel production are, in fact, implemented, this might change the scenario. As such, it could be a good time to consider alternatives to lessen the danger of severe food shortages if biofuels are adopted, especially in countries with poor access to imports, such as landlocked African nations.

- Fifth, the quantity of grain that is diverted at national level would not be sufficient to have an impact on **international** prices. However, there may be knock-on effects in neighbouring countries and this is investigated. In the case of US or EU biofuels, the volumes involved may well be high enough to have an impact on global prices.

1.6 Structure of the report

To look in more detail at the technical and operational issues associated with establishing such a scheme, the report is structured in six sections.

- It begins by assessing the **potential source of grains** for a diversion scheme at global and national level, presenting an overview of the supply and demand for maize and wheat around the world. It homes in on the major producers and consumers of these two grains and separates the consumption of grains for animal feed and for industrial use. It identifies countries where an animal feed grain diversion scheme could function and that deserve closer examination.
- The report then highlights potential **technical and operational issues** with switching grains from animal and industrial use to human consumption, identifying the role of cereals in animal feed, the economics of livestock and ethanol production, and quality differences between food and animal feed grains. It then draws on existing schemes in the **water sector** for insights into how to address some of the issues arising in grain diversion schemes.
- The technical and operational factors and potential for a grain diversion scheme from **animal feed** are then examined at country level, focusing on two middle-income candidate countries, **Mexico and South Africa**..
- The next section discusses the potential for diversion of grain from **biofuel production**, focusing on the **US and EU**, the world's two largest grain-based ethanol producers.
- The final section makes **recommendations** about whether such a scheme is workable, where it could work and under what conditions.

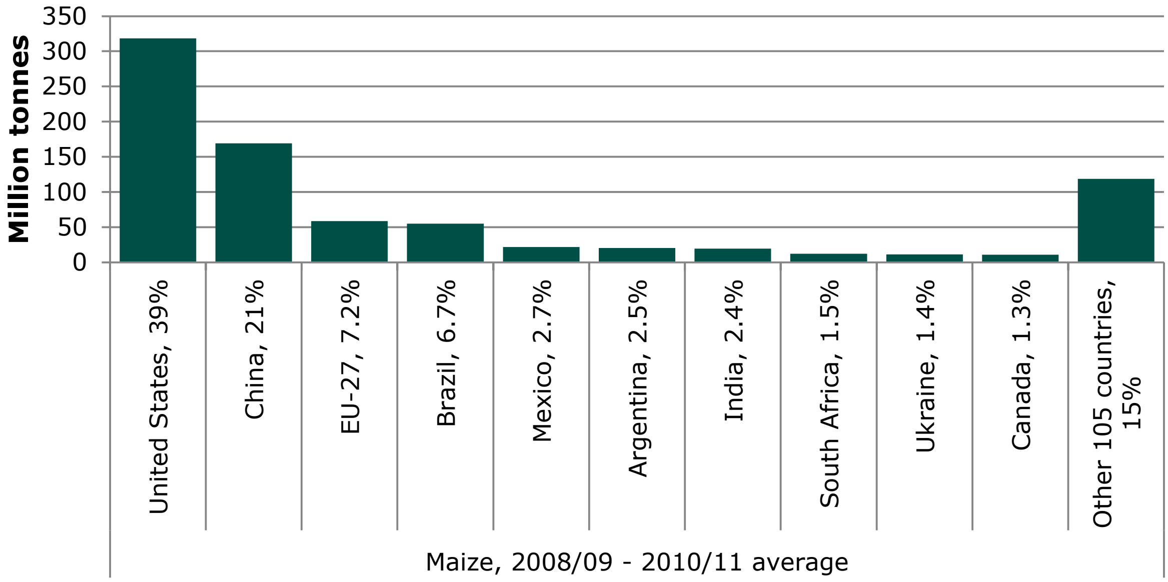
2 Overview of maize and wheat: markets and technical issues at international and national level

2.1 Principal producers of maize and wheat

Figure 2.1 and Figure 2.2 present major maize and wheat producers, respectively, based on average production between 2008/09 and 2010/11. As the figures demonstrate, ***maize production*** is extremely concentrated, with the top two producers – the US and China – accounting for around 60% of global production. The top 10 producers (taking the EU as a whole) account for 85% of production. The remainder of production, around 120 million tonnes, comes from 105 other countries.

Half the world's ***wheat*** comes from the EU, China, and India. Counting the EU as a single source, 83% comes from the top 10 producers. The remaining 110 million tonnes come from around 66 other countries.

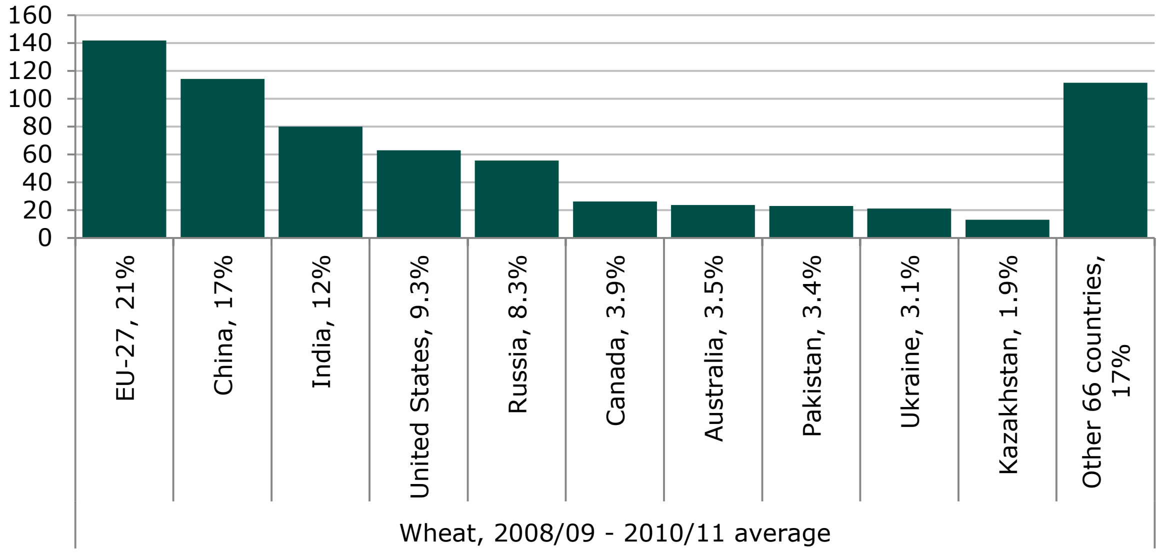
Figure 2.1 Contribution of different countries to global maize production, average 2008/09-2010/11



Source: With data from USDA.

Note: Percentages in the column labels represent contribution to world totals.

Figure 2.2 Contribution of different countries to global wheat production, average 2008/09-2010/11



Source: With data from USDA.

Note: Percentages in the column labels represent contribution to world totals.

2.2 Principal consumers of maize and wheat

Most of the world's maize is consumed in North America, with the lion's share used for animal feed and industrial uses in the US.[10] East Asia consumes the next largest share, of which animal feed use is more than double that used for foods, seeds and industrial (FSI) purposes; followed by the EU with substantially lower total volumes. Only sub-Saharan Africa and South Asia use more maize for food than for animal feed and industry.

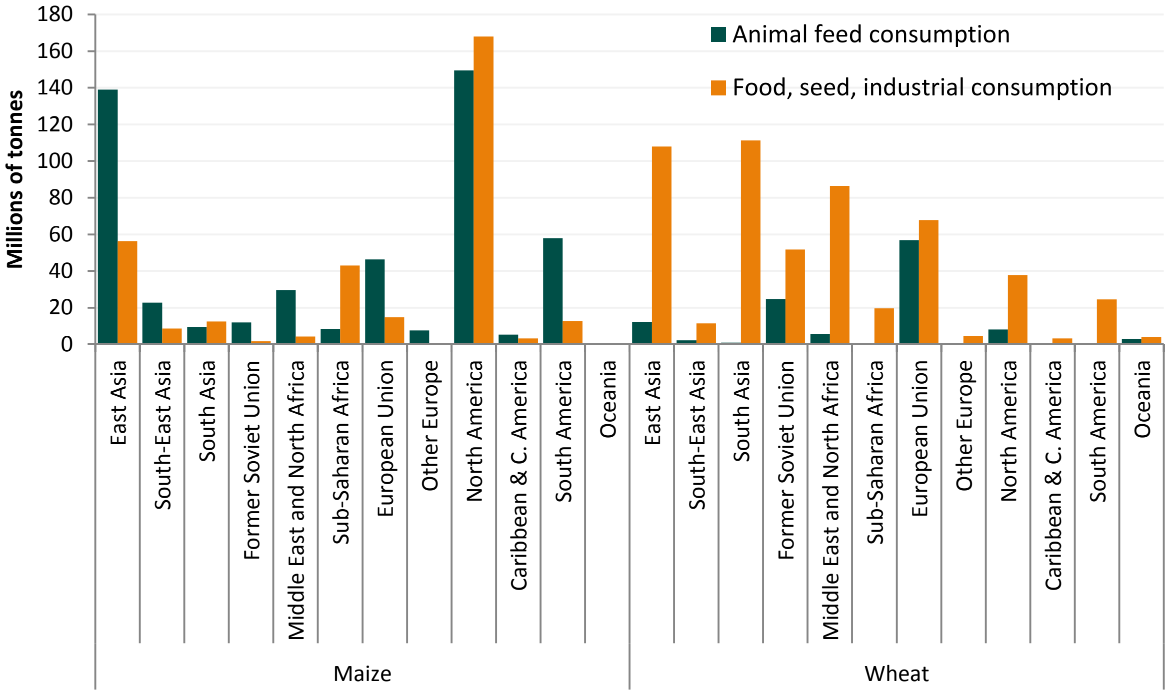
Wheat consumption is less concentrated, with much more going to food than feed or industrial uses. The largest consumers are the EU (although much of this is for feed) and East Asia, followed by South Asia, the Middle East and North Africa, and the countries of the former Soviet Union. Nowhere does feed use of wheat exceed FSI use.

Figure 2.3 shows the consumption by region in millions of tonnes (see Table B-2 in Annex B for regional use as a proportion of all global use).[11]

[10] USDA estimated that for 2010/11, about 128 million tonnes of US maize went to fuel uses, and 122 million tonnes to animal feed and residual, leaving about 36 million tonnes for food and seeds. This was the first year in which more US maize was used for fuel than for animal feed (USDA WASDE, March 2012)

[11] USDA FAS data does not disaggregate food, seeds, and industrial use. However, seeds are, in general, a small share compared to food (globally, 67 million tonnes went for seeds compared to 966 million tonnes for food in 2007 – 7%), and industrial use is extremely concentrated in the US for maize (by far the grain most used for industrial purposes) and in the EU for wheat, which is, in any event, very little used for processing: see Annex B, Figure B-1

Figure 2.3 Maize and wheat consumption by region, average 2008/09 −2010/11



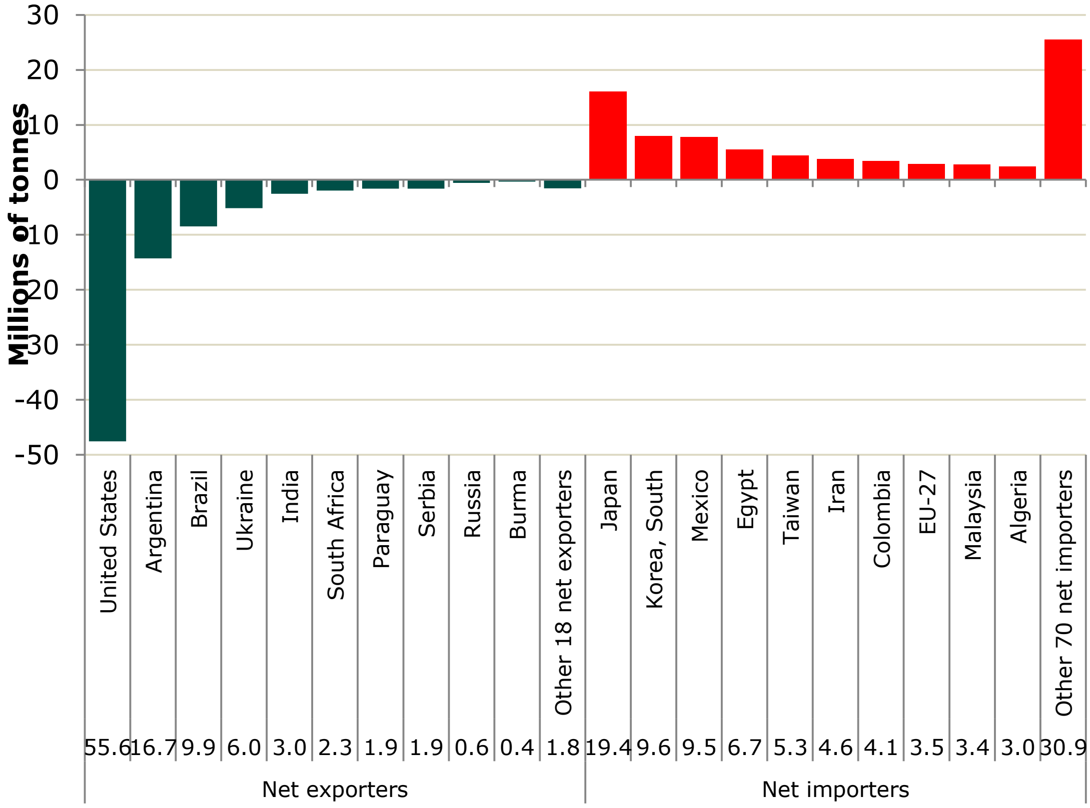
Source: Figure and table with data from USDA FAS. Note: Food, seed and industrial (FSI) consumption cannot be further disaggregated with the USDA data.

2.3 Trade flows in maize and wheat

Over 90% of recent maize exports have come from five exporters, with the US exporting nearly five times the volume of the next largest exporter. The top five importers — Japan, South Korea, Mexico, Egypt and Taiwan — account for about half of all maize imports (see Figure 2.4).

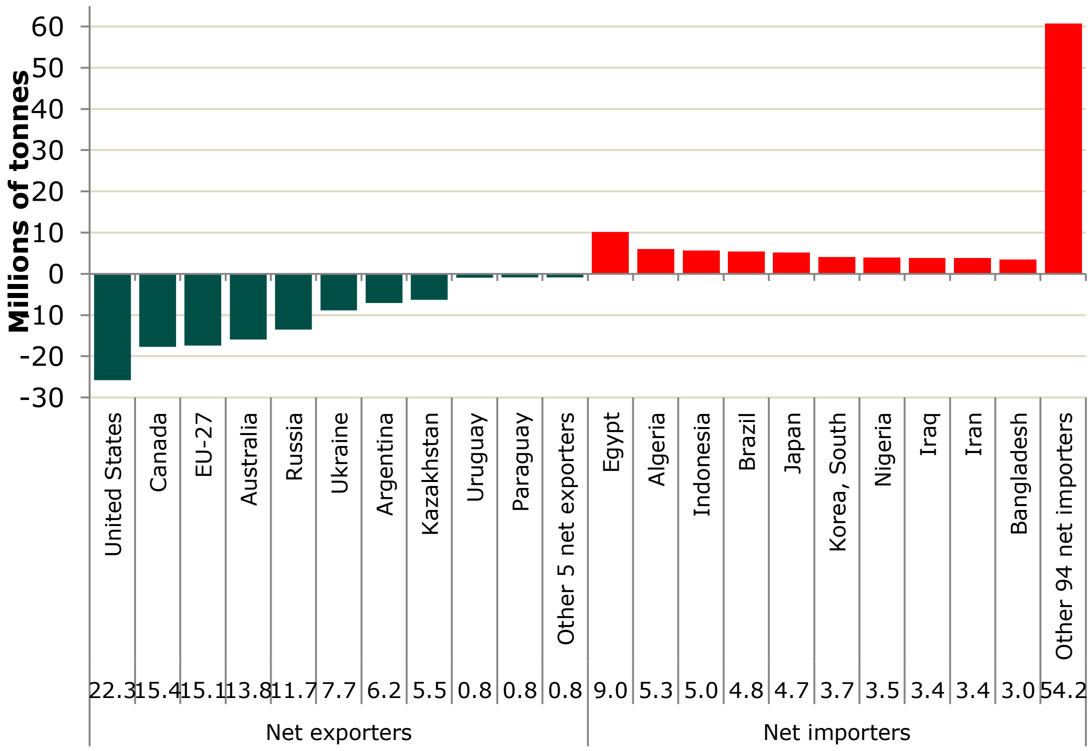
By contrast, wheat is a far less concentrated market, with the top five exporters accounting for 78% of exports and the top five importers accounting for 29% of imports (see Figure 2.5).

Figure 2.4 Average net maize imports, top participants, 2008/09-2010/11



Source: With data from USDA FAS.
Note: Numbers in the horizontal axis indicate per cent of total average net imports or exports.

Figure 2.5 Average net wheat imports, top participants, 2008/09-2010/11



Source: With data from USDA FAS.
Note: Numbers in the horizontal axis indicate percentage of total average net imports or exports.

2.4 Potential sources of grain diversion at national level

Diversion from animal feed

This section discusses which countries could be used to assess the feasibility of national diversion of grain from animal feed/industrial use. Countries were selected according to the following criteria:

- countries with significant populations of hungry or poor people
- countries where substantial amounts of cereals are fed to animals (this eliminates most LICs)
- countries where people's diets include relatively large proportions of maize and wheat (this eliminates much of East and South-East Asia).
- countries that are middle-income rather than high- or low-income, that might have the capacity to implement a grain diversion scheme.

Additional criteria used to help longlist potential countries were:

- the degree of inequality within each country, measured by the Gini coefficient, indicating pockets of deep poverty even in countries with reasonable levels of per capita incomes.
- net-import position, to identify net importers and net exporters of cereals.

Furthermore, descriptive statistics are provided to look at the following in order to select case study countries with varying characteristics:

- stock-to-use ratios to establish whether or not the country favours stockholding of cereals as a risk mitigation strategy(large stockholders might be less keen on a grain diversion strategy, unless it were seen as a cost-saving option or prevented even worse market disruption) [12]
- production and consumption, which show how much of a deficit might need to be made up by imports and/or by drawing down on stocks in any given year (this is closely related to the net import position)
- cereal production volatility, which shows how much local harvests tend to change, year-on-year (this has implications in any given year for how much cereal needs to be provided by stocks or imports; average figures can mask large annual variations).

The countries put on a longlist on the basis of these criteria appear in Table 2.1, arranged by loose geographic clusters. They are found in South, North, and West Africa; Central and South America; and Western, Central and South Asia. Within these regional groupings, they are arranged by income status, as upper middle-income countries (UMICs) or lower middle-income countries (LMICs).

Countries excluded from this longlist are those with high income levels, low animal feed or food use of maize and wheat, and low rates of hunger and poverty.

On the basis of the criteria used, two countries were selected from the longlist, namely, South Africa — a net exporter of maize — and Mexico, a net importer of maize.

- South Africa is a middle-income country but high inequality means that many South Africans live in poverty. Cereal production is volatile and stocks held are moderate.

[12] However, stocks may be high if access to world markets is difficult especially in a food crisis. If these same nations feed animals, grain diversion might be very attractive. Some MENA countries worried about shipping disruption or embargoes fit this category.

- In Mexico, poverty is high, as is inequality. Mexico is a moderate net importer and holds small levels of stocks. Politically, the price of maize is sensitive, as evidenced by the 'tortilla riots' of 2007.

Each case study examines the supplies and uses of grain in these countries, explores the consequences for them of diverting grains and their potential trade impacts, and highlights other options already tested in each country.

Diversion from biofuels

Various studies have attributed an upward pull on US maize prices resulting from mandated and subsidised[13] ethanol production in the US in the past (De Gorter and Just, 2010) and currently (Babcock, 2011). Recent studies looking at the potential impact on EU wheat prices and US maize prices of relaxing the EU and US mandates, respectively, indicated that removing or relaxing mandates could reduce hypothetical grain price spikes in the future (DEFRA, 2012; Helming et al., 2010; Tyner et al., 2012). While it is not the objective of this study to take a position on this, it indicates that diverting grain from biofuels in these countries may, indeed, achieve the over-arching objective of reducing price spikes, and this is the focus of our discussion of grain diversion from biofuels.

[13] Until January 2012, ethanol producers benefited from a Volumetric Ethanol Excise Tax Credit (VEETC).

Table 2.1 Longlist of countries for further investigation for a grain diversion scheme

	GINI index (WDI) – latest available if after 2000	Prod. of maize and wheat/ capita, kg, 2007/08 - 2010/11 (USDA)	Cons. of maize and wheat/ capita, kg, 2007/08 - 2010/12 (USDA)	Maize and wheat share of total food supply (FAO), 2007, kcal/ capita/day	World Bank income level (LMIC; UMIC)	Global Hunger Index (IFPRI 2011) Data of 2004/09	Poverty headcount nat'l pov. line - latest data available if after 2000 (WDI)	Cereal prod. volatility CDVI*100 (2000/0) (with FAO data)	Cereals used for feed as % of domestic supply of cereals (FAO)	Net Imports as % of supply, maize and wheat average2005/07 (FAO)	Maize & wheat STUR, average ending stocks 2007/08 - 2010/11 (USDA)
South Africa	67.4	281	262	**46**	U	6.4	23	17	26	6	31
Egypt	32.1	171	359	**50**	L	<5	22	6	25	42	22
Nigeria	42.9	54	76	**14**	L	15.5	54.7	15	**15**	36	4
Mexico	51.7	232	330	**40**	U	<5	47.4	6	38	28	8
Costa Rica	50.3	4	192	**12**	U	<5	24.2	16	55	92	10
Dominican Rep	48.4	3	149	**11**	U		50.5	10	56	102	13
Panama	52.3	24	167	**19**	U	7	32.7	8	43	87	136
Guatemala	53.7	85	166	**47**	L	14	51	11	32	49	12
Honduras	57.7	81	160	**37**	L	7.9	60	10	28	53	46
El Salvador	46.6	138	252	**32**	L	5.5	37.8	4	48	48	14
Nicaragua	52.3	77	124	**31**	L	9.2	46.2	9	**10**	32	466
Colombia	58.5	35	141	**21**	U	5.7	37.2	8	40	72	18
Peru	48.0	61	170	**21**	U	5.9	31.3	6	35	66	24
Brazil	53.9	319	294	**19**	U	<5	21.4	10	52	3	21
Ecuador	49.0	63	126	**14**	U	7.9	36	10	**20**	55	14
Venezuela	43.5	61	165	**29**	U	<5	29	8	26	43	11
Paraguay	52.0	510	90	**25**	L	5.4	35.1	17	**13**	-177	288
Bolivia	57.3	83	121	**34**	L	12.2	60.1	8	30	29	21
Turkmenistan		251	293	**56**	L	6.2		13	51	3	0
Uzbekistan	36.7	245	278	**54**	L	6.3		8	27	11	0
Armenia	30.9	73	168	**39**	L	9.5	26.5	23	**17**	74	12
Georgia	41.3	76	254	**47**	L	<5	23.6	26	21	71	18

2.5 Technical and operational factors in grain diversion[14]

The rise of intensive production systems

Most animal production in developed countries now takes place under semi-intensive or intensive production systems whereby livestock are fed in confined conditions (barn, house or fenced feedlot) to increase weight or milk production and to achieve certain meat or milk characteristics.

The rising reliance on intensive systems has been mirrored in developing countries with strong economic growth over the past decade, as mixed or extensive systems in certain regions have struggled to meet the accelerated demand for meat (FAO, 2006). Increased output has been achieved mainly through the intensification of production systems and through a shift towards poultry and pigs with much slower expansion of beef production; dairying has also increased in both scale and intensification (FAO, 2006; FAO/IFIF, 2010).

The emphasis on pigs and poultry has arisen partly because they are more suited to intensive production than cattle (ruminants) as they have a much higher feed-conversion rate than ruminants, which results in reduced feed costs per kg of meat. In an efficient pig production system, a pig for slaughter can put on one kg in live weight using less than three kgs of feed (FAO, 2009); poultry can gain one kg of weight for between two and four kgs of grain, while cattle can put on only one kg in live weight for every seven kg of feed per head (Rosegrant et al.,1999 in FAO, 2006).

The role of grains in intensive production systems

Cereals play an important role in the diet of animals in intensive production systems and account for a large proportion of variable production costs. Grains account for around 95% of a typical dairy diet, 60-65% of a standard diet in the poultry sector and 60-80% of a typical pig's diet.

Therefore, a reduction in the amount of feed fed to animals would decrease variable costs for producers. However, unit costs per animal per year would increase, as they would be kept in feedlot for longer periods, increasing other costs, such as labour per animal.

Turnaround times for growing an animal to slaughter weight differ between species and are much lower for poultry (45 days) than for pigs and cattle (6-12 months). This would allow poultry producers to be much more flexible than pig or cattle producers in responding to a request to idle production, and to getting production back on track once the need had passed. Conversely, a reduction in feed to pigs and cattle, with a longer growing time, could significantly disrupt the supply chain with knock-on effects on the supply of piglets or calves that would take more time to restore, particularly if a price spike lasted for a significant period of time.

As poultry and pig supply chains are often highly integrated and concentrated, a grain diversion scheme may not have to address multiple stakeholders but could deal with, for example, the integrator of a supply chain, who may even run a feed mill as well as supplying chicks or piglets. Dairy and beef are the exceptions, as they are less homogenous with different levels of integration and specialisation, which could make the number involved and choice of eligibility (cattle/dairy producer vs feed manufacturer) more complicated. Conversely, a highly-integrated system with few players could make an auction more expensive for the government.

Quality characteristics and standards of food, feed and industrial grains

While all grain users want grain of 'good quality', quality can be interpreted in different ways by different users, depending on its end use for that particular enterprise or individual (FAO, 1994; Simmonds, 1989). Growers want varieties that are high yielding and are resistant to pests and diseases, while millers will look for grains that are clean, easy to mill and have high

[14] See Annex C for further details.

milling yields (i.e., high quantities of flour that can be extracted from the grain) and that are suitable for consumer needs. Processors want flour that will suit a particular use, such as bread, cakes, pasta, noodles, etc. in the case of wheat, while consumers value flavour, aroma, texture, nutritional value and cost (Simmonds, 1989).

The qualities of different grains are usually expressed in specifications or gradings. There are at least 330 specifications for cereals and cereal products at national and international level (over 50 countries or regions) of which at least 12 are applicable globally (FAO, 1994).

Quality standards under bodies such as the *Codex Alimentarius* Commissions were designed to protect the health of consumers and ensure fair trade practices. Originally, this targeted food consumed directly by humans, but the BSE crisis in the early 1990s triggered a new focus on the safety of animal feed. This resulted in a Code of Practice on Good Animal Feeding, which applies to the production and use of all goods used for animal feed and feed ingredients, whether produced industrially or on an individual farm (WHO and FAO, 2006).

At international level, and in developed countries, such as the US and the countries of the EU, there is a reasonable degree of substitutability between different qualities of grain, although the higher level of moisture or broken grains may have implications for the length of time for which the grain can be stored.

Wheat tends to be more highly differentiated and stratified than maize.

- In leading wheat-producing and exporting countries, with highly developed and stratified classification and grading systems, very stringent quality characteristics are required of premium grade wheats. In such systems, feed wheat tends to be the low grade, residual wheat that does not reach the qualities or soundness levels required for milling or general purpose wheat.[15] While such wheat may not contain the ideal characteristics for milling, technically, it is usually fit for human consumption.[16]
- Unlike wheat, maize is a more homogenous product: the emphasis in quality standards is on cleanliness and the percentage of damaged or broken kernels, with little distinction made in relation to other characteristics.
- US maize grades do not appear to characterise grains according to end-use needs apart from the level of broken corn and foreign material (BCFM), moisture and test weights. This appears to result from the fact that the majority of grain is used for feed or biofuels, where quality is less of an issue than price, and buyers generally opt for the lower grades 2 and 3. However, even with feed grain, quality is still an issue and feed manufacturers are concerned with BCFM, moisture content, aflatoxin, crude protein content and hardness/ susceptibility to breakages (Mercier, 1994).

However, there may be less substitutability between different grades of grain at national level in developing countries, given less stringent requirements for particular parameters in feed and industrial grain (e.g., mycotoxins). This is further complicated by distinct consumer preferences in different countries for different types of grains.

Outside of the US, the main distinction in terms of end use is between yellow and white maize. Yellow maize tends to be preferred for livestock feeding as it gives poultry meat, animal fat and egg yolk the yellow colour valued by consumers in many countries (FAO, 1997).[17] Consumers tend to prefer white maize for direct consumption, with some consumers of white maize reluctant to switch to yellow maize. This may be due to issues of quality, particularly where yellow maize has been imported for food when it was originally intended to be used as

[15] Wheat that does not reach the levels of key parameters, such as protein content, of other grades of milling wheat but is suitable for milling and blending with other wheats.
[16] Communication with the Agriculture and Horticulture Development Board.
[17] In Mexico, where relatively large quantities of white maize are fed to animals, the colour deficiency is corrected by adding carotin as a colouring agent to the compound feed mix.

feed, or because of lack of knowledge of the properties of white maize relative to yellow maize (FAO, 1997). Such preferences can be very specific to each particular country, making it hard to generalise.

In general, white maize is not used to produce ethanol or high-fructose corn syrup (HFCS), with the exception of South Africa where wet millers have switched between the two depending on market prices.

2.6 Lessons from other sectors – the case of the Drought Water Bank in California

Schemes whereby water and electricity have been diverted from one use to another at times of scarcity provide useful lessons on how to operate a grain diversion scheme in practice.

The US State of California faces periodic acute water shortages and sustained pressure on water resources. In 1991, a Drought Water Bank was established by the State Government during a period of acute water shortage, using water-supply option contracts to allow additional use of pumped ground water for irrigation use and divert surplus surface water to urban areas and other areas experiencing critical shortage. This experience is well documented and provides useful analogies to inform thinking about a similar scheme for diverting grain (see Annex D for further details).

The experience in California with the Drought Water Bank demonstrates that voluntary option contracts can provide incentives for producers to divert water from irrigation to urban use at times of water shortages. Several factors have proved important for establishing effective pricing, including: solid knowledge of values of water or grain, and associated gross margins; a sense of the duration of the diversion; and an estimation of the total contract cost (see Box 3.1 for features of water provision contracts). The likelihood of success is greater if notice can provided as far as possible in advance, if prices are adjusted to take into account inflation and clear terms and conditions, underpinned by secure property rights to provide security and flexibility.

However, implementing water trades under US water rights systems has been challenging as it is very complex. It can also be difficult politically because of the nervousness about loss of rights if water is not used on farm or if the public discovers how much money has been transferred to users via these rights.

Box 2.1 Principal provisions of water-supply contracts

Michelson and Young (1993) detail a model of a Water Supply Option Contract, the same as that used by the Water Bank - a formal agreement between buyer and seller to transfer water during occasional critical drought periods. Such a contract contains key provisions that aim to make the contract mutually beneficial to both buyer and seller and enable water diversion to proceed on a voluntary basis

- The option guarantees the seller a minimum (exercise) price and guarantees the buyer a supply of water in time of need, as well as the option not to purchase if they choose.
- Premium over exercise price to retain the option of guaranteed sale at set price at some point in the future.
- Escalation over time to take inflation into account.
- To motivate early seller participation, the 1991 Water Bank contracts contained price-escalator clauses, ensuring that if the price extended to a similar seller had increased by a specific date beyond the price originally agreed, the seller of the early-participation option would receive the higher of the two prices (Israel and Lund, 1995). A water-supply contract assumes that the probability and severity of drought is anticipated to be within acceptable limits of risk for both parties.
- Under the option contract, the seller retains rights over the water, meaning that for an option

system to be effective, property rights over water must be definable and transferable for market exchange. This assumes that the latter may require amendments to legal water-rights rigidities (Michelson and Young, 1993), and that the willingness of farmers to sell or lease water is not perceived as an admission that they do not have beneficial use for the water, and are conceding rights to it, under certain states' laws (Hamilton et al., 1989).

- Agricultural operations must also be capable of temporary suspension, so the scheme necessarily excludes perennial (and high value) crops and most livestock.
- Finally, a successful water-supply contract is predicated on the fact that the total cost of the option would be lower than next most costly alternative.

3 Mexico - the case of a net importer

This chapter is a systematic exploration of the case for grain diversion in Mexico, where the price of the main staple, maize, is susceptible to price spikes, and where there are large numbers of poor and hungry people. The first section provides the background to food and nutrition insecurity in Mexico. The second looks at the country's cereal supply and demand, including an examination of local production and trade. A third section looks in more detail at Mexico's demand for meat and other animal products. The fourth section examines some aspects of its livestock and animal feed industry and markets, to review some of the technical feasibility issues raised by grain diversion. The fifth section assesses grain diversion as a policy option to counter price spikes in Mexico, in the context of other possible policy options that have been used or considered by the Mexican Government in the past. Finally, conclusions and recommendations draw out the implications of the chapter's investigation.

3.1 Background — poverty, malnutrition, and food insecurity

Mexico, an upper-middle income country with around 113 million people (2010 estimate) is the world's 11th largest economy (in GDP purchasing power parity terms, WDI, 2010). It can be divided into eight regions and 32 states.[18] In 1994, it became the first Latin American member of the OECD, the same year in which the North American Free Trade Agreement (NAFTA) came into force.

Poverty

Although poverty levels in Mexico are lower than they were 20 years ago, they have been rising in recent years, and the country still has a large poor and hungry population. Food availability and access have been high on the political agenda for much of Mexico's recent history, and people remain sensitive to increases in staple maize and tortilla prices. '*Sin maíz, no hay país'* ('without corn, there is no country') is a popular slogan in Mexico (The Economist, 2011).

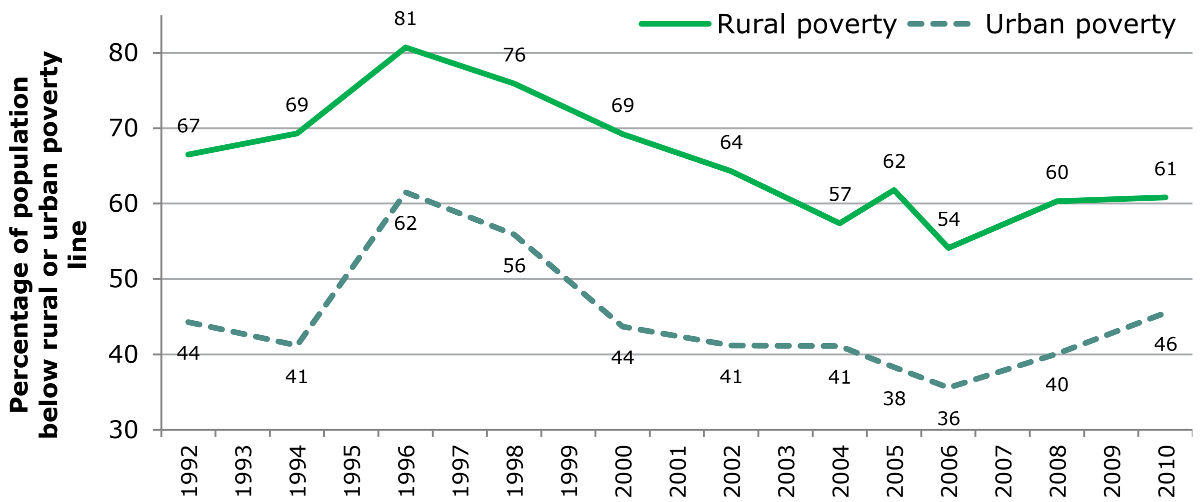
Tens of thousands protested the rise in maize tortilla prices in Mexico City in 2007 (BBC, Feb 2007). The importance of the tortilla is reflected in its contribution to Mexico's Consumer price index (CPI) of 1.2% (The Economist, 2011).

Poverty levels spiked in the economic recession of the mid 1990s, and then fell until 2006, when they started to rise once again (see Figure 3.1). In 2010, 61% of the rural population, and 46% of the urban population were living below the rural and urban poverty lines respectively. In general, poverty is lowest in the northern states and highest in the south.[19]

[18] Counting the Distrito Federal – the area including Mexico City – as a state: See Figure F-1 in Annex D for a map of Mexico's states

[19] See Figure F-3 in Annex D for a poverty map of Mexico for 2000

Figure 3.1 Poverty trends, 1992-2010



Source: With data from World Bank WDI Note: it is not clear how closely the recent upturn in poverty is related to increased food prices, though it could be hypothesised there is a relationship.

Food poverty[20] is also higher in the southern states, although the problem is not limited to these areas. In 16 states, more than 15% of people live in food poverty; and in eight of these the rate is more than one in four (see Figure 3.2).

Stunting of pre-schoolers, an indicator of chronic hunger, is also concentrated in the southern states.[21] Although rates have been improving, they remain high for rural populations, at 24% (see Figure F-2 in Annex F).

Nutrition

Increasingly, Mexico is struggling with the problem of overweight and obesity, in part because people consume foods with high calories at the expense of fruits and vegetables. One-quarter of children are overweight or obese, with the number rising to one-third for teenagers, and more than two-thirds for adults.[22] Proportionally, more urban than rural dwellers are overweight (Juarez and Gonzalez, 2010).

Micronutrient malnutrition is less visible and less well documented.[23] While Mexico has made considerable progress in iodine supplementation,[24] anaemia rates are above 10%, and in certain populations including under-fives and elderly people, above 20%. Rates in rural areas are worse than in urban areas (Juarez and Gonzalez, 2010). In addition, 23% of children under the age of 12 are deficient in vitamin A (FAO, 2010).

[20] The 'food poor' are people without enough income to purchase goods from the basic basket, even were they to use their total income. This is one element of food insecurity, which might be caused by lack of availability of food (the physical amount in the markets), lack of access (for economic reasons), lack of utilisation (for health reasons or other reasons affecting the body's ability to digest and absorb nutrients), and lack of stability (because of crises).

[21] See Figure F-4 in Annex F for a map of stunting rates by state for 2006.

[22] Direct and indirect costs of obesity to the Mexican government reached an estimated 80 billion pesos in 2010 (Juarez and Gonzalez, 2010), which is over $6 billion.

[23] Databases focus on anaemia, vitamin A and iodine, but nationally-representative figures are not often updated. Iron-deficiency anaemia is reportedly the biggest micronutrient problem for under-fives in Mexico, and the status for both iron and zinc is linked to vitamin A status (Muñoz et al., 2000).

[24] Households consuming adequate amounts of iodised salt increased from 28% of households in 1992 to 91% in 2003.

Figure 3.2 Percentage of population living in food poverty by State, 2008

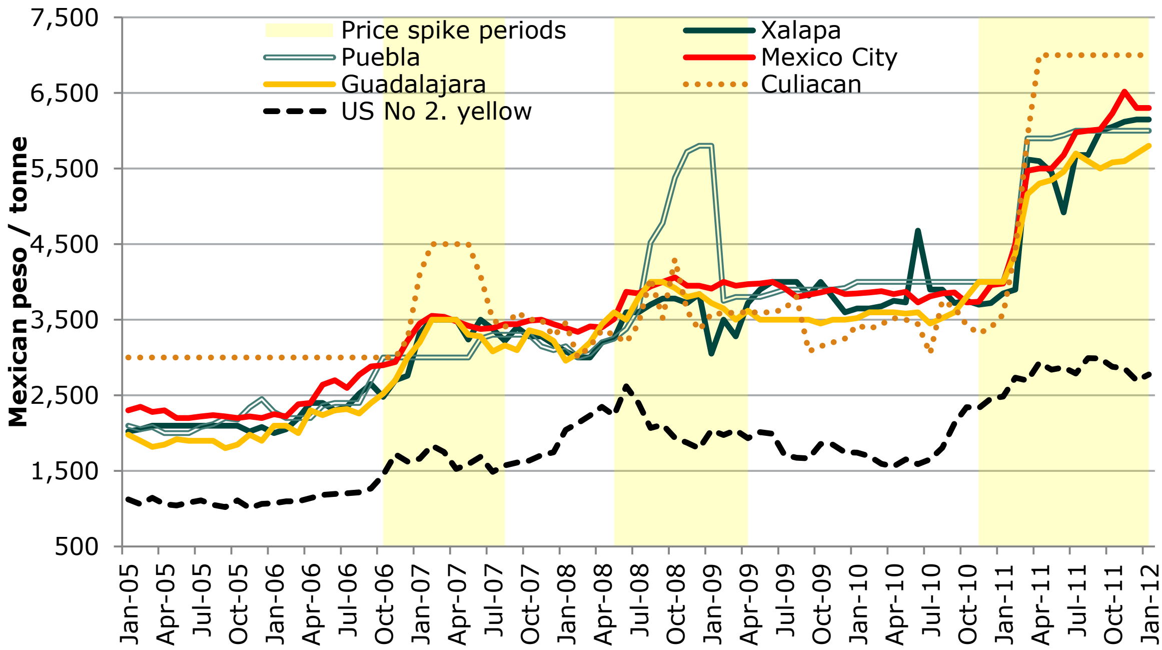
Source: Constructed with data from Juarez and Gonzalez, 2010.

Increasingly, Mexico is struggling with public health issues arising from poor diet and nutrition. An estimated 6.1% of overweight mothers have a stunted child under the age of five (Barquera et al., 2006). Statistics like this, the high levels of obesity in adults, and the fact that nationally, three in every 20 pre-schoolers are stunted, rising to almost one in four for rural pre-schoolers, have prompted the recommendation that programmes to improve nutrition in Mexico should always consider the high risk of obesity (Barquera et al., 2006).

Food price trends

Price spikes have occurred in Mexico in recent years, and maize prices have been volatile, in part because prices in Mexico have strong links to US market prices[25]. Figure 3.3 shows Mexican and US maize prices from January 2005 to January 2012.

Figure 3.3 Maize prices in Mexico compared to US yellow maize price, January 2005 -January 2012



Source: With data from FAO GIEWS. Note: Mexican prices are for white, wholesale maize. The US maize price is the export price converted to pesos at the official exchange rate.

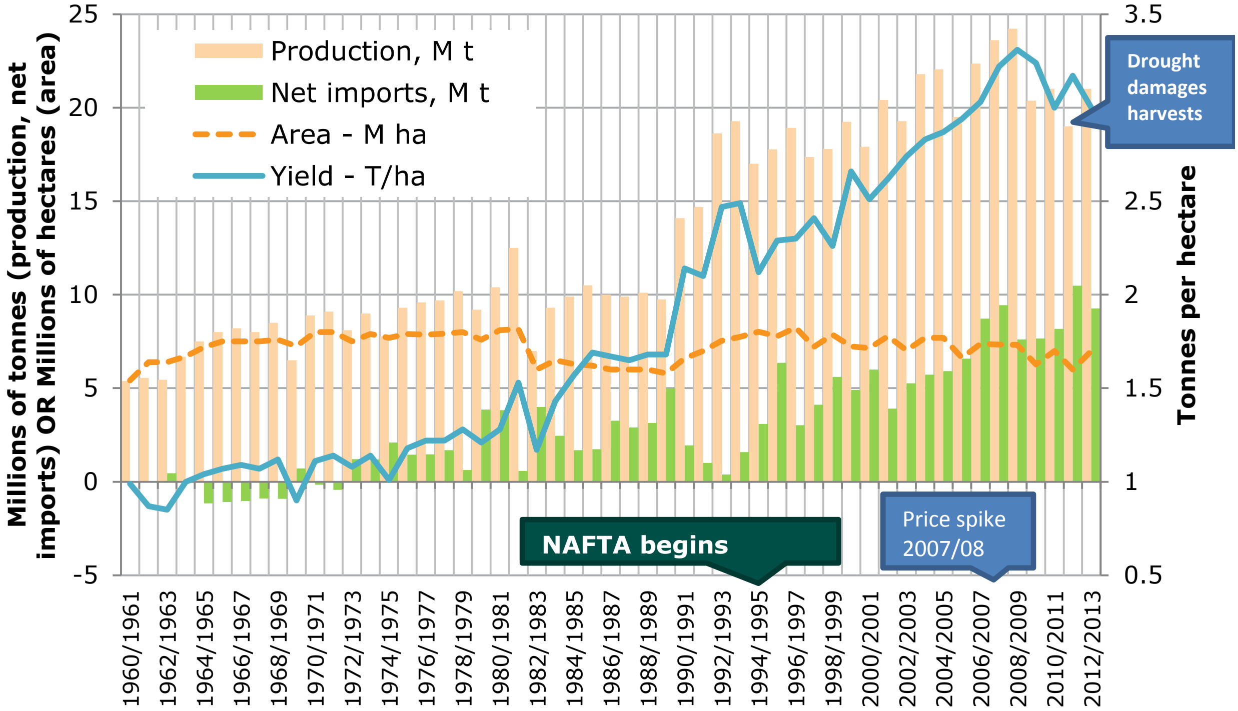
[25] Mexican maize prices are currently strongly correlated within domestic markets, but also with the US market. Correlation coefficients of monthly US and Mexican maize prices from January 2001 to January 2012 between US and Mexican prices run at 80% or more, with most of the transmission happening within three months. On top of price transmission, price rises in Mexico in 2011 are also in part a response to severe drought, which decreased local production of cereals (Juarez and Hansen, 2012)

Three price spikes are apparent in Figure 4.3: from around late 2006 to January 2008, from mid-2008 to early 2009, and from late 2010 throughout 2011. Food prices have, in general, seen an increase in the second half of the 2000s. From 2000 to 2005, Mexico's food CPI grew by 5.1% per year, and from 2006 to 2011 it grew by about 6.4% per year (FAOSTAT data).

As well as being influenced through transmission from international markets, maize and tortilla prices in Mexico are influenced by government policy, with a history of government intervention. For example, when the Government removed subsidies for tortillas in the second half of the 1990s, their prices rose in markets by 127% from 1997 to 1999. They rose a further 22% from 2000 to 2002 (Zahniser and Coyle, 2004).

As a traditional and heavily-used staple, maize carries political weight in Mexico. This is likely to have influenced the Government's decision to subsidise white maize production from 2000 (even if there are reports that this subsidy is directed mostly to large-scale farmers; see The Economist, 2008) in the face of higher white maize food imports from the US. From 1998 to 2002, 15% of US maize exports to Mexico were white, compared to about 2% from 1991 to 1993 (Zahniser and Coyle, 2004).

Figure 3.4 Mexican maize production, area, yield, and imports: 1961-2012



Source: With data from USDA.

Liberalisation around the time of NAFTA also contributed to a reduction in public stockholding, which accounted for around 40% of Agricultural General Services Support Estimates in the early 1990s, but 0% in 1996. Most of this has been replaced by increases in spending on agricultural schools, inspection services, and marketing and promotion.

3.2 Overview of cereal supply and demand

Maize is overwhelmingly the top cereal produced and consumed in Mexico, though use of wheat is growing (on average over 2006/07 to 2011/12, Mexico used around 29 million tonnes of maize and around 6 million tonnes of wheat). This case study focuses on maize.

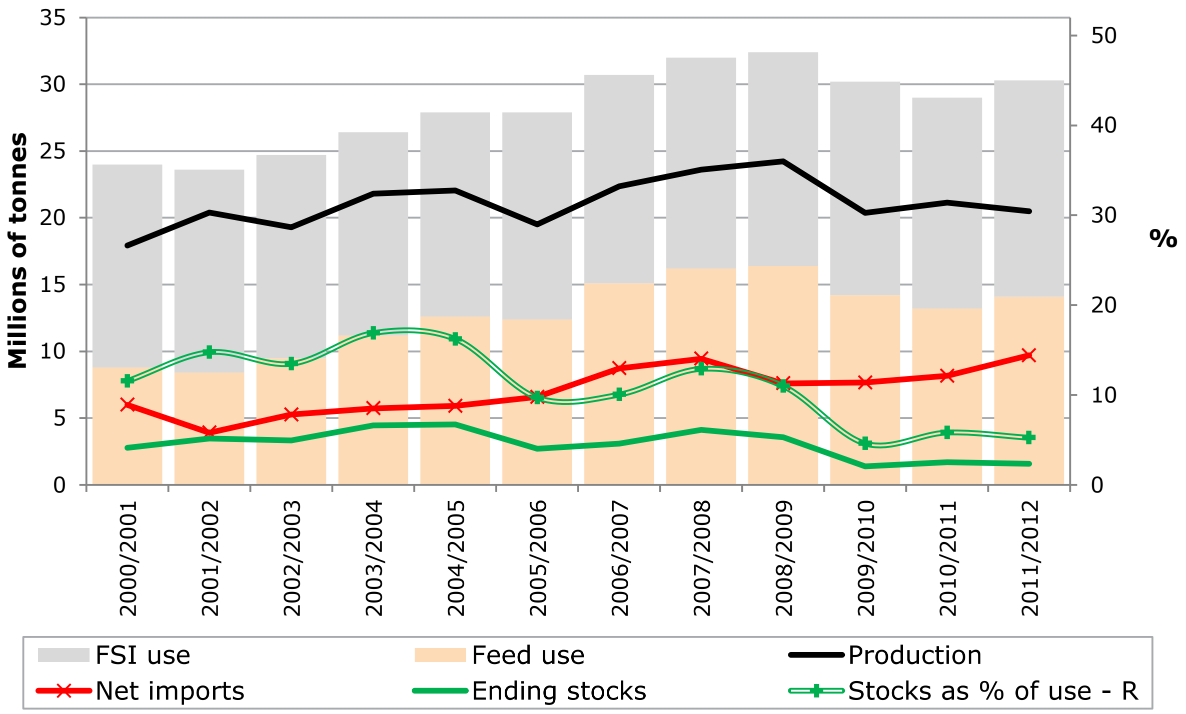
Maize is produced almost everywhere in Mexico where it rains, with no major concentration. Most regions plant in May or June, and harvest from October to January. In the North-West, maize is planted in September or October and harvested from January to March.

National annual maize ***production*** has been about 20 million tonnes in recent years,[26] and has not changed by more than 4 million tonnes per year since 2000/01, with annual variations in production averaging about 1.7 million tonnes over the 2000–2011 period. In recent years, Mexico has produced about 70% of the maize it has used, as annual ***consumption*** has been closer to 30 million tonnes. About 47% of domestic maize consumption has been for feed, with the rest for food, seeds, and industrial uses.[27]

Close to 10 million tonnes are being ***imported*** annually, compared to about 5 million tonnes at the beginning of the 2000s. Net ***imports as a percentage of use*** have been around 25%–30%.

Stocks, which accounted for around 15% of use in the early 2000s, now account for around 5% of use (see Figure 3.5).

Figure 3.5 Maize production, consumption, trade and stocks, 2000/01-2011/12



Source: With data from USDA FAS. Note: FSI = Food, Seeds, Industrial.

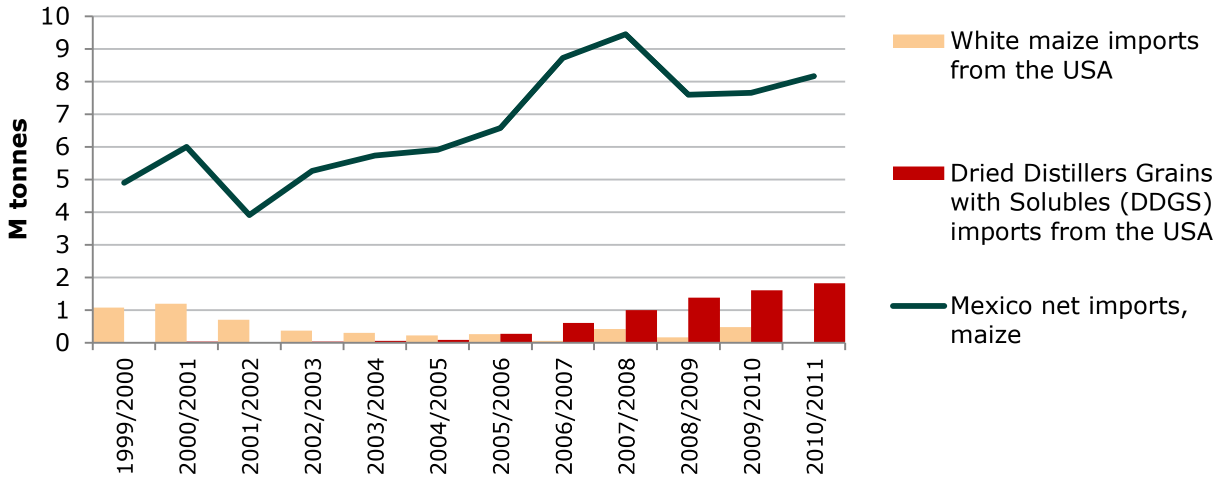
About 8 million tonnes of maize have been imported in recent years, most of it yellow, and much of it from the US for use, primarily as animal feed (see Figure 3.6). More access to US yellow maize is helping to foster expansion of hog and poultry production in Mexico (Zahniser and Coyle, 2004).

New to feed imports are Dried Distillers Grains with Solubles (DDGS), a by-product from ethanol distilleries used for energy and protein in animal feeds, largely for cattle. By 2010/11, almost 2 million tonnes of DDGS were imported. This is a feed-only product that has no substitutability with food.

[26] SIAP-SAGARPA estimates that include forage maize are slightly larger, such that in 2010, Mexico produced 23.3 million tonnes of grain maize, and 11.8 million tonnes of forage maize. See Figure F-5 in Annex F.

[27] Also: 'According to SAGARPA, approximately 50% of the yellow corn in Mexico is used by the livestock industry. Cornstarch production uses nearly 2.3 million metric tonnes of yellow corn annually; 90 to 95% of the cornstarch is produced using corn imported from the United States' (Juarez and Branson, 2011).

Figure 3.6 Mexico's maize imports, 1999/2000-2010/11



Source: Data for net imports from USDA FAS database, data on white maize and DDGS from USDA ERS. Note: reports indicate that, in 2011/12, Mexico purchased 854,000 tonnes from the US and South Africa in the first eight months of 2011 (Agrimoney, 2011).

Cereal consumption by type

Food accounts for about 45% of total maize use, with feed at 35% and processing at 5%.[28] Waste and other uses account for the remainder. [29]

Until recently, only small amounts of wheat have been fed to livestock in Mexico: 0.1 million tonnes in the mid-2000s rising to 0.5 million tonnes in 2009/10-2010/11. However, for 2011/12, USDA projects that the feed use of wheat was 1.25 million tonnes[30] — probably a response to the increasing competitiveness of feed wheat compared to feed maize, as maize prices have risen and the margin between maize and wheat prices has withered.[31]

Cereal for human consumption

Maize, as Mexico's main staple, provides 32% of people's average calories per day. In total, cereals provide 43%. People eat 126 kg of maize on average every year in Mexico. Of the remaining cereals, wheat is the next most popular, with an average per capita consumption in 2007 of 36 kg, followed by rice and other cereals, which, when combined, total around 14 kg.

Average cereal consumption has fallen slightly from its highs in the 1980s, as has that of pulses. In kg terms, per capita consumption of tortillas (the main maize-based food) reportedly dropped 25% from 1997 to 2007, from 120 kg to 90 kg — though it remains the most important component of the Mexican diet (Juarez and Branson, 2011). Average diets are, increasingly, provided by animal products, sugar, and other vegetable products.

Most maize eaten by people in Mexico is white, which is used in traditional tortillas and tamales. A number of dishes use yellow maize but it is, in general, destined for livestock or starch production. However, there is substitutability, and food-grade yellow maize is used to make cornflakes, chips, beer and some other foods, while white maize can be used as animal feed (Zahniser and Coyle, 2004). White maize accounts for 75% of the maize people eat, yellow maize for just 6%. White maize (along with some yellow maize varieties) is used in tortilla production because its soft starch is easily ground into meal. Yellow dent corn has a harder starch content and is more appropriate for feed. Food maize is sometimes substituted for feed when the premium for white maize is low, but feed maize is less often substituted for food use (Zahniser and Coyle, 2004). The remaining 19% comes from blue corn, hominy, and

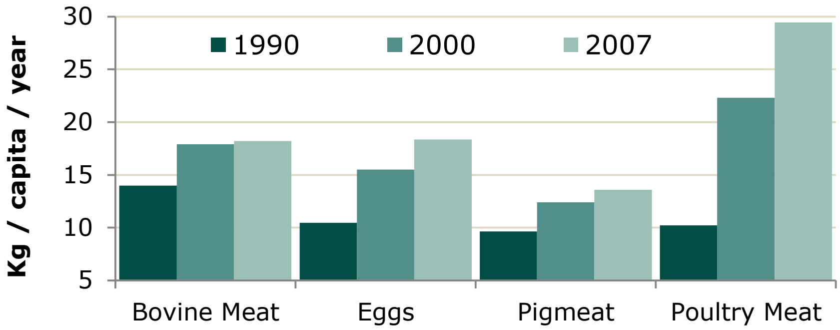
[28] Processed maize includes starch.
[29] This category is very small in Mexico, and refers to the industrial uses of maize that is not intended for human consumption, plus the amount consumed by tourists and pets.
[30] FAO databases do not yet show wheat being used for feed in Mexico.
[31] See Wiggins and Keats (2012) for more detail.

popcorn (Mejia and Peel, 2009; SIAP-SAGARPA). Box B-1 in Annex B compares white and yellow maize for human consumption.

3.3 Trends driving animal production in Mexico

Mexico's demand for meat is growing as its population becomes wealthier. From 2000 to 2007, the average annual per capita combined consumption of meat from cows, pigs, poultry and eggs increased by close to 12 kg per capita (see Figure 3.7).

Figure 3.7 Per capita use of selected animal products in Mexico, 1990, 2000 and 2007



Source: From FAOSTAT data

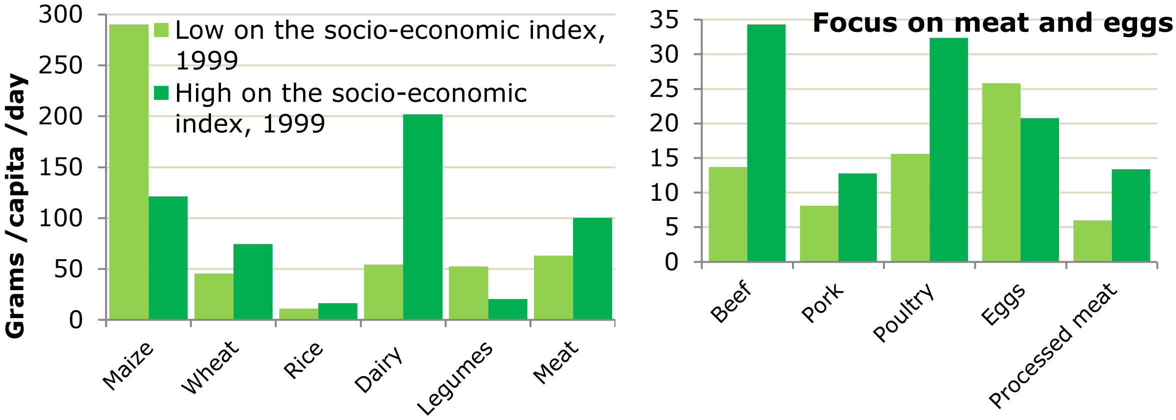
Poorer people consume less animal products that their wealthier counterparts. The poor rely heavily on maize, and eat more beans and eggs than the wealthy (see Box 3.1). Any policy that reduces the availability or increases the cost of animal products needs to consider the possible impact on the consumption – especially of micronutrients -- of the poorest people.

Box 3.1 Consumption at opposite ends of the income scale

A low proportion of households in rural Mexico consume adequate amounts of different food groups at adequate frequencies, according to nutritional criteria suggested by Mexico's National Public Health Institute (Juarez and Gonzalez, 2010).

The poor eat more maize than the rich, who eat more wheat and rice. Legumes are a key source of protein for the less well-off, who report consuming them more frequently than eggs. Dairy products are consumed far more by richer segments of the population. Of the high-protein animal products, poorer people consume mostly eggs, followed by poultry, then beef (see Figure 3.1a).

Figure 3.1a Food consumption at opposite ends of the income scale

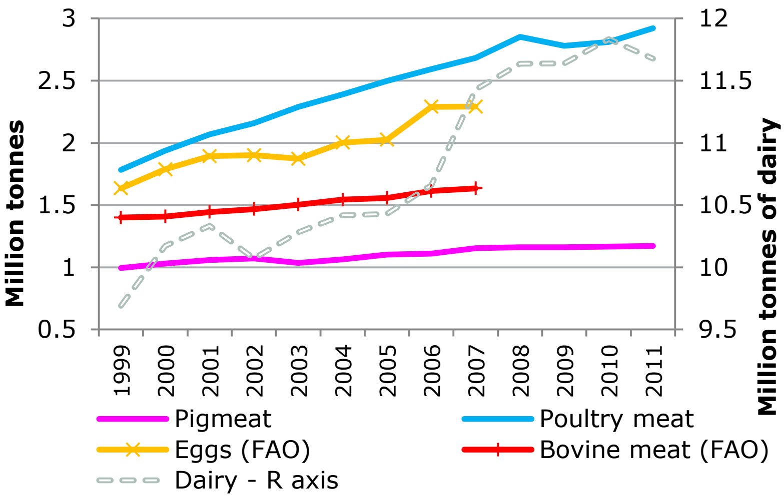


Source: Data from Barquera et al., 2006. Note: Original source MNS–2, 1999.

3.4 Characteristics of the livestock and animal feed industry in Mexico

In 2011, Mexico produced about 1.8 million tonnes of bovine meat, 1.2 million tonnes of pig meat, 2.9 million tonnes of poultry, and 11 million tonnes of milk. In 2007, it produced 2.3 million tonnes of eggs (see Figure 3.8). Chicken and egg production in Mexico has been growing rapidly since the turn of the century, while the growth in beef, pork, and dairy production has not been as fast.

Figure 3.8 Production of animal products and growth rates, 1999-2011



Production annual growth rates, 1999 – 2011*:

Pig meat	1.4
Poultry meat	4.0
Dairy	1.7
Eggs	3.8
Bovine meat	2.0

*Growth rates for eggs and bovine meat go to 2007

Source: Data from USDA except for bovine meat and eggs, which are from FAO (data in FAO only until 2007).

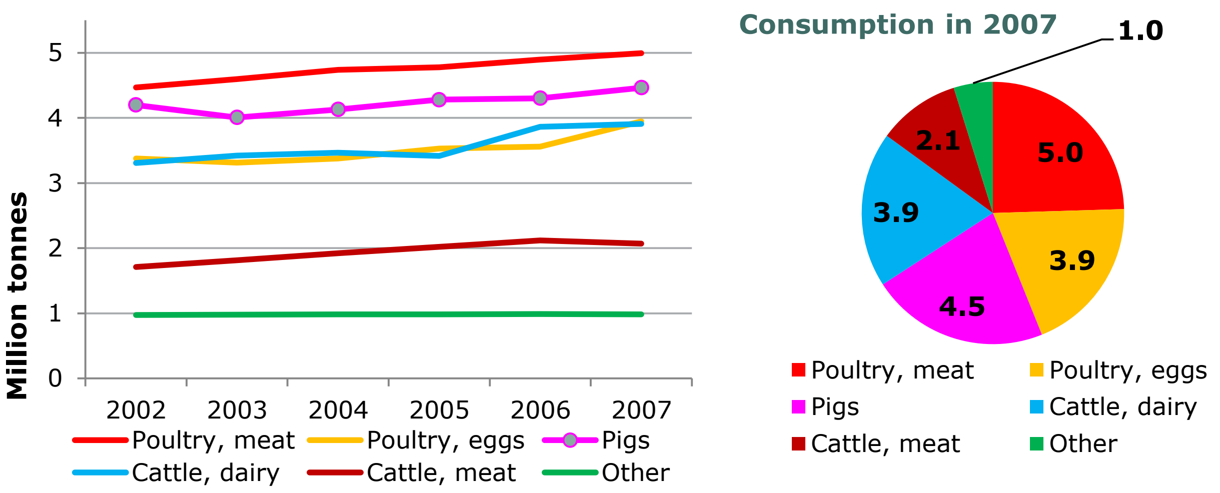
Grain for animal feed

Maize, mainly yellow, is the key grain fed to animals. Other top grains for animal feed include sorghum, brans, and soya. Not only is grain being imported to meet demand for animal products, but also the animal products themselves. Production growth is not keeping up with consumption growth and Mexico is increasingly reliant on imports, particularly from the US (Zahniser and Coyle, 2004). Mexico's imports of pig and poultry are significant: in 2011, net imports contributed about 32% of pigmeat and 16% of poultry. About 3% or less of beef, dairy, and eggs are imported (USDA data for all except eggs, which is FAOSTAT data).

Poultry consume the most grains in Mexico: almost 9 million tonnes of grain feed in 2007. Pigs ate 4.5 million tonnes and dairy cattle almost 4 million tonnes. Maize fed to dairy cattle, however, tends to be whole-crop maize, produced by harvesting and ensiling the entire plant (SIAP-SAGARPA), and is not, therefore, substitutable for maize grain.

Beef cows tend to be raised extensively; however, there is an industry in Mexico that produces young cows to be sent to feedlots in the US (Peel et al., 2011) and these are fed concentrates. Figure 3.9 shows how much grain was fed to animals from 2002 to 2007.

Figure 3.9 Feed grain consumption by type of animal in Mexico, 2002-2007



Source: data from SAGARPA (http://www.sagarpa.gob.mx/ganaderia/Estadisticas/Paginas/default.aspx). FAOSTAT estimates for total feed cereals in 2007 are slightly higher than the SAGARPA figures.

As beef cattle are mainly grass-fed, this case study focuses on dairy cattle, pigs and poultry.

Dairy cattle

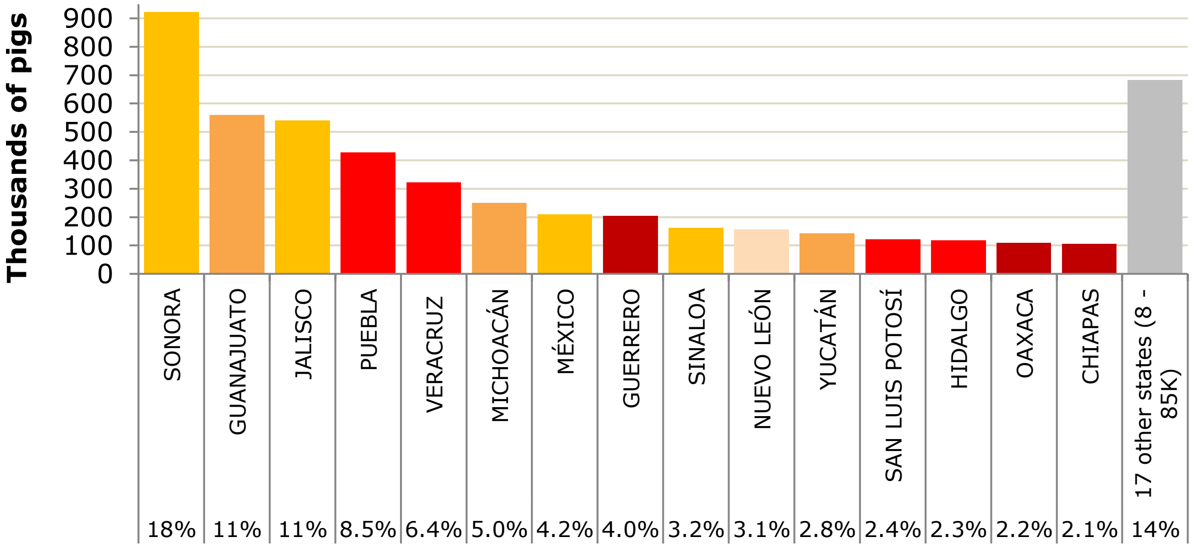
Dairy cattle consume large amounts of silage maize. If maize destined for silage is not harvested as whole-crop maize, it can be harvested for the cobs if left in the field for a few more weeks until the cobs fill. As with maize for grain, there is no great concentration of silage maize production. Among the provinces, Jalisco produces the most (27% of the country's total production), followed by 12% in Durango. Milk production is also high in Jalisco, though it is more intensive in Baja California, Coahuila, and Aguascalientes.

Pigs

In 2007, a detailed census in Mexico found that the total pig population in farms with over five animals to be about 9 million, including 3.5 million breeders and 5 million in production. Pigs in feedlots may be easier to put on short rations and to target for a grain diversion scheme. The distribution of pigs in feedlots is shown in Figure 3.10. Large numbers of the pigs in feedlots are in Sonora, which has large feedlot operations similar to those in the US, driven to a great extent by imports of yellow maize from the US.

There are also large numbers of pigs more centrally (Guanajuato, Jalisco, Puebla, Veracruz, Michoacán, México) as well as significant numbers of pigs in some of the poorer provinces – Guerrero, Yucatan, Oaxaca, and Chiapas.

Figure 3.10 Distribution by state of pigs in feedlots, 2007



Source: INEGI, Agriculture, Livestock and Forestry census 2007. Note: coloured by food poverty rates as in Figure 3.2.

Market concentration of pigs

Pork production is highly skewed: while over one million hog producers are registered, the top two companies account for 17% of market share, while the top five companies in pork production account for 36% overall.

Poultry

Poultry are major consumers of feed grains in Mexico, with animal feed industry contacts reporting that 40% of feed grain is sourced domestically, while the remaining 60% is imported (Juarez and Branson, 2011). Poultry production is concentrated in the West, Centre-East, Yucatán and Nuevo León.

In 2007, 76% (117 million) of the 154 million chickens in Mexico were involved in egg production, while the remaining 24% (37 million) were involved in meat production.

Poultry market concentration

Egg production, while less concentrated than meat production, is still fairly concentrated, with the top four companies accounting for 32% of egg-market share, while the top three broiler companies account for 64% of broiler-market share.

In the case of broiler chickens then, a scheme targeted at some of the larger producers could capture a large proportion of the industry.

The animal feed industry

Animal feed production is quite concentrated, with the top company, Amepa A.C. accounting for 30.5% of market share in 2011. The next two largest companies, CONAFAB, and UNA, accounted for 22% and 19.8% of market share respectively (USDA, May 2011).

Large firms in the hog and poultry sectors in Mexico often integrate feed and meat production, and, in general, have good access to financial capital (Zahniser and Coyle, 2004).

In the poultry sector, approximately 73% of total demand for feed grain is currently covered using risk management tools to mitigate impacts of high grain prices (Juarez and Branson, 2011, citing some poultry producers). Juarez and Branson wrote:

> 'Poultry producers have expressed their intention to avoid unexpectedly strong increases in broiler production costs, as occurred during the record high grain prices in 2007 and 2008. Thus for MY 2010/11, they are hedging against such price risks using the GOM's "Forward Contract Program" ..., under which the price-risk volatility for domestic corn and sorghum is covered. In addition, larger poultry producing companies have bought futures contracts to cover the price risk for imported grains and continue to produce their own grains.'

There are reports that similar hedging practices have been followed by larger pork and beef producers, and in general, private sources estimated in early 2011 that livestock producers and starch manufacturers were covered with forward contracts until the end of the calendar year (CY) 2011 (Juarez and Branson, 2011).

While these types of contractual arrangements help when price spikes are short-lived, they may not serve the same purpose when increases in prices are sustained.

3.5 Policy options to address a price spike in Mexico

Spikes in the price of maize, the key staple in Mexico, threaten the welfare of the poor. Faced by higher maize prices, they will either have to reduce their consumption, or else cut back on other essentials — including higher value foods rich in protein, vitamins and minerals. Diets could suffer in both quantity and quality. The fact that Mexico has so many poor people makes this a widespread problem.

In the event of a spike, the government has two options: first, to reduce the cost of staples; and second, to compensate poor households faced by higher staples prices.

How might these be done? If the problem is a price spike, implying a temporary, sudden and sharp rise in prices, then remedies might include holding stocks that can be released on to the market to bring prices down, setting price controls by administrative order, or subsidising the cost of staples. It is here that diverting grain from animal feed might be one way to reduce demand and so bring down prices.

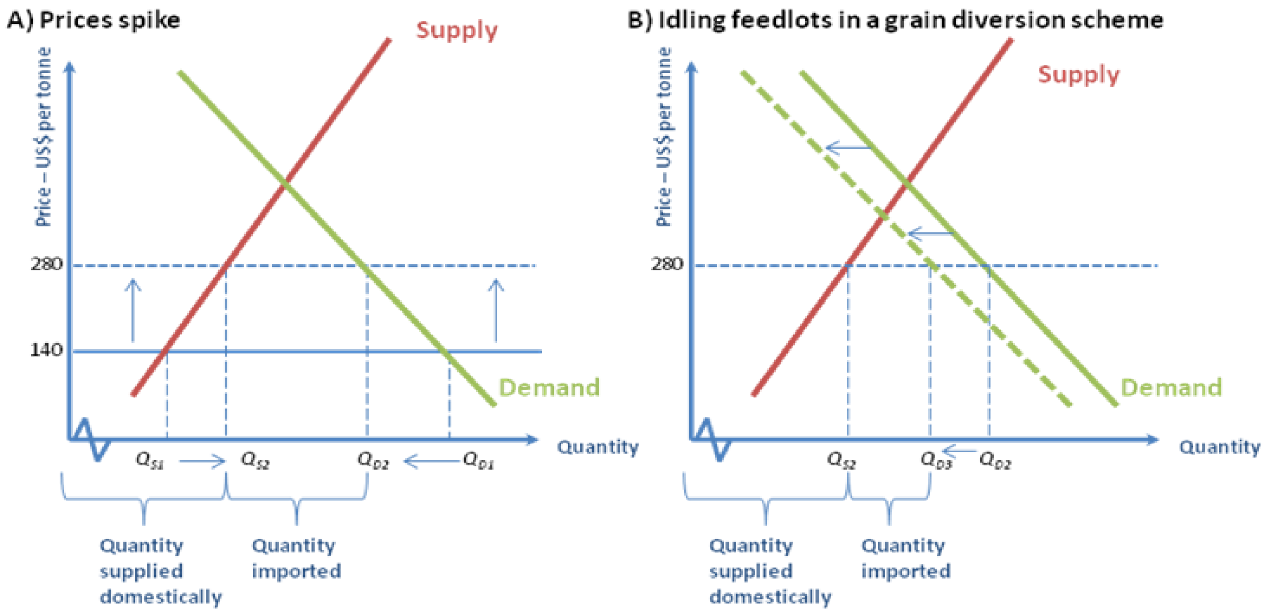
Would diverting grain from animals to humans remedy a price spike?

Grain diversion in Mexico might involve moving grains from animals to people via a policy to restrict grain-fed production of livestock on a temporary basis. The case for grain diversion in Mexico warrants exploration, because of the country's high numbers of poor and hungry people, and because almost half the maize consumed in Mexico goes to livestock feed.

In 2007, about 20 million tonnes of feed grain was consumed by poultry, pigs, and cattle in Mexico, about 10 million tonnes of which was maize. Were 10% of the maize to be diverted from animal to human uses, or 1 million tonnes, this might be expected to increase availability of maize for the food poor — particularly if it were used in conjunction with a targeted distribution scheme. Approximately 13 million tonnes of maize were used for food in 2007, so an extra million tonnes represents about 7.7% of food consumed — a sizable proportion.

But what would grain diversion achieve? The market diagram in Figure 3.11 shows how a spike in world prices and grain diversion might be expected to influence quantities supplied and demanded for a country such as Mexico that is a net importer of maize and where prices are determined by those on the world market.

Figure 3.11 Price spike and grain diversion market diagrams for maize in Mexico



Source: Authors' construction.

Panel A shows how the quantity supplied and demanded changes in the event of a price spike. Price movements in this figure are comparable to the change in US maize prices over the food price spike of 2007/08. At world prices of around US$140 per tonne, as applied until late 2006, Mexico's domestic markets supply Q_{S1} and demand Q_{D1}. This means the demand that is not met by domestic producers (Q_{D1} minus Q_{S1}) must be met by imports. If the price then doubles to US$280 per tonne – the level reached in mid-2008 – the quantity supplied domestically would increase to Q_{S2} (depending on the steepness of the supply curve, which is less elastic in the short run than in the long run), and the quantity demanded would fall from Q_{D1} to Q_{D2}. Imports would contract to equal Q_{D2} minus Q_{S2}.

Panel B shows what then happens if demand for maize falls as a result of the reduced production of animal products in the wake of grain diversion. Demand falls and shifts to the left, as displayed by the dotted line, so that the quantity demanded moves from Q_{D2} to Q_{D3}, meaning that the amount of demand that must be met by imports shrinks by the difference between Q_{D2} and Q_{D3}.

Therefore, a grain diversion scheme would probably lead to less maize being imported, but not necessarily to any change in domestic price. The only way to reduce domestic prices would be to control trade, in this case by keeping imports constant — for which there are few instruments other than an import subsidy. This is, in essence, inconceivable, partly because of the costs to government, and partly because it would probably be forbidden under NAFTA's extensive provisions — whether or not US exporters would object.

What would happen if domestically-grown white maize currently destined for livestock feed were used in a grain diversion scheme? It is not easy to tell how much domestic white maize goes to livestock. What is clear is that the best part of 4 million tonnes of maize goes to ***dairy cattle*** and much of this is ensiled maize: grown domestically, and presumably drawn mainly from white maize varieties. The question then becomes: what if a fraction of this were diverted away from dairy cows, left to mature further in the fields, and then harvested for grain?[32]

[32] To get 1 million tonnes would require a high diversion(25%). Even to get 650,000 tonnes (5% of food use in 2007) would require the diversion of about 16% of white maize to dairy.

Such a reduction in demand for domestic maize would, again, merely reduce imports as shown in Figure 3.11 That is, the poultry feedlot operators might well buy up the grain that is not going to dairy and reduce their imports. Of course, if large poultry and pig farms are locked into contracts, then they may continue to import costly maize despite the increased supply of cheaper grain on the domestic market. If that were the case, then a wedge may develop between domestic and world prices over and above any transport costs, giving an incentive to export the grain.

What instrument might reduce the use of ensiled maize for dairy cattle? Much of this takes place on farms that grow their own maize and ensile it for their (quite small) herds. One way to divert this would be a premium paid on grain to make it worth their while. The Government might offer to buy such maize at a premium, but it would then have to offer the same to all maize producers, as it would be difficult to separate out maize from fields destined for silage from other maize. While there are administrative ways to try and do this, such as allowing only maize from dairy producers in strict proportion to their milk deliveries, this would become an administrative tour-de-force, given the fragmentation of dairy production, and is difficult to imagine.

If all maize is then bought at a premium, the suspicion is that this will be rather costly, as well as administratively difficult: just how much storage does the State have, and how much administrative capacity to handle such an operation?

Alternatives to grain diversion in Mexico

This section looks at alternative policies under two sub-categories:

- measures to dampen prices or reduce price volatility
- measures to compensate poor households faced with higher prices.

Measures to dampen prices or reduce price volatility

Mexico has applied a number of other measures in recent years to prevent price spikes or reduce price volatility.

Price controls

In the 2007/08 food crisis, the Government attempted price controls by fiat as part of the 'Tortilla price-stabilization pact' of 2007 whereby the Government and large tortilla companies signed a pact to put a ceiling price on tortillas of MXN $8.50 /kg (Harrington, 2007). The pact was criticised for being non-binding and for accepting the 30% increase in tortilla prices that had already happened. Many tortilla makers ignored the agreement. Three months after the pact began, tortilla prices were reported to be lower in most of Mexico's 53 largest cities (still, however, remaining in many cases above the ceiling price agreed), though this was largely a result of falls in the average maize price. This measure was combined with measures to limit private stocks, whereby the Government stated it would clamp down on speculators or hoarders. While such options may reap political rewards as they show the government to be taking action, it is not clear that they are effective. Limiting private stockholding also risks dampening incentives for private stockholders to maintain stocks, which risks sharper spikes in the future.

Production subsidies

Subsidising production is another way to cope with price spikes and volatility. This may well boost production and farmer incomes in the medium term, as well as increasing supply; however, unless the timing is perfect it is not likely to dampen prices in the short term. In October 2008, Mexico announced it would support white maize production in Sinaloa for the 2007/08 fall/winter season. Estimates suggested SAGARPA would provide approximately US$100 million in support to cover 3.85 million tonnes of white maize production (Juarez, 2008).

Hedging

Hedging with futures and options is another option that is being used increasingly by domestic farmers and buyers through the Government's Forward Contract Program. This works by helping growers and processors to purchase put and call options.[33] It means that industries purchasing grain for tortillas, as well as for animal feed can counteract the risks associated with uncertain supply or prices in the near future, while farmers are guaranteed a market and thereby encouraged to invest in production (Juarez, 2008; Juarez and Branson, 2011).

In an unusual and recent move, the Government of Mexico also bought maize from the US on futures markets. In July 2011, Mexico bought 823,000 tonnes of US maize, about 550,000 tonnes of which was for delivery in the 2011/12 marketing year beginning in September that year, with the remaining 273,000 tonnes for delivery in the 2012/13 marketing year. It is unusual both for the Government to buy futures and for any buyer to book corn more than a year in advance (Polansek, 2011). However, the 550,000 tonnes for 2011/12 delivery represents less than 6% of the 9.7 million tonnes of maize USDA estimated that Mexico would import in 2011/12, and less than 2% of the 30 million tonnes of maize consumed. On such a scale, it is likely that this measure is intended to demonstrate to consumers the Government's willingness to help with staple food supply, rather than being a complete hedge against spikes or excessive volatility in prices. It is not a tool to cope with sustained price rises.

Releasing stocks

There are other options to dampen price spikes, including the release of stocks or reductions in food taxes, though these have not been possible in recent years because Mexico does not hold large public stocks,[34] or tax staple foods.

Measures to compensate poor households faced with higher prices

Mexico has a long history of interventions or programmes intended to improve people's food and nutrition security. Policy instruments have ranged from universal subsidies on staple foods to more targeted cash transfers.

Food subsidies

The prices of essential staples — including maize tortillas and cooking oil — have long been subsidised. Since the 1990s, food policy has changed from universal programmes to those that are targeted more selectively (Barquera et al., 2006; Gundersen et al., 2000), and food subsidies are now targeted to poor households. This has proved effective. Among poor people in Oaxaca city, 12% of pre-schoolers were underweight in a community that received the tortilla subsidy, compared to 19.2% in two other communities, one of which had never received the subsidy and one which received it up to five years before the study (Shamah Levy et al., 2003). Families receiving the subsidy initially spent 45% of their income on tortillas, and the subsidy reduced this by 9% (Shamah Levy et al., 2003). It is possible that food transfers could come from grain diversion schemes, though this has not been tried.

Targeted cash transfers

In the 1990s, Mexico began conditional cash transfers through one of the world's largest programmes. *Oportunidades*, a national programme that aims to improve the nutrition, education and health of the poor, transfers cash to families in extreme poverty, reaches up to one in five Mexican households. Paid every other month to mothers, payments are conditional on infants being brought to clinics for health care, and school-age children attending school until they complete their secondary education. Initially designed for the rural poor, the programme now covers poor households in urban areas as well. In 2004, it had an annual budget of US$2.273 billion, and covered five million families in rural and urban areas in more than 70,000 locations (Barquera et al., 2006).

Evaluations have found positive impacts, including the reduction of disease among pre-schoolers, an increase in pregnant women attending health centres, reduction in morbidity among adults, and a reduction in anaemia in under-twos (Barquera et al., 2006). Cash

[33] The buyer of a put option on a specified price has the right, but not the obligation, to sell the asset at this specified price at the predetermined date on the contract. The buyer of call options on an asset at a specified price and predetermined date has the right, but not the obligation, to buy the asset for this price at this time.

[34] Mexican government spending on public stockholding fell from around 40% of the Agricultural General Services Support estimate in the mid-1990s to 0% by 2000, where it has remained (OECD data).

transfers in urban areas have resulted in more high-protein food being consumed, by more people than was expected. Cash transfers have been an important determinant of the improved nutrition observed among programme recipients (Angelucci and Attanasio, 2011). In poor rural communities, cash or equivalent in-kind transfers have led households to increase total energy consumption by 5%–9%, energy from fruits and vegetables by 24%–28%, and energy from animal source foods by 24%–39% (Leroy et al., 2010). In addition, iron, zinc, vitamin A, and vitamin C consumption have improved significantly.

Given that one condition of the cash transfer is that families ensure children attend school, evaluations have found positive effects on school enrolment. In addition, the conditional transfer has largely or completely eliminated the impact of an economic shock on school enrolment (Gertler et al., accessed 2012).

Chávez-Martín del Campo and Villarreal Páez (2009) found that using *Oportunidades* to channel resources to the food poor and nutritionally poor was a more effective option than food subsidies or universal transfers, and was better-targeted. However, while this could reach five million households (most of the very poor in Mexico), it might not reach all those who are nutritionally vulnerable and would need to be extended. According to Chávez-Martín del Campo and Villarreal Páez (2009):

> 'Even so, the utilization of social programs as a platform to overcome the country's nutritional shortfalls presents several challenges. Certainly, an important percentage of the households that fall below the nutritional poverty line are not currently incorporated into the social program network. Thus, one of the fundamental challenges for the federal government will be to expand this social welfare net in the short and medium term.'

3.6 Conclusions and recommendations

Mexico's dependence on maize for human consumption, its large numbers of poor, and its fair-sized livestock industry make it an attractive case for the investigation of grain diversion as an option.

It should possible to sort out the technical issue of the transferability of maize originally intended for animal consumption to human consumption in Mexico's case. For instance, even grain originally intended for silage could be left to mature in the field to attain a food-suitable quality.

Similarly, market concentration would be a major obstacle, though it would still be technically and administratively costly to dampen production across many thousands of small producers, particularly in a relatively non-concentrated livestock industry such as dairy.

A more major issue, however, would be the unintended knock-on consequences to poor people of making products with high nutritional value like eggs, milk and meat more expensive through policies to reduce supply. Poor people in Mexico already rely too heavily on lower-value foodstuffs that are not a sufficient source for essential vitamins and minerals.

But the critical stumbling block for any grain diversion scheme for Mexico is the issue of trade. Diverting crops from animal to human consumption in the absence of trade control measures — import subsidies specifically — would only lead to a reduction of imports, and would not be expected to have any smoothing impact on prices. Import subsidies are essentially inconceivable, partly because of the costs to government, and are likely to be forbidden under NAFTA's extensive provisions — whether or not US exporters are likely to object.

It seems, therefore, that the diversion of grain from animal to human consumption is not a viable option for smoothing price spikes in Mexico.

On the other hand, the advantages of existing schemes in Mexico have real potential to be sufficiently agile and cost effective as a means of protecting poor consumers from the negative consequences of maize prices that suddenly spike.

The main alternative would be to increase targeted transfers to poor and vulnerable households. This is probably cheaper and administratively simpler — especially when the country already has a substantial targeted programme to transfer cash, *Oportunidades*, that covers five million families, or about 20 million people, that could be temporarily deepened to include an emergency food payment.

4 South Africa - the case of a net exporter

4.1 Introduction

Maize prices in South Africa are vulnerable to high fluctuations as a result of factors on global and regional markets and in South African grain production. As maize meal is the main staple consumed by the poor, these price spikes hit their food budgets particularly hard, leading to wider and deeper food insecurity as the most vulnerable reduce their food consumption. Grain diversion is proposed as a possible short term measure that governments could enact during emergency periods of high prices; grain destined for feed use would be diverted to the poor either by the market or through food transfers.

This case study will look at whether the diversion of a relatively small percentage of the grain consumed by the livestock industry could mitigate a price spike in retail market prices, given the size and organisation of the South African livestock industry, and examine how it compares to alternative mechanisms at the Government's disposal.

Section 4.2 and 4.3 provide a brief overview of South African food security and grain use. Section 4.4 looks at maize use within the livestock sector. Sections 4.5, 4.6 and 4.7 examine grain diversion and the range of other measures South Africa can take to control prices, comparing grain diversion to alternatives. Conclusions are presented in Section 4.8.

4.2 Background

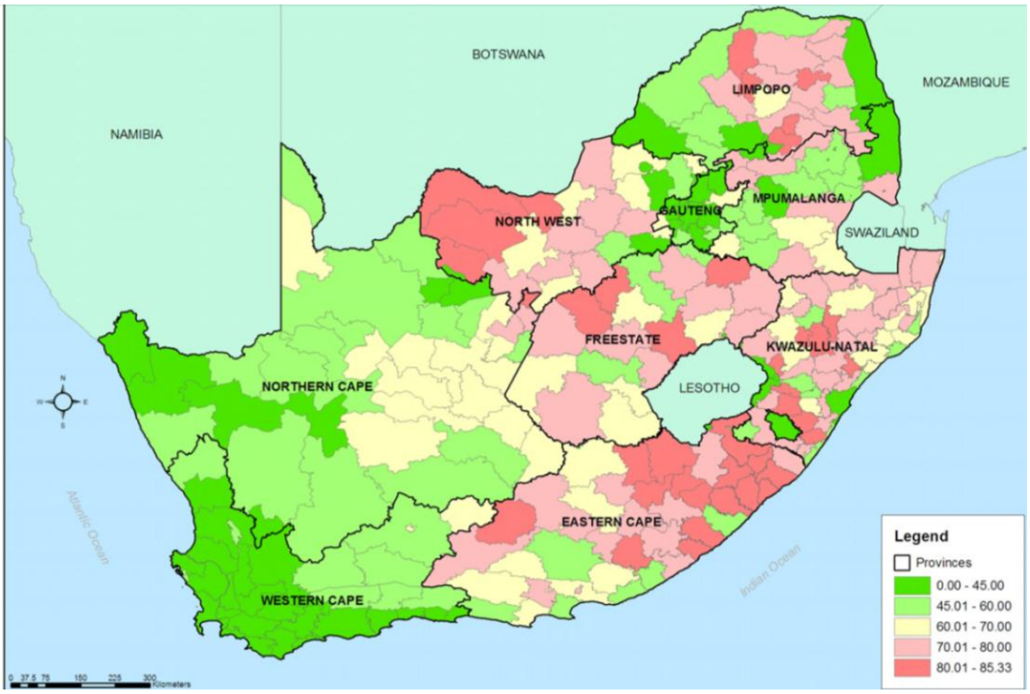
Poverty in South Africa

Over the last 15 years, South Africa has experienced sustained growth and now ranks as an upper-middle income country (UMIC). It has a modern industrial and financial sector, and has experienced an annual average growth of over 3.5% since 2000. This is expected to continue in the next few years (World Bank data) leading to its inclusion as the latest member in the BRIC group of countries, which currently includes Brazil, Russia, India and China.

At the same time, a large segment of the South African population has been left out of this growth, as poverty reduction has not kept pace with economic growth. Although the Gini index (measuring the disparity between the richest and poorest) dropped back from 67.4 to 63.1 between 2006 and 2009, this is still one of the highest disparities in the world, and above the level of other UMICs (WDI 2012), with much of the wealth still concentrated in the hands of a small number of rich people. Many of the disadvantaged — largely South Africa's black majority — have not experienced rising living standards, especially those living in the former 'homelands' and other rural areas. Some 70% of the poorest households live in rural areas, and poverty rates are higher in rural provinces; 67% of rural individuals are classified as poor compared to 32% of urban dwellers (Armstrong et al., 2008).

Food security in South Africa reflects this dichotomy. Areas of high food insecurity and poverty overlap and are shaded in red in Figure 4.1 below (Department for Agriculture, 2006). At the national level, South Africa is food secure and, on average, produces enough grain to feed itself, support a relatively large livestock sector and regularly export grains to other countries within the region. On the other hand, household surveys show that 20–35% of the population is classified as 'food insecure' by some measure (Koch, 2011) with 20% of the population having inadequate or severely inadequate food access (De Schutter, 2011). Children are particularly susceptible; stunting affected 18% of under-9 year olds in 2005, with children in former tribal areas ('homelands') having the highest incidence (Berry and Hall, 2010).

Figure 4.1 Poverty map of South Africa

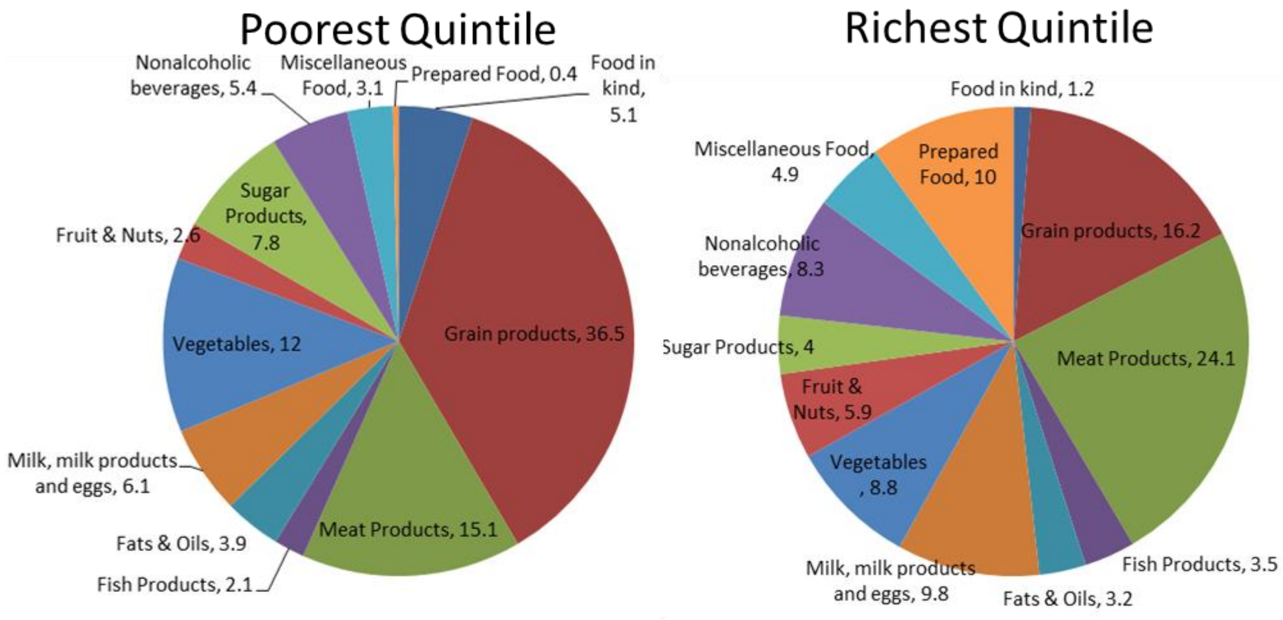


Source: South Africa Department for Agriculture (2006). Note: The legend indicates areas with percentages of households living in poverty.

South African diets: the dominance of maize in the diets of the poor

Maize is the main food staple for South Africans and constitutes a major part of daily consumption in terms of both volume and expenditure. Figure 4.2 shows the different expenditure on food groups by the richest and poorest quintiles in urban areas, who spend 57% and 13% of their total spending on food respectively. The poorest quintile spends 36.5% of their food budget on grain products, of which half is spent on maize meal (with wholemeal bread and rice making up the remainder). This compares to the richest quintile's 16.2% of total expenditure, which is made up of mainly wheat-based items, with very little maize meal (Martins 2005).

Figure 4.2 Diets of the richest and poorest urban South Africans, 2004 (percentages)

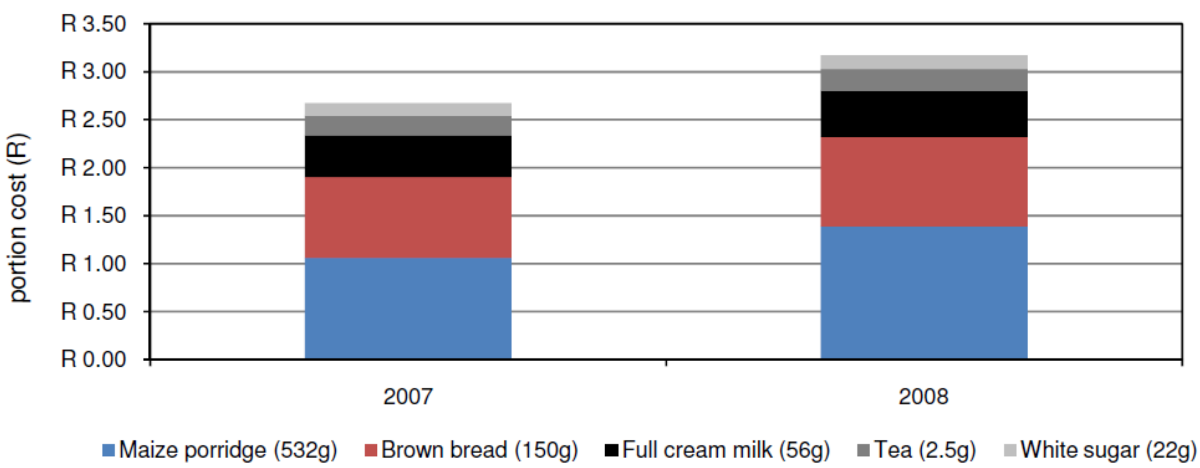


Note: Figures correspond to percentage of total expenditure on food.

Source: Data from Martins (2005).

Given the high percentage of total spending on food and the high volume of maize within this, poor South Africans are hit particularly hard by high grain prices (NAMC, 2009). Over the period 2007–2008, South Africa experienced high levels of food inflation, partly as a result of the rising price of maize meal. Figure 4.3 shows the rise in the cost of a portion of food for the poorest quintile over this period, much of which was attributable to the rise in the cost of maize porridge. Although domestic prices later fell as international prices came down, poor consumers were hit again by high food prices in 2011, when maize meal prices rose by 41% ('super' maize) and 64% ('special' maize). This contributed to a rise in spending on food for the poorest 30% of the population from 33.9% to 38.7% of their income.

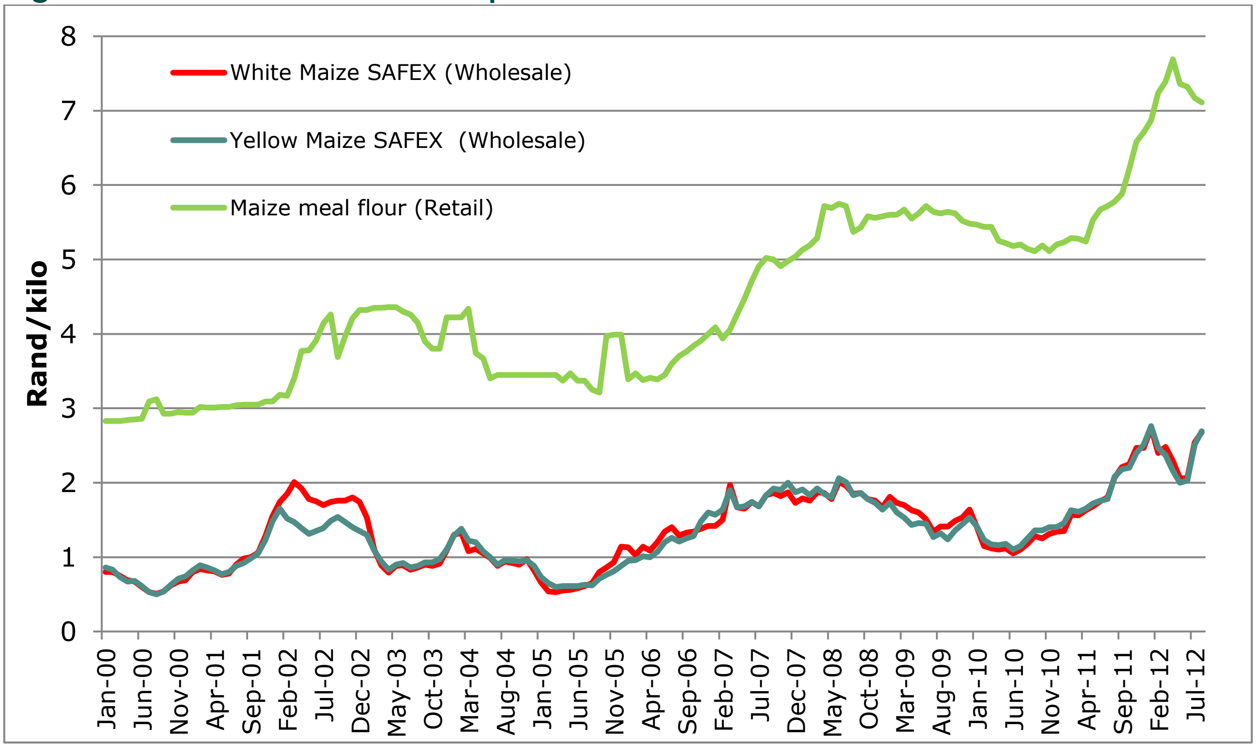
Figure 4.3 Average cost for the typical portions of five food items consumed most widely by very poor consumers in South Africa, 2007-2008



Source: NAMC (2009).

Figure 4.4 shows the maize prices in South Africa of wholesale white and yellow maize (red and blue lines), and the retail price of one kilo bags of maize-meal flour (green line). Several points are evident from this. First, white and yellow maize wholesale prices move closely together throughout the time period, with only one significant period of divergence (during 2002–2003). They follow a seasonal pattern, dropping to the lowest in May in most years, when the main harvest occurs. Second, while maize-meal prices do follow movements in wholesale prices, they lag by approximately four months, and display higher levels of volatility. Periods of high prices also appear to last longer in maize-meal markets than in wholesale markets. These markets are affected by both local, regional and international events; a regional drought raised prices in 2002–2003, and periods of high international prices pushed up domestic prices in 2007–2008. Similarly, high export demand in 2011–2012 supported domestic wholesale prices, which contributed to higher retail maize-meal prices (USDA, 2008).

Figure 4.4 South African maize prices 2000-2012

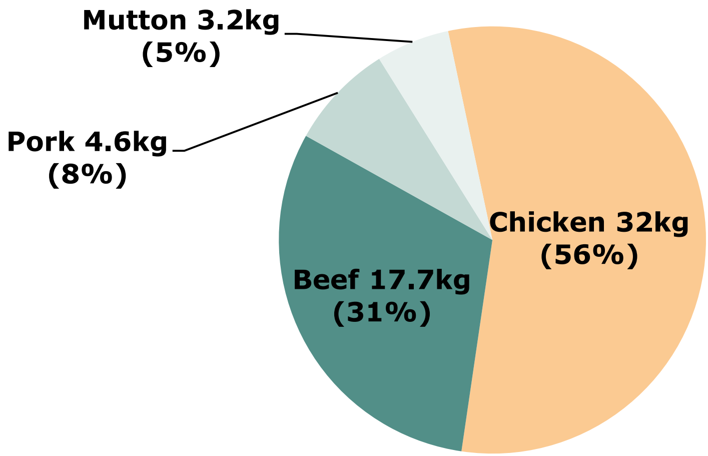


Source: FAO GIEWS (wholesale prices) and South African Grain Information Service (retail price).

Patterns of meat consumption also reflect affordability and the differences in disposable income amongst South Africans.

Currently, South Africans eat more chicken than any other meat (32 kg per person per year) which accounts for 56% of total meat consumption (57.5 kg per person per year). This is followed by beef, which accounts for 31% of total consumption (equal to 17.7 kg per year). Smaller amounts of pork and mutton are also consumed (BFAP 2011).

Figure 4.5 Average annual per-capita consumption of different meat products in South Africa, 2010

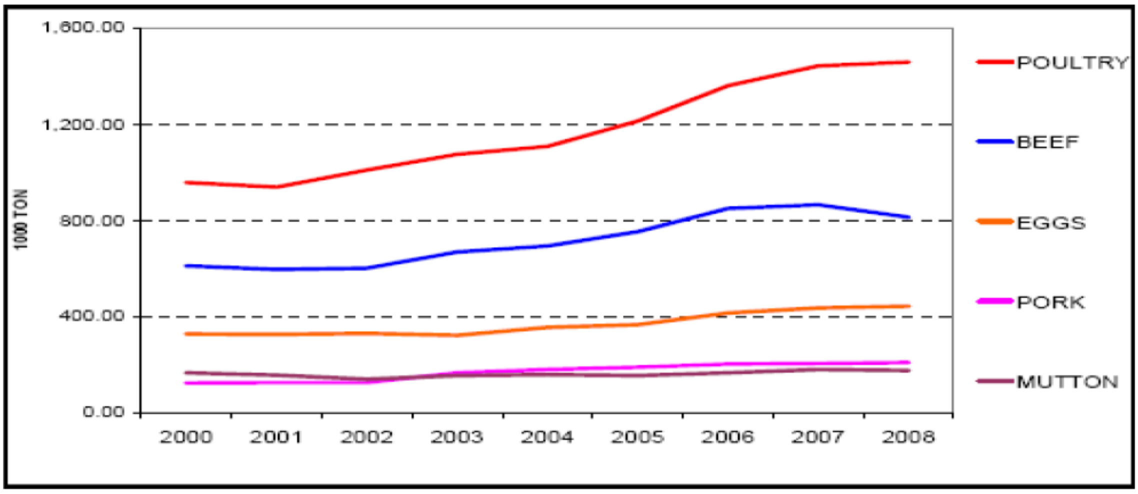


Source: BFAP 2011. Note: Figures indicate kilograms of meat consumed per capita per year; figures in brackets indicate percentage of total meat consumption.

As illustrated in Figure 4.2 consumption and expenditure on meat products differs by income class. The richest quintile spends 24% of their food budget on meat, which, in monetary terms, is ten times the total amount spent by the poorest (BFAP 2011). In terms of meat products, the largest part of expenditure by the poorest quintile is spent on chicken (55%). This compares to more even spending on meat by the richest quintile, who spend 24% on beef, 23% on chicken and 20% on lamb. Similarly, total expenditure on milk products and eggs by the poorest consumers is ten times lower than that of the richest.

Poultry consumption has seen the biggest expansion in recent years, with the consumption of chicken doubling since 1993 and continued strong growth throughout the 2000s (Figure 4.6). More poultry is now consumed than all other animal protein sources combined (NDA, 2011). Total per-capita consumption of beef has risen slightly in recent years, although remains lower than the peak levels reached in the 1960s. Consumption of pork and mutton have remained low, with pork consumption at one-third of international levels (Taljaard et al 2006).

Figure 4.6 Consumption of animal products in South Africa, 2000-2008



Source: SAPA (2009).

Consumption of meat is expected to continue rising to 2020. Poultry meat consumption is expected to continue to grow the fastest, at about 4% per year. The growth of beef consumption is expected to be slower, at 3%, and pork and mutton lower still (BFAP, 2011).

Several points emerge from the discussion which are relevant for a discussion on grain diversion. First, chicken is an important food item in the diets of all South Africans, while beef is mainly consumed by richer people. Second, as beef is a luxury good in South Africa[35], consumption of beef will not adjust much to higher prices, as the richer population can continue to afford it. This means that while rising grain prices will raise the price of a main source of food for poor people (maize-meal), they will not have a large impact on the meat consumption of the richer population.

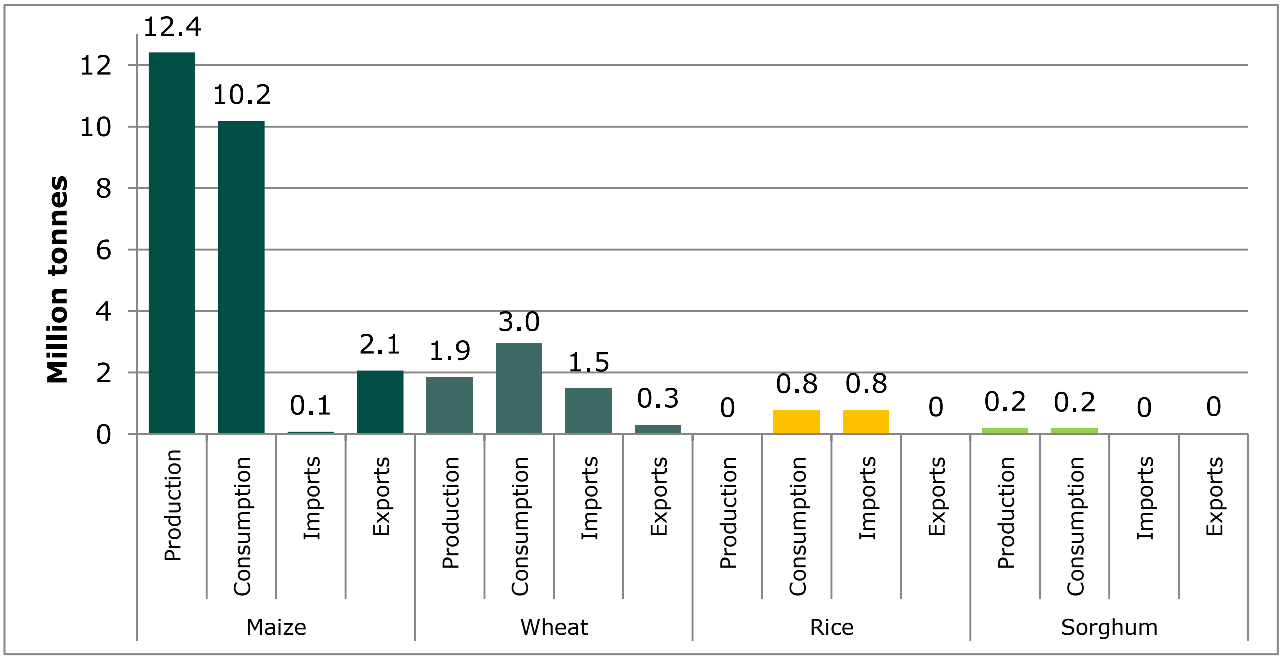
4.3 Overview of cereal supply and demand

The supply/demand balance of key grains in South Africa

Maize is by far the most important grain produced and consumed in South Africa (see Figure 4.7). Over the past five years, production has exceeded 10 million tonnes per year, the majority of which is consumed domestically. Although wheat is also an important staple for millions of South Africans, wheat production is relatively low, at about 1.8 million tonnes per year. South Africans also consume rice and sorghum, although their production is small in comparison (780,000 tonnes and 180,000 tonnes respectively).

In most years, South Africa produces all the maize that it needs and generates a surplus for export to other countries in the region. It is, however, dependent on imports to meet its consumption needs for both wheat, given the lower incentives for wheat production since liberalisation (which have seen wheat plantings drop to the lowest area planted since 1931) and rice, owing to an unsuitable climate for cultivation in most of the country (FAO, 2012). As a result of the low volume of wheat produced in South Africa, and the fact that domestic and imported wheat is used almost entirely for human consumption, this study does not explore wheat in detail.

Figure 4.7 Profiles of major crops in South Africa (2007-2012 averages)



Source: Data from Grains SA.

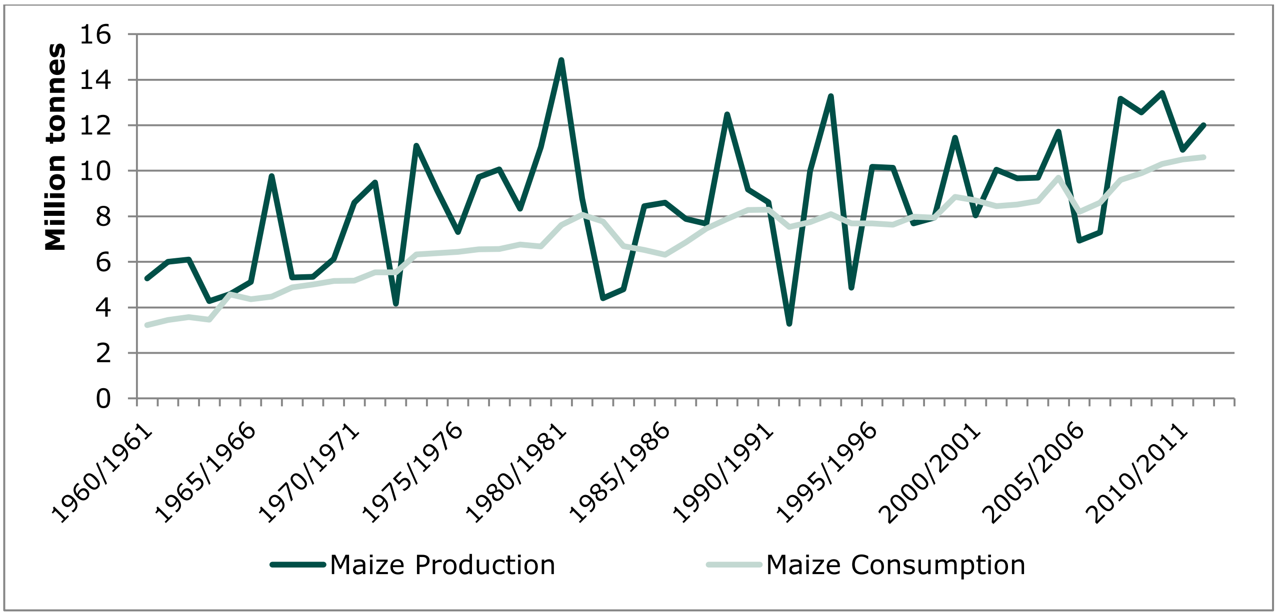
[35] The price elasticity of beef is low, estimated at 0.16 by Taljaard (2003).

Production of maize in South Africa

Despite being the most important crop, maize production in South Africa varies widely across different years because of rainfall patterns that affect the southern African region.

Figure 4.8 illustrates the erratic nature of production, which moves from peaks to troughs every few seasons. The most recent dip in production was in 2005–2006 when production fell short of consumption by 7 million tonnes, which was followed by three years of consistently high production of around 13 million tonnes, including the highest harvest in 30 years.

Figure 4.8 Maize production and consumption trends since the 1960s



Source: Data from Grains SA.

Maize grown in South Africa consists of both white and yellow varieties. The land area planted to white maize is currently around 60% of the total arable land, and total white maize production, at 6.8 million tonnes is correspondingly larger than yellow maize production at 4.7 million tonnes (Table 4.1). Since the liberalisation of crop markets, the planting of white maize has been higher but the growth of the animal feed sector (the main yellow maize consumer) has triggered increased planting of yellow maize, and this is expected to continue in the future to 2020 (BFAP, 2011).

Table 4.1 Production of white and yellow maize, 2010-2012

	2010–2011		2011–2012	
Maize	Area planted (‘000 hectares)	Production (‘000 tonnes)	Area planted (‘000 hectares)	Production (‘000 tonnes)
White	1,418	6,052	1,590	6,800
Yellow	954	4,308	1,040	4,700
Total	2,372	10,360	2,630	11,500

Note: Figures are compiled using USDA Gain 2012, from SAGIS and CEC. Figures given are only for the commercial sector.

Use of maize

Human consumption

Like other southern African countries, much of the maize used for human consumption is white (in the form of mealie meal). Figure 4.9 provides a breakdown in usage over the past ten years, which illustrates a gradual increase in human consumption of white maize to current utilisation levels of 4.45 million tonnes.

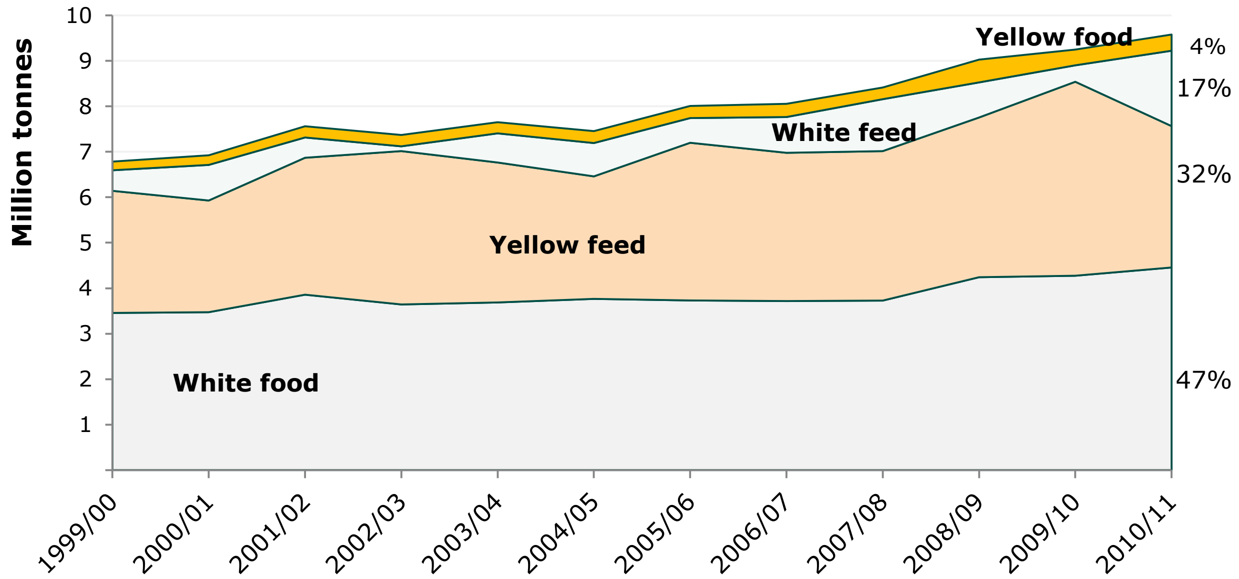
For South Africans as a whole, it is projected that with rising incomes, total white maize consumption will grow relatively slowly as families switch to other forms of starches such as bread, potatoes and more wheat-based products including biscuits and pasta. As a result, human consumption of white maize is expected fall by 0.4% annually to 2019 (BFAP, 2011). Nevertheless, as already discussed, white maize is, at present, a main food source for the poor, and is likely to remain so in the near future.

Box 4.1 South African maize grades

South Africa differentiates between three classes each for white and yellow maize (WM 1, 2, 3; YM 1, 2, 3) and a separate class for ‘other’ maize that does not fall into either the white or yellow categories. All grades have a maximum moisture content of 14%, and the assignment to different grades depends upon a small number of non-nutritional characteristics, namely foreign-matter contamination; defective kernel penetration; the presence of other coloured maize; and the inclusion of pinked maize (WM grades only) (Agricultural Products Standards Act, 1990).

In terms of maize type and grain quality, the feed industry can change between white and yellow maize relatively easily, depending upon availability and price. Manufacturers can use all grades of yellow maize, but have a preference for WM2 for white maize. The nutritional quality of white and yellow maize is equal, although the presence of high-β-carotene in yellow maize makes it preferable for egg production. The egg industry, therefore, uses only yellow maize.

Figure 4.9 Maize food and animal-feed use in South Africa, 2000-2011



Source: Data from Grains SA.
Note: Percentages on right-hand side represent 2010/2011 breakdowns of the total.

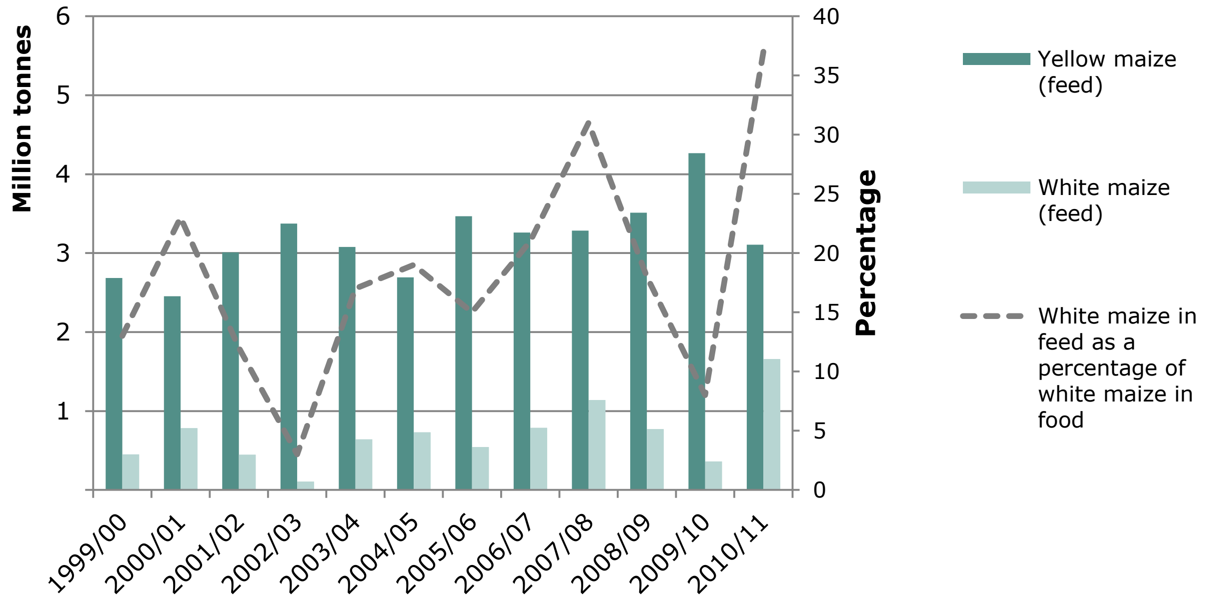
Feed consumption

The feed industry, the second largest maize user, has traditionally consumed mainly yellow maize, using an average of 3.2 million tonnes on average over the past 10 years. It also uses some 600,000 tonnes of white maize per year (Figure 4.10). In the 2010–2011 season, the livestock industry used almost as much maize as was consumed as food, at 49% of total consumption (32% yellow, 17% white). The amount of maize consumed by the animal feed industry is expected to continue to rise with increased meat consumption, to become the largest consumer of maize within the next few years (BFAP, 2011).

In general, the livestock industry prefers yellow maize, particularly in years where this is cheaper than white maize, such as 2002–2003 (see figures 4.4 and 4.10). However, when white maize is more affordable, this is used instead (apart from for egg-laying chickens, in which yellow maize is more valued, given the importance of the yellow colouring for egg yolks). Although increased livestock consumption of maize in future years is expected to come from increased yellow maize supply, the use of white maize for feed has been growing slightly in recent years, and growth in demand for white maize from the livestock industry has outpaced demand from food markets. In 2008 and 2011, for example, the amount of white maize that went to feed use exceeded 30% of the white maize used for food(see dotted line in Figure 4.10).

These were years in which maize prices were relatively high. This suggests that in these years, the market does not ration livestock consumption of white maize, which remains relatively high as long as yellow maize prices are equally high. **Therefore, during these periods (when high yellow-maize prices remain equal or below white-maize prices) some volume of the white maize consumed by the feed industry could be diverted to food markets**. In general, demand for maize for animal-feed rations appears to be relatively inelastic, with white maize being used to fill gaps in supply when yellow grain is limited.

Figure 4.10 Use of maize in feed, 1999/00-2010/11



Source: Data from Grains SA.

4.4 Composition of the livestock sector and maize consumption

This section discusses the use of maize within the livestock sector, to explore whether grain could plausibly be diverted, given the characteristics of the sector.

Meat production in South Africa

South Africa consumes most of its domestic meat production and imports significant quantities of chicken (predominantly from Brazil) and some beef in most years, making it a net importer of livestock products. Poultry production is by far the largest industry in the country, in terms of meat output. Within the commercial sector, 1.3 million tonnes of chicken meat are produced annually, followed by beef as the second most produced meat at 579,000 tonnes per year. The commercial pork sector is relatively small, producing 165,000 tonnes of meat per year, and is not considered in detail in this case study. Similarly, smaller livestock sectors, including ostriches, goats and sheep are not analysed.

Although poultry is an important industry and a major user of animal feed in South Africa, its reliance on yellow maize and its importance as a source of nutrition for all consumers in South Africa means that only overall figures on its size are discussed in this section (with additional details presented in Annex H). The main discussion here focuses on beef production.

Table 4.2 Total annual meat production[36]

Meat product	Production (animals)	Production (‘000 tonnes)	Imports (‘000 tonnes)
Broilers (2010)	969 million birds	1,300	240
Beef	8.8 million cattle (standing), 1.5 million cattle, (slaughtered)	579	35
Pork	2.2 million pigs (slaughtered)	165	11

Sources: Meat Trade News Daily (2011) (beef); USDA Gain (broilers); SAPPO (pigs).

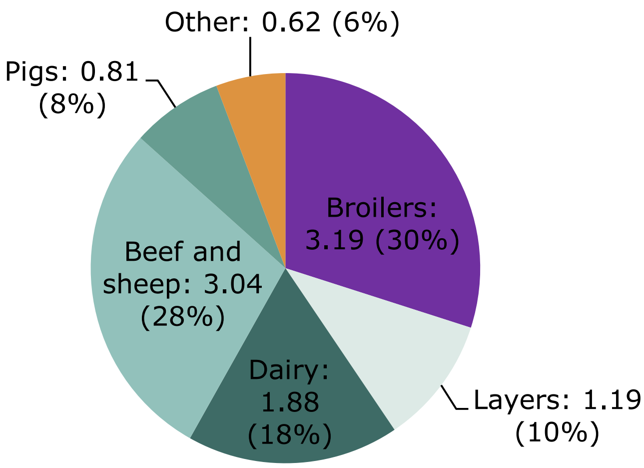
Total consumption of animal feed

The relative size of the industries are reflected in their feed consumption, although as a result of lower feed conversion ratios (FCR) the beef industry consumes more feed per kilo of meat produced than broilers. FCRs in the beef feedlot industry vary for different breeds[37] but are much higher than those for broilers and pigs.

Figure 4.11 highlights the use of feed by different livestock sectors over recent years. Sales to the poultry sectors accounted for 40% of sales, most of which went to broiler production, which consumed 3.2 million tonnes of feed per year. The red-meat sector consumed slightly less (3.0 million tonnes), followed by the dairy sector (1.9 million tonnes). Pig feed accounts for 8% of total feed production.

[36] Broiler numbers are for 2010; figures for beef for feedlot enterprises for 2011; pork figures are for the 400 producers with between 50 and 7,000 sows. South Africa is an importer of meat products in all years.
[37] http://www.charolais.co.za/files/grothtestresultscharolaisxnguni.pdf

Figure 4.11 National sales of feed to different sectors, 2010-2020 (millions of tonnes)



Source: AFMA Chairman's Report 2011. Note: Figures indicate millions of tonnes of feed produced including concentrates for all producers.

In terms of feed ingredients, maize is the main ingredient for all animal feed in South Africa (representing 50% of volume for poultry feed; and 60% and 65% of pig and beef rations respectively). It also represents a major part of production costs for all subsectors, including 50% for dairy manufacturers and 42% for broilers (Louw et al., 2011).

Sourcing of feed by livestock industries

Feed for livestock enterprises is sourced through different channels, with some variation depending upon the sector and business model of the enterprise. Around 90% of poultry producers buy pre-mixed feed from an accredited company. Contract growers are supplied with feed from the parent company, and are usually required to use only supplied feed in order to control diets, and minimise risks related to health and contamination (SA Poultry Survey, 2011). Feed-sourcing in the beef sector is split between sourcing from feed companies and growing grain on farm (KwaZulu Natal Government, 2012).

Overview of the beef sector

The number of feedlot operations has been growing in the commercial sector and total approximately 70 today, with an average standing herd of 420,000 head and producing 75% of South Africa's A-grade beef. The remainder is produced through more extensive systems that use grasslands and forage crops to feed cattle, and on farms that have other agricultural activities, including grain production (NAMC, 2003).

Within the feedlot sector, nine large feedlots account for between 80–90% of cattle (Table 4.3). The largest feedlots are in Northern Free State and Southern Gauteng in areas with good access to grain. These enterprises operate throughout the year (Oliver, 2005). These feedlot owners also have their own abattoirs, where most of the produced beef is slaughtered (NAMC, 2003).

Table 4.3 Major players in the feedlot industry, 2004

Name	Number of standing cattle (thousand)	Location
Karan Beef	70	Gauteng
Kolosus/Vleissentraal	40	Northwest Province, Gauteng
EAC Group	40	Free State
Sparta Beef	40	Free State
Crafcor	30	KwaZulu-Natal
Beefcor	25	Gauteng
SIS	22	Mpumalanga
Beefmaster	20	Northwest Province
Chalmar Beef	15	Gauteng

Source: Olivier (2004)

Given these characteristics, the beef sector could plausibly be targeted for grain diversion. The high level of concentration of production within the feedlot industry, and the high contribution of maize to beef cattle diets indicate that it may be relatively simple to source maize from this sector.

4.5 Policy options to address a price spike in South Africa

Would diverting grain from animals to humans remedy a price spike?

The discussion so far indicates that there could be a case for addressing maize prices in South Africa at times of high prices, which push up the cost of the food consumed by large segments of South Africa's poor, and especially the population in the lowest income decile. It also suggests that the beef sector, as a large consumer of maize (some of which is white in most years) is a candidate target if this option is pursued. The arguments for this are spelled out further below.

There are significant volumes of grain of reasonable quality ...

Diverting grain from South Africa's livestock sector would provide significant volumes of maize of a reasonable quality.

- South Africa has a large livestock population that consumes half the country's maize.
- While the majority of maize used for feed is yellow, the beef industry uses more white, which is preferred to yellow maize by South African consumers. Assuming 65% of beef cattle feed is maize, the industry consumes roughly 1 million tonnes per year.
- The quality of this maize should be reasonable, as the feed industry uses mainly class 2 maize.
- Higher percentages of maize in beef-feed rations and higher Feed Conversion Ratios for beef, compared to other livestock, suggest that targeting the beef sector would

yield proportionally more maize for each unit of meat forgone than either the chicken or pork sectors.

- There are more options for changing the feed ingredients for cattle than for poultry. Options include grazing cattle for longer periods, using other sources of feed or reducing rations. Altering feed for poultry may be more problematic, given the genetics of bred birds, and fewer alternatives for feed.
- More chicken is consumed than any other meat nationally, especially among the poor, while beef consumption is concentrated in higher-income groups.

A valid question to ask here is whether any intervention is needed, or whether markets will act to reduce white maize consumption in the livestock sector to negligible levels. Whilst this is an empirical question, which this discussion paper cannot answer definitively, the discussion in Section 4.3 suggests that this may not be the case during times when yellow-maize prices are high (e.g. as a result of low harvests in the Southern African region, or high international prices). The relatively low price elasticity for beef in South Africa may make it profitable for feedlots to continue feeding white maize to beef cattle, even at prices that are high for the poorest segments of the maize-meal consuming population. In a situation when markets do not ration feedlot consumption of white maize at a socially acceptable rate, grain diversion could be undertaken using methods proposed below in Box 4.2. A stylised calculation of the cost of a grain diversion (presented in Annex H) also indicates that the price of a grain diversion is likely to be cheap in comparison to other options, costing around $1.5 million per month.

Box 4.2 Options for a grain diversion scheme

The principal function of a grain diversion mechanism would be the reduction of feed consumption of white maize by feedlots. In practice, this could involve feedlots selling pledges to reduce consumption to a government agency through the submission of a sealed envelope bid (or other suitable mechanism).[38] Within a fixed budgetary outlay, officials could opt to purchase offers based upon criteria of desired efficiency and volume. The mechanism could use some simple rules, such as requiring that whenever grain prices reach a certain level, an offer to purchase grain would be issued, and feedlots would respond by selling their reduced-consumption pledges. The volume of grain available would, therefore, be determined by the market, based upon feedlots' sensitivity to prices, knowledge and predictions of market dynamics. It could also involve the sale of maize inventories and future maize-delivery contracts by feedlots. However, this is likely to be a minor component as many feedlots rely on grain purchased from markets[39] and tend to only purchase contracts for a maximum of three months in advance.

Asking feedlots to reduce their feed consumption and providing compensation for forgone profits is likely to be relatively simple and cheap, given a high maize price scenario. A compensation mechanism for grain diversion would accelerate this reduction.

As described in the introduction, grain diversion would only be enacted over a short period of time. Reduction in feed supply is unlikely to have any great impact on the production costs of feedlots or disrupt their production cycles unduly: feedlots may be able to reduce rations, leave cattle on grass for longer periods or slaughter some cattle earlier at relatively low financial cost. The auction system should, in theory, primarily reduce demand from feedlots that operate with low profits, or those that are able to switch to other sources of feed easily, as these would lower offer lower bids.

As a second best option (and where expediency is considered critical), the Government could mandate reductions in the feeding of white maize across the board in the feedlot industry and provide compensation. Again, given tight margins, compensation costs are likely to be low. However, this approach is not as effective as the use of an auction or option contract, and it lacks their voluntary nature.

[38] To ensure that bids are grains genuinely forgone, bidders would have to show their offers related to an average previous use of maize, perhaps the preceding three years, with bids to forgo maize also implying a cap on the amount of maize used.

[39] Several large feedlots (e.g. those run by Spar Beef) grow their own maize, lucerne and hay for silage as well as purchasing from farmers or silo operators.

... but there are questions about its effectiveness

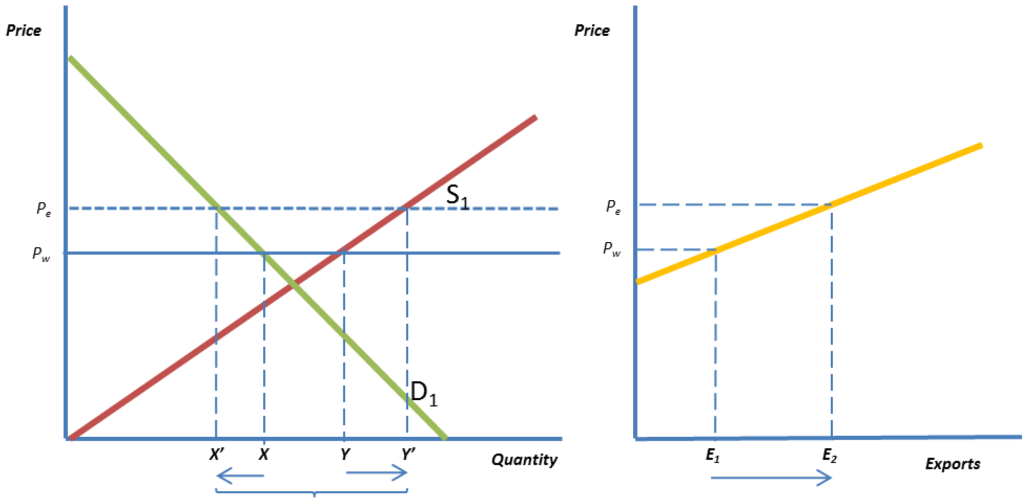
Two issues emerge however, which suggest that grain diversion alone may have limited effectiveness. First, if South Africa has a net maize-export position, the additional volumes made available on the market from grain diversion may simply be exported, nullifying the impact on the domestic price.

Second, even if grain diversion did succeed in reducing the wholesale price, there is no guarantee that this price reduction would feed through fully to consumers in the form of lower retail prices.

Barriers to dampening domestic prices

Figure 4.12 illustrates the basic situation for South African maize markets, representing the country's net export position in most years with a surplus (Y minus X). As South Africa is a relatively small producer in global terms and exporter, it is a price-taker on international markets and increases in the international price will tend to raise domestic prices. From a position of domestic consumption at X and domestic production at Y, a rise in international prices for P_w to P_e would also move the domestic price up from P_w to P_e. This would increase exports from Y-X to Y'-X'[40] (or E_1 to E_2 in Panel B).

Figure 4.12 Effect of a price spike on South African prices



Source: Authors' construction.

Under these conditions, a release of additional domestic grain (whether from stocks or grain diversion) is likely to be sold on to the world market, with negligible effect on the domestic price. To prevent this, and to drive a wedge between the domestic and international prices, trade-management measures such as taxes, or quotas on exports would have to be imposed. However, since the introduction of export restrictions alone should be sufficient to dampen prices, additional management through grain diversion may be unnecessary. as an additional measure.

Export bans are relatively quick to implement and, as long as border policing is effective, they are likely to be successful in controlling domestic prices. However, the use of export restrictions is controversial and restrictions have not been used by South Africa since market liberalisation in 1997. There are several arguments against the use of export restrictions. They are likely to increase the costs of maize for other countries in Southern and Eastern Africa that

[40]In reality, a production response would be lagged, as farmers are unable to respond directly and immediately to higher prices with higher grain outputs.

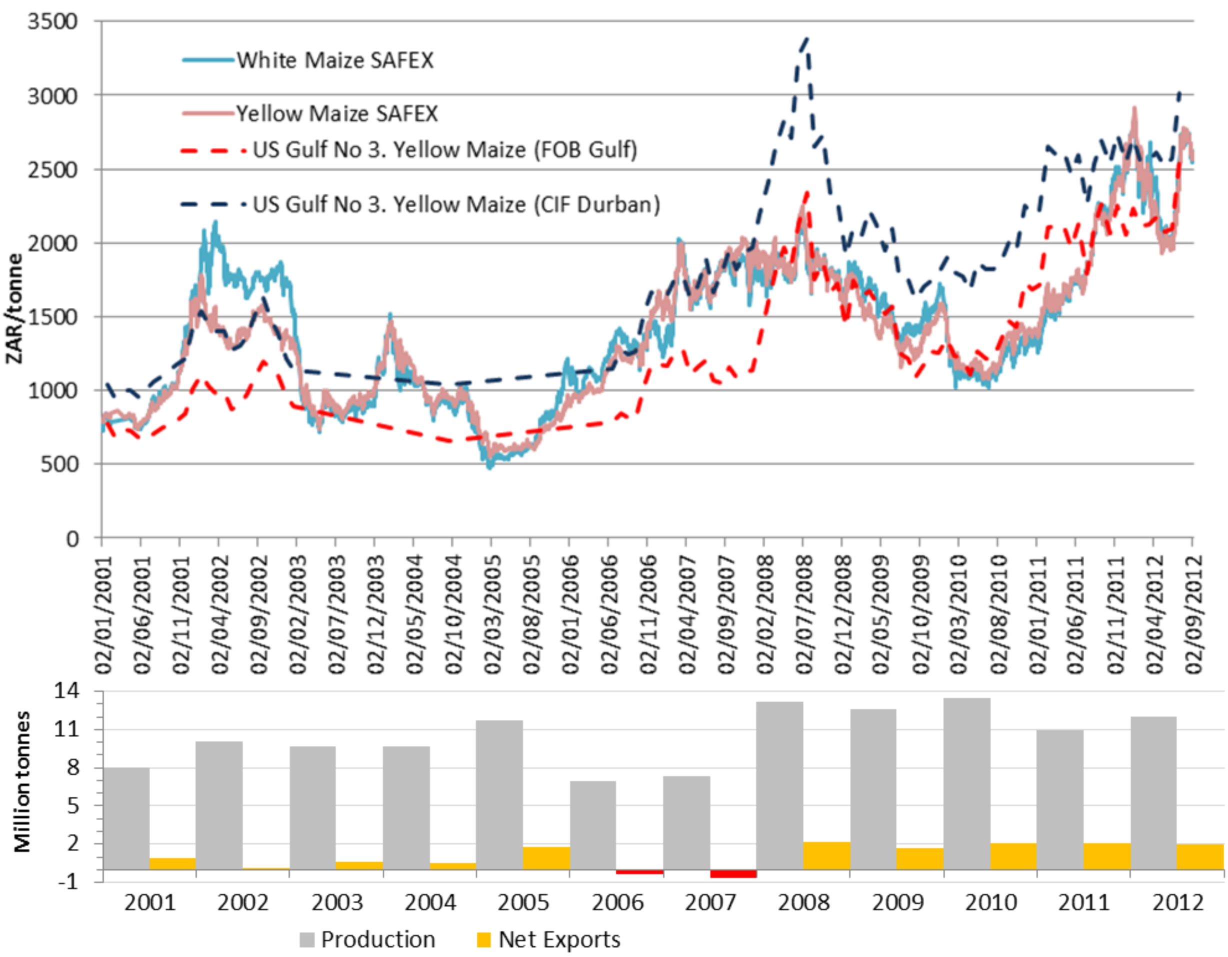
rely on imports of South African maize in some years. Domestically, the introduction of trade restrictions is also likely to be disruptive for local producers who will be unable to benefit from high international maize prices.[41]

A further issue caused by intervening in export markets would be the effects on SAFEX markets, which are important for the grain trade across the Southern African region. Actions to limit trade may nullify certain contracts, and have an impact on its effectiveness as a trading platform. Such an impact could, however, be tempered by clarity over the terms and conditions of intervention, and by establishing rules for internationally-traded contracts.

Box 4.3 Assessing the link between international and South African maize prices

Figure 4.13 displays the price difference between the SAFEX cost of maize in South Africa, the Freight On Board (FOB) export parity price of US maize and the Cost, Insurance and Freight (CIF) import parity price of US maize landed in Durban, measured in South African Rand (i.e. accounting for the fluctuating Rand-Dollar exchange rate). Production and trade volumes of South African maize are displayed in the bottom graph. In general, the domestic prices of maize are closer to the FOB price during periods of net export surplus, and closer to the CIF price when in a net import position.

Figure 4.13 US and SAFEX yellow-maize prices (top) and South African maize production and exports (bottom)



Source: South African Grain Information Service and SAFEX (prices), USDA (production and trade volumes). **Note:** Production and exports are marketing-year aggregates, running from the previous season (May to April); negative net exports are in red.

[41] Domestically-imposed export restraints are likely to be unpopular with producers, who face several restraints from importing countries, including standard duties of 50% on South African maize under a regional trade agreement with the East African Community and bans of imports of genetically-modified maize by most of South Africa's neighbours. In recent years, finding sufficiently large and reliable export markets has been the main challenge for South Africa's grain trade.

There have been some exceptions to this, namely in 2002, when the SAFEX price exceeded both the export and import parity prices for almost one year, and again in 2010–2011 (where it remained below the export parity price for about 16 months), as a result of domestic and regional factors. For example, the Food Price Monitoring Committee's investigation into high prices during 2002 indicated that there were several reasons why SAFEX prices should have fallen earlier and yet did not. These included the upwards revision in crop estimations, announcements of new shipments to South Africa and the sending of international food aid to neighbouring countries (rather than South African grain), which should all have contributed to lowering prices. A major factor that sustained high prices through a second season was expectations of high regional demand, especially from Zimbabwe (where maize production had collapsed), and Malawi and Zambia where there were shortages (FPMC, 2004). Arguably, a well-publicised reduction in domestic feed demand would provide a much stronger signal to markets and bring down prices, but this is difficult to state with certainty, and may depend on whether there is confidence among traders that the scheme is effective.

Limited price transmission along the maize supply chain

Would additional maize on the markets translate into lower prices in supermarkets and other retail outlets? This has been the subject of a Competition Commission enquiry in South Africa in recent years, as retail maize-meal prices have followed SAFEX prices upwards much more quickly than they have downwards (see Figure 4.4). This continues to be raised as an issue in the media.[42] As such, it is not clear that a reduction in SAFEX prices would translate automatically into reduced food prices and a response lag, or whether only partial transmission of demand reduction may reduce the potential effectiveness of grain diversion.

Implications for grain diversion as a feasible option

Given these issues, grain diversion **alone** would not be result in lower retail prices; other measures would be needed to limit exports of additional grain, as well as to ensure lower consumer prices. Without these complementary measures it is likely to prove ineffective, and be unnecessarily disruptive to grain and feed markets.

However, grain diversion may be useful as part of a package of measures for a price spike crisis scenario. During a food price crisis, the South African government is likely to have with a limited number of options.[43]

1. Do not intervene, risking sustained high maize-meal prices that are likely to affect large numbers of poor consumers.

2. Target one sector — e.g. the milling or retail sectors — to reduce prices by introducing ceiling prices. While this may act directly on food prices, it places the economic cost fully on the specific sector. Similarly, placing the burden on export markets (by imposing large trade restrictions) will impede consumer welfare in those countries.

3. Compensate poor consumers through direct transfers (explored in Box 4.4). This is a likely to be effective in alleviating some of the effects of high prices. However, while it increases poor people's purchasing power, it only targets those who are already registered within schemes, and does not provide relief for those who are above a minimum threshold. Also, if the reserve price for maize by feedlots is high, additional transfers to poor consumers may result in lower exports to neighbouring countries.

4. Share the burden across these sectors by simultaneously diverting grain and managing trade at previous levels. While implementing a full trade ban would be disruptive, if a quota level was set at an average of the previous years' trade, it is unlikely that the effect

[42] http://www.iol.co.za/business/opinion/consumers-allow-firms-to-abuse-free-market-1.1372279#.UFBz7o2PXSg

[43] Other options, including releasing government stocks or distributing grain directly through rations are not considered appropriate. The South African Government does not hold large stocks of grain; and the establishment or expansion of a food distribution system running in parallel to the cash transfer system is likely to be expensive and unnecessary.

on both the producers and importers of grain would be punitive. Complementing this with grain diversion from the livestock industry would be likely to result in a fall in domestic prices and ensure that available white maize goes to food markets.

Box 4.4 Consumer support through cash transfers

Cash transfers to poor consumers can compensate for the loss of purchasing power resulting from higher food prices. Several cash transfers (social grants) are used in South Africa, including the old-age pension, child support grant and a social distress grant. These are means-tested and therefore target only poor and vulnerable sections of the population (OECD, 2009; SASSA, 2011). The old-age pension is especially important in South Africa, given the high number of HIV-affected families and the high number of households in which an elder family member looks after orphaned or sick relatives. Extending the coverage of social protection mechanisms (by increasing the eligible age range) was the main means of protecting poorer South African consumers during the 2007–2008 price spike (OECD, 2009). The child grant has since been extended again to cover children up to 18 years old (SASSA, 2012).

During a price spike, social grant recipients could be compensated for higher prices by increasing the cash transfer to cover the increase in food costs. While some administrative costs would be incurred in ensuring that levels of additional compensation are adequate and targeted specifically to the poorest recipients, this is likely to be the least disruptive option.

However, the use of cash grants is not likely to reduce aggregate demand, keeping maize prices high. Depending on the severity of the price spike, those who are poor but who are not grant recipients will not see any relief from high prices. In addition, if the price elasticity of demand for white maize remains high in the feed sector, high prices will still ration exports to countries dependent on South African maize imports.

4.6 Conclusions

South Africa's poor face disproportionately higher increases in the costs of their purchased food during times of high food prices (as a result of the larger than average increases in the price of staples), and are least able to maintain their nutritional status because of their limited resources. Therefore, finding ways to limit the effects of a price spike is particularly important in a country like South Africa, where so many poor people depend largely on a main staple: white maize. Of all the measures that the South African Government could take, providing the poor with additional cash transfers (in order to compensate for higher prices) is likely to be the most effective and administratively easiest option.

However, while cash transfers restore the entitlements of the poor, they are unlikely to ration demand for maize, so there is a danger that prices will rise further (as an effective cash transfer maintains demand, while supply falls). To mitigate this, some form of supply management may be justified.

As this chapter has discussed, many of the basic conditions for a successful grain diversion scheme are in place in South Africa, with significant volumes of maize of a reasonable quality being used for animal feed, a livestock industry that is sufficiently concentrated and integrated to be targeted, and relatively low costs of compensation compared to alternative schemes, such as additional cash transfers. However, the analysis has also identified several questions about the scheme's effectiveness as a **stand-alone** measure to mitigate price spikes, including the link of the domestic price to international prices in the absence of export controls, and the lack of transmission of price reductions along the supply chain to consumers.

For South Africa — an exporter of maize — the simplest measure is some form of export restriction: this would limit speculation that stocks may run out. However, this too has its drawbacks, as it would disrupt trade and lower welfare in neighbouring countries, who often rely on South African exports, especially in low harvest years. To limit the impact on countries dependent upon South Africa's maize exports, a combination of measures could be explored:

exports could be set at a level equal to previous years (or perhaps some high fraction of this) through export quotas, and additional demand rationing could be carried out by offering to compensate beef feedlot operators for reducing their use of white maize through bidding.

Such an arrangement would be attractive on the grounds of efficiency as well as equity. By limiting livestock consumption of white maize during periods of scarcity (when it may increase if it is cheaper than yellow maize) this arrangement would increase the amount of maize available for human consumption and contribute to lower prices. This would benefit those consumers who are near poor (those who are just above the threshold of eligibility for social grants). Limiting the bidding to white maize would also enable the livestock industry to continue consuming yellow maize (which is not a staple for human consumption) and would, therefore, minimise any disruption to the livestock industry.

It is clear that grain diversion may be useful as part of a set of policies to manage the availability of white maize in the South African market, when coupled with export restraints and cash transfers to poor consumers. Given effective markets, by rationing demand of exports (through quotas) and livestock (through auctions), the supply of white maize for consumers should increase, resulting in lower prices for poorer consumers.

As stated in the introduction, the ideas presented in this discussion paper have been presented on the basis of readily available sources of information and some assumptions about the nature of the South African maize market and its response to high prices based upon observations of its previous movement. The concept and practical implications of the actions proposed in this paper should be researched (e.g. through modelling exercises under different market scenarios, and more consultation with South African grain experts) before these are recommended as definitive options.

5 Testing grain diversion from biofuels at national level

5.1 Context

In line with the focus of this study, this section discusses the question of diverting maize in the US and wheat in the EU from ethanol production to human consumption using call options, either directly, or indirectly by diverting grain from biofuels to animal feed and releasing grain from animal feed for human consumption (Wright, 2011b). While this presupposes the need for flexible biofuels mandates or partial waivers to enable such diversion to take place, it also covers the possibility of diverting maize from ethanol production in situations where biofuels mandates may no longer be binding, i.e., in cases where oil prices have risen to such a level that biofuels are competitive without mandates.

In common with the discussion about the possibility of enacting flexible mandates, the grain diversion option raises several questions, including:

- whether the quality of the maize used for ethanol production is substitutable for grain for animal feed/human consumption
- what level of compensation might be needed to provide sufficient incentive for ethanol producers to reduce or suspend production
- whether there are any technical or administrative barriers to the pursuit of such an option.

5.2 Overview of grain and ethanol production in the United States and European Union

United States

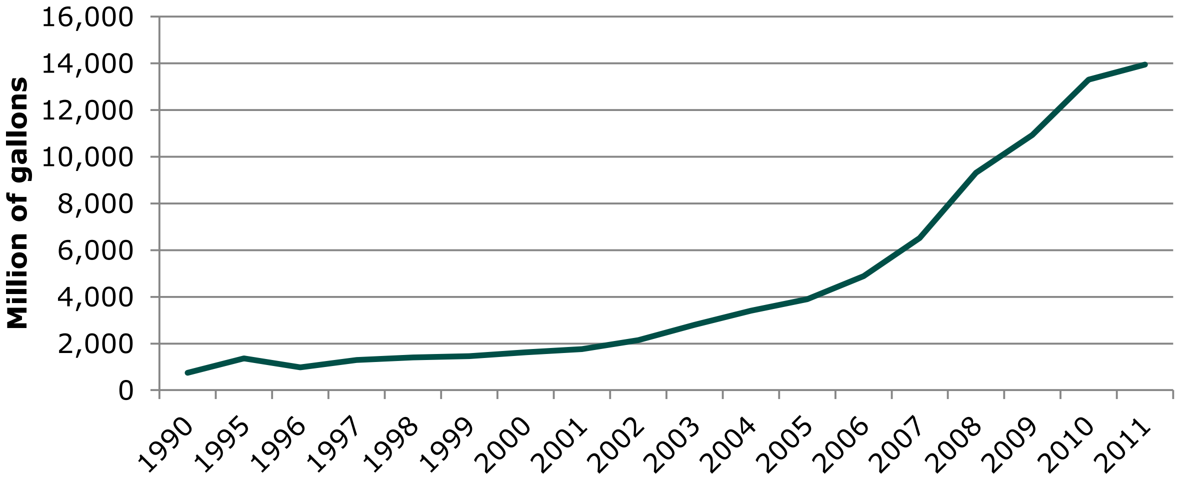
Figure 5.1-5.3 present the background to ethanol production and maize use in the US. As Figure 5.1 demonstrates, US ethanol production has increased dramatically since the 1990s, with accentuated expansion over the last 10 years, from just under 2 billion gallons (nearly 8 billion litres) in 2001 to 14 billion gallons (53 billion litres) in 2011.

There is still some room for growth in ethanol production and consumption. The US Energy Policy Act of 2005 established the first renewable fuel volume mandate in the country, setting a mandatory blend of 7.5 billion gallons of renewable fuel to be blended into gasoline by 2012 under the Renewable Fuel Standard (RFS). Under the Energy Independence and Security Act (EISA) of 2007, which established the foundations for the RFS2, the volume of renewable fuel required to be blended into transportation fuel was increased from 9 billion gallons in 2008 to 36 billion gallons by 2022, with new categories of renewable fuels established on the basis of life-cycle greenhouse gas performance threshold standards. This includes both diesel and gasoline, but ethanol accounts for the majority of renewable fuel. Mandated domestic maize ethanol consumption is capped at 15 billion gallons in 2015, with additional sugarcane-based ethanol imported from Brazil in the category of 'advanced others'.

In January 2011, the US Environmental Protection Agency (EPA) approved the use of 15% ethanol in fuel in certain vehicles, an increase from the previous blending wall of 10%, which limited domestic ethanol use to a maximum of 13.3 billion gallons. While there has been little response to this opportunity so far,[44] it paves the way for possible further expansion of the domestic market above mandated volumes (RFA, 2012).

[44] The EPA approved 15% blends in February 2012, but only for vehicles built since 2001, which constitutes around two-thirds of the US auto fleet. This means that any fuel vendor converting from E10 to E15 would have to forgo one-

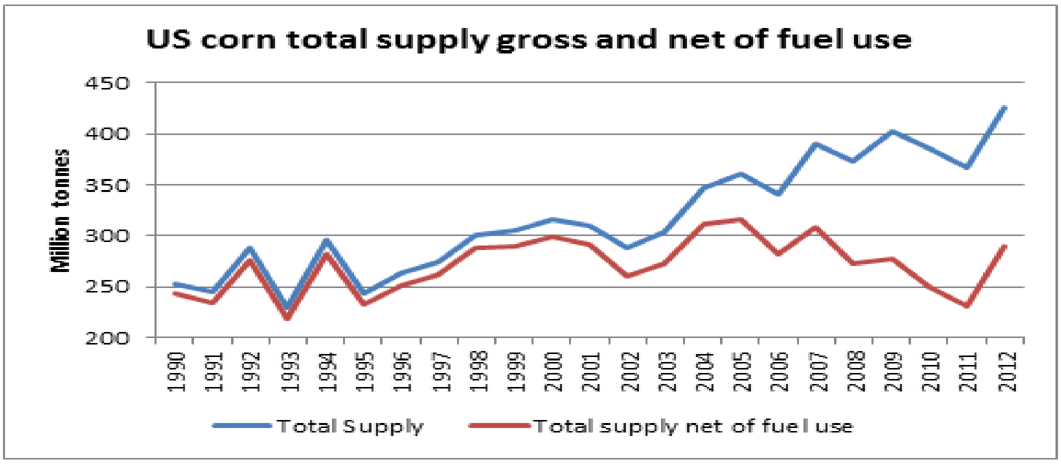
Figure 5.1 United States ethanol production, 1990-2011



Source: USDE.

Production of maize in the US has risen in line with ethanol production (Figure 5.2) while exports have stayed reasonably stable (Figure 5.3). According to Figure 5.2, approximately 135 million tonnes were expected to be used for fuel production in 2012;[45] in 2009, around 125 million tonnes of maize were used for fuel, equivalent to over 16% of world production in that year.

Figure 5.2 Total United States maize supply, gross and net of fuel use, 1990-2012(e)

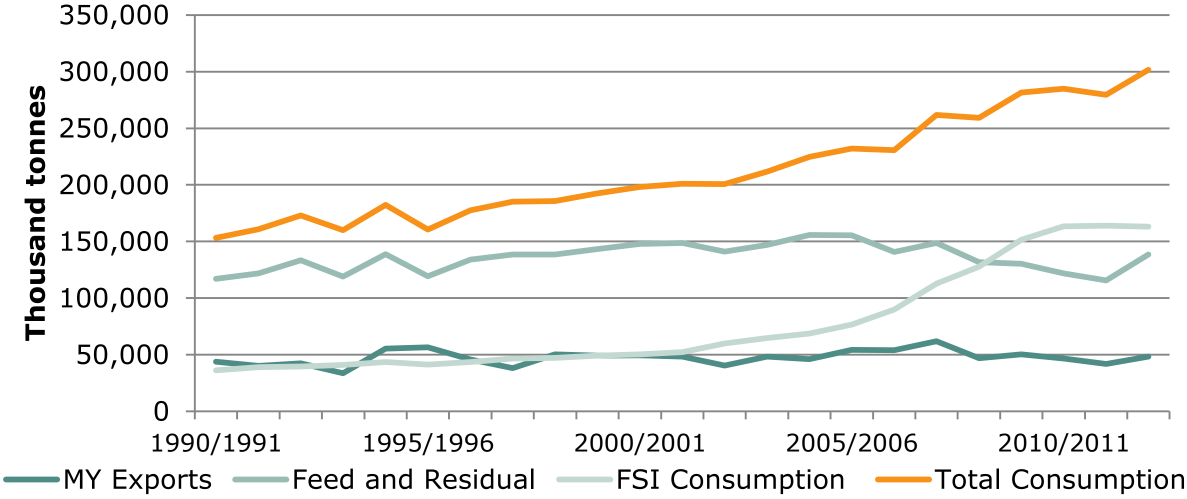


Source: USDA. Note: (e) refers to an estimate

third of their customers, limiting possible response. Since final approval in February 2012, only three of the 161,000 fuel vendors have begun offering E15 (communication with Wally Tyner, October 2012).

45 If you consider the gross volume of maize used for fuel, it is a fraction over 40% of total domestic production. However, if you deduct the DDGS that goes back into the animal feed system, it reduce this proportion to 27% (Abbott et al., 2011).

Figure 5.3 Historic United States maize consumption, 1990/91-2010/11

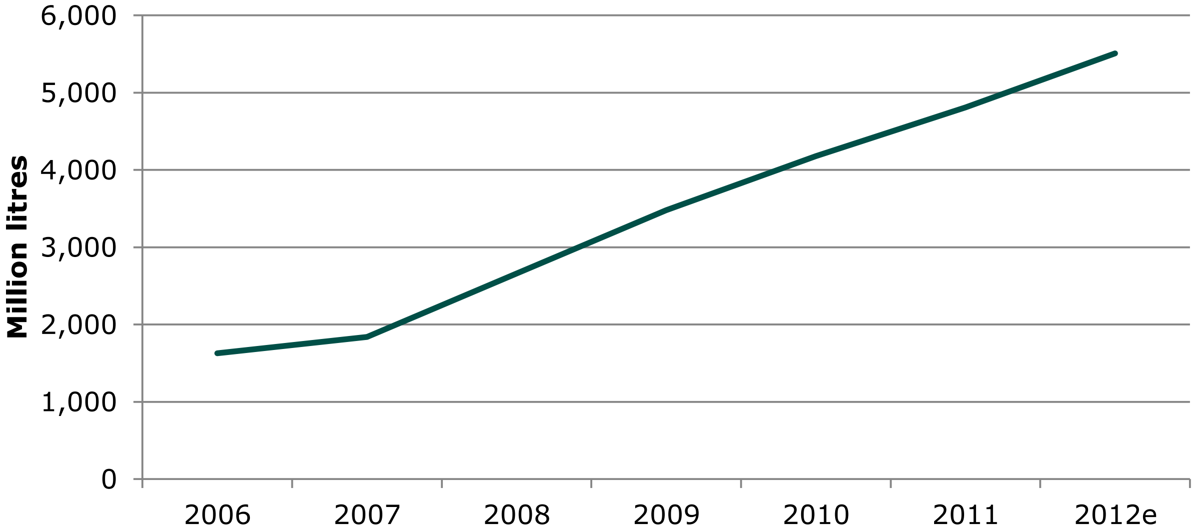


Source: USDA.

European Union

The main regulations impacting the EU biofuels market are the Biofuels Directive (2003/30), the Fuel Quality Directive (2009/30), and the EU Energy and Climate Change Package (CCP). The CCP, which was adopted by the European Council in 2009, includes the so-called '20/20/20' mandatory goals for 2020, one of which is a 20% share for renewable energy in the total EU energy mix. Part of this 20% share is a 10% minimum target for renewable energy consumed in the transportation sector. This goal is to be achieved by all EU Member States and is, in practice, the driver behind demand for biodiesel and ethanol.[46]

Figure 5.4 Fuel ethanol production in the European Union, 2006-2012(e)



Source: USDA 2011. Note: (e) refers to an estimate

[46] The EC has just announced that it plans to cap crop-based biofuels to 5% of transport fuel, after campaigners expressed concern about the impact of existing mandates on food availability and prices. http://www.reuters.com/article/2012/09/17/us-eu-biofuel-idUSBRE88G0IL20120917

Table 5.1 presents the EU's supply/demand balance for conventional fuel ethanol. The majority of ethanol production capacity has been established in France, the Benelux countries, Germany, the UK, Poland and Spain. As the table shows, during the period 2007–2010, only about 60% of the available capacity was utilised. This reflects, in partly, the start-up phase of the ethanol sector, during which plants are not yet fully operational. Utilisation of installed capacity was also low as a result of high grain prices, in particular for wheat in 2007, 2008 and 2010, and competition from ethanol imports from Brazil from 2006 to 2009, and the US in 2010 (USDA, 2011).

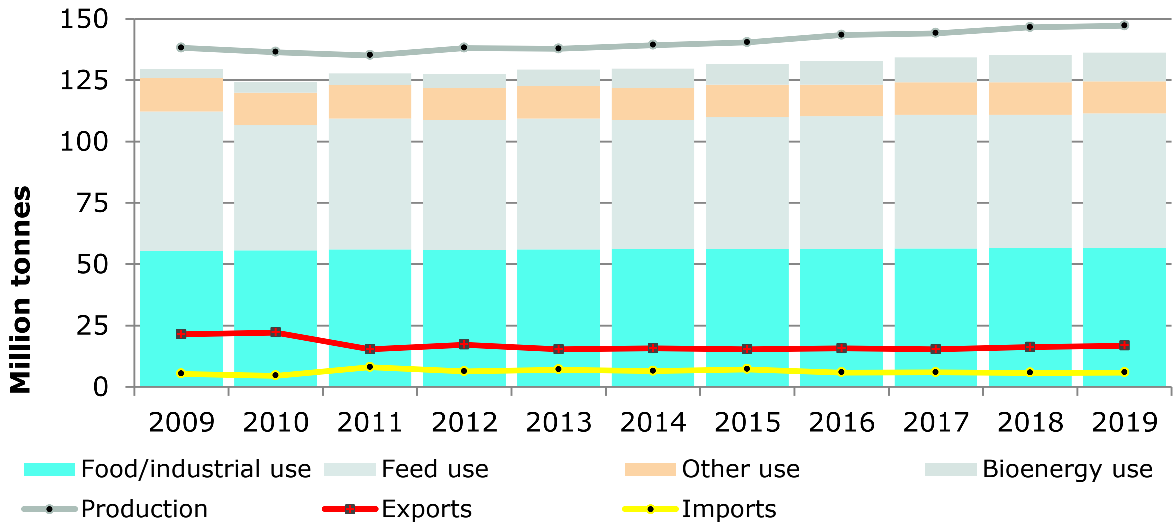
Table 5.1 Conventional fuel ethanol in the European Union, 2006-2012(e)

	2006	2007	2008	2009	2010	2011	2012(e)
Conventional fuel ethanol (million litres)							
Production	1,630	1,840	2,660	3,480	4,180	4,810	5,510
Imports	230	1,000	1,100	900	830	950	630
Exports	50	60	60	60	80	90	90
Consumption	1,740	2,370	3,550	4,560	5,190	5,670	6,050
Ending stock	70	480	630	390	130	130	130
Production capacity – conventional (million litres)							
No. of bio-refineries	40	51	61	65	71	74	80
Capacity	2,400	3,390	5,150	6,600	7,430	8,000	8,700
Capacity s use (%)	89	63	62	59	60	62	66
Co-products from conventional biofuel production (1,000 tonnes)							
DDGS	1,490	1,360	1,530	2,460	3,090	3,650	4,550

Source: USDA 2011.

Figure 5.5 presents information on production and consumption of wheat in the EU-27 between 2009 and 2020. According to the table, ethanol production accounted for 3.7 million tonnes of wheat use in 2009, which was less than 1% of world wheat production in the same year. The use of wheat for ethanol is projected to rise to 12.6 million tonnes in 2020; even at current levels of global wheat production, this would account for less than 2% of global wheat production.

Figure 5.5 Wheat supply/demand balance in the European Union, 2009-2020(e)



Source: EC (2010). Note: (e) refers to an estimate

5.3 Grain quality in the United States and European Union

United States

Most ethanol plants in the US purchase No. 2 maize, which allows for 5% damage and places limits on mycotoxin levels (Jessen, 2011) in order to provide DDGS of acceptable quality to feed manufacturers and facilitate an efficient fermentation process. As such, there should be a reasonable degree of substitutability between grain used for ethanol production and human consumption, as No.2 maize is also used for food uses (Mercier, 1994).

European Union

EU ethanol producers tend to use the lowest grade of wheat, the same as that used for animal feed wheat. Technically, flour could be made out of EU feed and industrial grain although it would not be the best quality in the EU and would produce bread that is nutritionally poorer than that normally produced.[47]

5.4 The legal basis for flexible mandates or waivers

United States

While there is no designated response of biofuel mandates to high grain prices in US legislation, several provisions exist that might permit the use of flexible biofuel mandates or waivers. The US EPA can grant waivers if it determines that the implementation of RFS2 would severely harm the economy of a State, region or the United States as a whole.[48] In 2008, a 50% waiver request from the RFS was made by the State of Texas on the grounds that it would harm the economy (particularly livestock farmers) and drive up global food prices. However, this waiver was turned down on the basis of an EPA investigation, based upon the findings to date.

Waivers can also be provided if there are production shortfalls, where projected production does not meet the minimum applicable volume for cellulosic biofuel, or if there are significant

[47] Interview with Charlotte Garbutt, AHDB, April 14, 2012.
[48] www.epa.gov

feedstock disruptions for biodiesel. The focus of these waivers is on the availability and cost of the biofuels, and not on the cost or availability of the feedstock, or its implication for food prices.

However, there has been a proposal in the US Senate to reduce RFS mandates when the national maize stocks fall below a certain level (Schafer, 2012): the proposed RFS Flexibility Act of 2011. The bill proposes that the national maize stocks-to-use ratio be reviewed every six months. If the ratio were above 10%, there would be no adjustment. However, if the ratio fell below 10%, adjustments would be made to ensure enough maize supply to meet both the demand for ethanol and animal feed, as well as other end-users' needs, according to the criteria shown in Table 5.2.

Table 5.2 Proposed Renewable Fuel Standard (RFS) Flexibility Act adjustments - United States

Level of maize stocks:use ratio	Reduction in ethanol mandate
10% to 7.5%	10%
7.49% to 6%	15%
5.99% to 5%	25%
Below 5%	50%

Source: Schafer (2012).

There does not appear to have been any discussion of compensation in the proposal submitted.

More recently, in July 2012, livestock producers in several states petitioned the EPA to grant up to a one-year waiver on the federal biofuels mandate, citing severe economic harm caused by soaring corn prices (Peterka, 2012).

European Union

In terms of flexibility to adjust mandates, the European Union's Renewable Energy Directive (RED) legislates EC reporting dates on issues related to its implementation. Corrective action can be proposed (and implemented) based upon the findings of these reports. The EC also has a responsibility to monitor commodity-price changes associated with biomass and energy use, and the associated positive and negative effects of food security. Indeed, the recent announcement of plans to limit crop-based biofuels to 5% of transport fuel up to 2020 cites concerns about the impact of biofuel production on land use and competition for food.[49]

5.5 Compensation issues

The cost of idling production

Biofuel production is characterised by high initial fixed costs. As such, maximising throughput is paramount for lowering unit costs. If the sector's level of operation varies significantly over different periods, this could lower the utilisation rate of capital and labour and increase the unit costs of production significantly (Laborde, 2011).

Even so, the cost of feedstock constitutes the single largest proportion of total costs and the cost per gallon of ethanol produced.

This section presents stylised calculations of the potential unit cost of compensation that would provide a sufficient incentive for grain diversion. In practice, the level of compensation should

[49] 'We are pushing biofuels that …do not compete with food…'. http://www.reuters.com/article/2012/09/17/us-eu-biofuel-idUSBRE88G0IL20120917

be established through the *ex ante* bids submitted by producers as part of an option contract or auction system. As discussed in the South African case, less efficient producers may be the first to advance themselves as their margins are lower, although this is influenced by the structure of production.[50]

The level of compensation may also be offset by the use of futures markets by biofuels producers. If biofuels producers forward contract for the majority of the grain needed for their ethanol production at prevailing prices, and if that price rises following a shortfall in the crop, the value of the biofuels producers' long position will increase. Even if a reduced mandate dampens the price spike, a biofuels producer who opts to decrease the use of grain for ethanol production could sell the grain that is no longer needed, with the price increase covering part of the losses from reduced throughput. However, this is contingent on several factors, including the use of future markets for the majority of grains purchases, and the margin gained on the grains price relative to the profitability of the ethanol production forgone.

However, any scheme that has to get government funds approved will need some estimation of the total cost of incentives based on initial calculations, even if no detailed calculations would be needed on a producer-by-producer basis.

United States

Table 5.3 presents a standard breakdown of maize ethanol production costs net of byproduct revenue for a production plant with a nameplate capacity of 100 million gallons. As the table demonstrates, operating costs account for approximately 90% of total gross production costs (without taking into account the value of the by-product, DDGS) with the purchase of maize accounting for the lion's share of this.[51]

Table 5.3 Maize ethanol production costs - United States

Component	Cost per gallon of Ethanol (US$)
Shelled maize	2.72
Other raw materials and variable costs	0.24
Fixed costs	0.11
Depreciation of capital	0.21
DDGS credit	-0.85
Total production cost (net of DDGS credit)	2.43
Total production cost	3.28

Source: http://www.agmrc.org/renewable_energy/

If voluntary contracts were pursued with the biofuel producers, with compensation for reducing production, a rough idea of the level of compensation needed could be based on gross margins, with compensation for fixed costs that are incurred whether the plant is operating at full capacity or not, plus a margin that might be earned on the forgone throughput (e.g.,

[50] For example, US ethanol cooperatives aligned to farmers may not be among the first to bid for the option of diverting grain away from ethanol production, as their profits are also linked to maize production (discussion with Professor Wally Tyner, September 27, 2012).
[51] For an ethanol plant in Iowa; variables may differ depending on the state or region.

15%)[52] added to the byproduct credit that would be lost. Table 5.4 presents the results of this calculation, based on the costs in Table 5.3, showing a hypothetical example of the compensation that would be due to biofuel producers for every gallon of ethanol and every tonne of maize. This could then be multiplied by the possible volume of maize released by a one-third reduction in quantity of maize used for biofuels; this would currently equate to approximately 40 million tonnes.

Fixed costs are equal, approximately, to the cost of labour, supplies and overheads, plus depreciation. While some labour costs will be variable, others will be fixed; the variable costs of labour are likely to be offset by the fixed proportion of utilities. According to the calculations, the value of the fixed costs plus a margin for forgone output and DDGS credits would total just under US$90 per tonne of maize.

Table 5.4 Basic costs of compensation associated with reducing throughput in a United States ethanol plant

	US$/gallon	US$/tonne maize[1]
Fixed costs	0.32	35.28
15% of net total costs plus value of DDGS forgone	0.49	54.24
- Net total costs	2.43	267.87
- Value of DDGS	0.85	93.70
Total compensation	**0.81**	**89.51**

Source: Author's calculations based on costs in Table 5.3.
Note: 1. 1 tonne maize = 110.24 gallons ethanol (RFA, 2012).

These calculations will be affected by several factors, including the installed capacity of the ethanol plant, energy costs, the conversion ratio between maize and ethanol (which has increased over time) and the value of the DDGS credit. However, they serve to provide a rough estimate of possible costs for the US Government to factor into a potential budget for compensation and judge opening bids. Table 5.5 presents the calculations of the total potential cost of diverting one-third of the US's fuel maize production from biofuels. At current levels of operation in the US of 130 million tonnes per year, a one-third reduction in maize use would imply more than 40 million tonnes being freed for other uses, including maize export, which would dampen most imaginable spikes.

At a basic compensation cost of nearly US$90/tonne of maize plus a premium of 5% to provide added incentive to idle production, this would equate to a total cost of nearly US$4.1 billion. By comparison, the US 2012 Farm Bill is projected to cost US$100 billion per year, with approximately US$80 billion of this in food stamps (the Supplemental Nutrition Assistance Program) reaching around 46 million people (Smith, 2012; Abrams, 2012).[53]

[52] 23% of gross production costs (i.e., without DDGS value) is the rate of earnings before interest, taxes, depreciation and amortisation (EBITDA) expected in the UK ethanol industry; we assume a lower rate of 15% given that depreciation is included in total costs and also because the level of competition in the US ethanol industry is higher than in the UK, bidding down the rate of return. If costs are average at diversion, 15% are likely to overestimate the average incentive needed to divert. Nonetheless, the calculations present a topline estimate of likely unit compensation costs.

[53] These numbers reflect the version of the Farm Bill that passed in the Senate. The House of Representatives has not passed a bill; when it does, it is expected to have a lower value.

Table 5.5 Potential total costs of compensation — United States

	Potential cost
Cost/tonne of maize (US$)	89.51
5% premium/tonne of maize (US$)	4.48
One-third of US fuel maize production (million tonnes)	43.33
Total potential cost (million US$)	**4,072.79**

European Union

Table 5.6 presents a standard breakdown of wheat ethanol production costs net of byproduct revenue for an ethanol plant in the EU. As the table demonstrates, feedstock costs account for approximately 51% of total gross production costs (without taking into account the value of the by-product, DDGS) or 63% of total net production costs.

Table 5.6 Wheat ethanol production costs — European Union (2004 €)

	Cost/litre ethanol	Cost/tonne wheat
Feedstock cost	0.40	142.40
By-product credit	0.15	53.40
Net feedstock cost	0.25	89.00
Processing costs	0.28	99.68
Estimated depreciation	0.10	35.60
Total net production cost	**0.63**	**224.28**

Sources: International Energy Agency (2004); Biomass Technology Group (2004).

Table 5.7 presents the results of the calculation of the basic compensation levels that would be required by EU ethanol producers for them to be indifferent between producing ethanol and reducing/suspending production, based on the costs in Table 5.6. According to the calculations, the value of the fixed costs plus a margin for foregone output and DDGS credits would total just over €104 per tonne of wheat. As with maize ethanol in the US, several factors affect this calculation. In addition, it is an average across the EU and does not differentiate between more competitive producers in different member states in the EU, nor between different scales of production. In reality, the less efficient producers, with lower profit margins, are likely to be among the first to put themselves forward for compensation. Nonetheless, it provides a simple benchmark for the potential fiscal cost of compensation.

Table 5.7 Basic costs of compensation associated with reducing throughput in an ethanol plant - European Union

	€/litre ethanol	€/tonne wheat
Fixed costs	0.18	62.80
15% of total costs	0.12	41.65
- Net total costs	0.63	224.28
- Value of DDGS	0.15	53.40
Total compensation	**0.29**	**104.45**

Source: Authors' calculations based on IEA and BTG costs.
Note: 1 tonne wheat = 356 litres of ethanol (USDA, 2006).

Table 5.8 presents the calculations of the total potential cost of diverting the entirety of the EU's fuel wheat production from biofuels. At current levels of operation in the EU, a complete reduction in wheat use for biofuels would imply around 6 million tonnes being freed for other uses, including wheat export, which would be equivalent to around 4% of total wheat exports in 2010 (USDA, 2006).

At a basic compensation cost of just over €104/tonne of wheat plus a premium of 5% to provide added incentive to idle production, this would equate to a total cost of just over €614 million. This compares to an annual cost of the EU's Common Agriculture Policy (CAP) of around €55 billion (Europa).

Table 5.8 Potential total costs of compensation — European Union

	Potential cost
Cost/tonne of wheat (€)	104.45
5% premium/tonne of wheat (€)	5.22
EU fuel wheat production (M tonnes)	5.60
Total potential cost (million €)	**614.17**

Source: Authors' calculations

Additional cost issues

If more detailed cost calculations proved to be necessary, several issues would need to be taken into account.

- While the calculations of basic compensation costs assume that operating costs will decrease in direct proportion to any reduction in production, this may not occur because operating efficiency would be reduced. For example, if a fermenter is run at 50% of installed capacity, it would not run at the same level of efficiency, such that operating costs would be more than 50% of those at full capacity.[54] This would need to be taken into account by producers when submitting their bids for option contracts.
- Moth-balling parts of plants may have costs and additional costs could be incurred associated with remobilisation, particularly with respect to labour. Once again, these would need to be factored into bids by producers.

[54] Interview with David Knibbs, Vireol, June 18, 2012.

Other potential impacts of idling production

In addition to the direct impact on costs and profitability of reducing production, other issues may need to be taken into consideration in negotiating compensation with biofuel producers.

- Many biofuel producers organise to supply to off-takers under contracts that have penalty clauses in the case of not supplying the agreed quantity.[55] Such penalties would need to be included in any compensation amount.
- Unless production were reduced across the board (a preference of the biofuel producers interviewed compared with the option of only some biofuel producers reducing or suspending production), biofuel producers that agreed to reduce production run the risk of being seen as unreliable suppliers, tainting customer relations. As such, even if a biofuel producer might be financially indifferent about producing ethanol or reducing/suspending production, concern that contracts might be developed with alternative suppliers outside the country might work against the proposition.[56] This might be mitigated by forward announcements by government, combined with a waiver or reduction on the mandated volume of ethanol that needed to be blended. In addition, the ethanol industry already has the experience of operating below capacity as a result of adverse economic conditions as demonstrated by the evolution of the EU's ethanol industry and the experience of ethanol producers idling capacity in both the EU and US at difficult times, normally when grain prices are high.
- Some biofuel producers' financing arrangements, when funded through project finance rather than off the balance sheet, can include a clause in the financing contract that means that they will have financing withdrawn if they default on supply contracts.[57] Again, it would be important to see whether this could be offset by prior announcements of the system and adjustments in the medium term to the contracts.

5.6 Alternative policy options – flexible mandates or waivers

Pressure has been building both in the US and EU to adjust the mandated volumes of ethanol used in domestic transport fuel. In the US, the domestic livestock industry has requested a partial waiver of the renewable fuel standard to alleviate pressure on the domestic maize price. In the EU, concerns about competition by biofuels for food crops has driven the plan to limit biofuel in transport to 5%.

This section looks more closely at waivers or flexible fuel mandates as an alternative to a grain diversion scheme, drawing on the recent discussion of the proposal for a partial waiver in the US. A recent paper analysing the potential impacts of a partial waiver on ethanol demand (Tyner et al., 2012) concluded that this would only be likely to trigger a reduction in the domestic demand for ethanol if a continued high maize price were combined with:

- a moderate crude oil price (< $100/barrel)[58]
- flexibility on the part of refiners and blenders in the US to adjust their octane level in petrol production (see Box 5.1).

The impact of a waiver in the short term would be enhanced if Renewable Identification Number (RIN) credits were available for use in 2013.[59]

[55] Interview with David Knibbs, Vireol, June 18, 2012; Tyner et al.(2012).

[56] Interview with Clare Wenner, Renewable Energy Association, June 14, 2012.

[57] Interview with David Knibbs, Vireol, June 18, 2012.

[58] One analyst has estimated that maize, which hit a record high of US$8.43 a bushel, would have to rise to US$10 a bushel and crude oil, currently trading around US$97 a barrel, must drop below US$70 in order to make ethanol too expensive to blend (McGurty and Robinson, 2012).

However, if refiners and blender do not have such flexibility or choose not to adjust their octane proportion because of the relative cheapness of ethanol, a partial waiver would have no impact. One option suggested in the Tyner et al. paper is to replace a partial waiver with a total waiver on the 'advanced other' category of renewable fuels, which includes sugarcane-based ethanol imported mainly from Brazil (see Annex G). This ethanol would then be available at the lower RIN prices applied to the category of conventional renewable fuels and would be counted towards meeting the RFS mandate.[60]

This indicates that a grain diversion scheme would be a necessary add-on to a partial waiver if all the conditions required for a partial waiver to work were not in place. It could also have the advantage of being a slightly less blunt policy instrument that would weed out some of the less efficient ethanol producers. However, both the partial waiver and the grain diversion scheme could be rendered ineffective in the short term if refiners and blenders are unable to adjust their technology to be able to produce 87 octane rather than 84 octane or choose to continue to use ethanol as a relatively cheap octane enhancer.

In the case of the EU, if biofuels based on food crops are limited to 5% of transport fuel, it becomes less likely that grain diversion would have a significant impact on wheat prices. The flexibility of refiners and blenders to adjust to different levels of ethanol use in the EU would also need to be looked at.

Box 5.1 Ethanol as an oxygenate and octane booster

In the early 1990s, through the Clean Air Act Amendments of 1990, the United States Environmental Protection Agency began to require increased gasoline oxygen content in certain areas of the country (mostly in California and on the East Coast) to help control emissions of carbon monoxide during the cold months, and established the reformulated gasoline (RFG) programme to reduce emissions air toxins and ground-level ozone (smog). RFG is now a required fuel in about 30% of the country's service stations.

While the oxygen requirement was eliminated in 2006 and gasoline producers can now meet the clean air rules any way they choose, most use oxygenates to meet the standards. The most commonly-used oxygenates are ethanol and methyl tertiary-butyl ether (MTBE). However, because of the occurrence of MTBE, a known carcinogen, in groundwater, 17 states have limited the use of MTBE in gasoline and ethanol is the dominant oxygenate used. Therefore, even without the Renewable Fuel Standard, one-third of the US gasoline supply typically contains ethanol to meet clean air rules.

Conventional gasolines also can contain oxygenates, added to help meet octane number specifications, which measure a gasoline's ability to resist engine knock. The most common octane grades are regular (usually 87 octane), mid-grade (usually 89 octane) and premium (usually 92 or 93). In some states, 87 octane is the minimum grade that can be offered at petrol stations.

Since 2008, the increased availability of ethanol and the lower cost of ethanol relative to other types of octane boosters, such as reformate, have led refiners and blenders to produce 84 octane fuel that is then blended with ethanol to reach the 87 level, rather than producing 87 octane directly. This has entailed some investment on the part of refiners/blenders in the adjustment of their production technology, and they may be unwilling to change their technology back for a short period of time. Indeed, it may take them between three and six months to adjust (Tyner et al., 2012). One option to explore further could be the possibility of compensation to offset the costs involved, although this would add to the costs of implementing a waiver/grain diversion scheme.

Sources: http://www.epa.gov/otaq/fuels/basicinfo.htm;
http://www.ftc.gov/bcp/edu/pubs/consumer/autos/aut12.shtm;
http://www.huffingtonpost.com/2012/08/24/ethanol-mandate-corn-drought_n_1826740.html

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[59] The Renewable Identification Number (RIN) system was developed by the US Environmental Protection Agency (EPA) to ensure compliance with RFS mandates. A RIN is a 38-character numeric code that corresponds to a volume of renewable fuel produced in or imported to the US. RINs are generated by the producer or importer of the renewable fuel. In theory, the RIN market ensures that mandated demand will generate high enough biofuel prices to allow biofuel producers to cover their production costs up to the RFS2. http://www.ers.usda.gov/media/138383/bio03.pdf

[60] This would negate the environmental goal of the 'advanced other' category as well as having potential knock-on effects on producers and consumers in Brazil, the main source of sugarcane-based ethanol.

5.7 Conclusions and recommendations

As discussed in this section, in many respects, the conditions are in place to ensure an effective scheme to divert grain from biofuels to food use.

- Quality standards in the EU and US mean that most feed/industrial grain is suitable for human consumption, even if it lacks all the desirable quality characteristics for different consumption uses. However, as noted in the general discussion of grain quality earlier in the study, in the case of maize, there may be marked preferences for white maize for human consumption in some countries, as opposed to the yellow maize exported by the US.
- The volumes of grain involved could have an impact on prices, particularly in the case of the US,[61] which acts as a price setter on the international market. It is less apparent that switching wheat from ethanol production in the EU would have a marked impact. While the 2012 study by the UK Department for Environment, Food and Rural Affairs (DEFRA) implied that such a switch could reduce a hypothetical price spike by up to 15% if biofuel mandates were removed altogether, this study was carried out before the proposal to cap the volume of biofuels in transport fuel by 2020.
- The legal basis for influencing domestic ethanol demand exists in both the US and EU, through provisions for waivers or changes to existing mandates.

In addition, a grain diversion scheme appears, at first sight, to have some advantages over the alternative proposed at this time, namely that of a partial waiver of the biofuel mandate, in that:

- a waiver only works if certain economic conditions are in place even when the feedstock price is high (conditions that could be influenced by option contracts established under a grain diversion scheme)
- initial reductions, in the case of the US, could be effected initially through reduced exports.

As such, a grain diversion scheme could provide a necessary complement to a partial waiver if economic conditions were not in place for a waiver to operate as a stand-alone initiative. It would also ease the impact of idling production on producers and workers.

However, the very economics that operate to stop mandates from being binding can also act against the desired impact of a grain diversion scheme on maize prices. Currently, the wholesale price of gasoline (RBOB) is US$2.75/gallon while the wholesale ethanol price is around US$2.35/gallon. As such, using ethanol reduces the price of the blended product by 4 cents/gallon.[62] As long as the price of crude oil stays at around US$100/barrel and maize at less than US$393/tonne, ethanol will be the cheapest form of providing octane and oxygen, and cheaper than gasoline.

In such a situation, if the option contracts have the desired effect of lowering maize prices, while oil (and ethanol) prices are unaffected, this would increase the profitability of ethanol production for remaining producers. If these producers have spare capacity, they could crank up production, increasing demand once again for maize and, again, putting upward pressure on maize prices. Alternatively, if ethanol prices were reduced because of the initial decline in maize prices, ethanol would become even more attractive to ethanol blenders, boosting demand for ethanol, thereby pulling up the maize price, and increasing the cost and offsetting the impact of the diversion programme.

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[61] While there is some built in lack of flexibility in the system to reduce the consumption of ethanol as a result of EPA requirements for RFG, given the volumes anticipated to be needed to dampen international prices, a one-third reduction in the volume of grain used for ethanol should be feasible.
[62] Communication with Wally Tyner, October 2012.

Therefore, if the relative prices of oil and maize operate in favour of ethanol production and spare ethanol production capacity exists in remaining producers, the scheme would need to be backed by complementary policy measures to work effectively. A variable tax could be placed on ethanol sales to close the gap between ethanol and oil prices, related to triggers such as the domestic maize stocks:use ratio. Alternatively, limits could be placed on total maize use by the domestic ethanol industry by, for example, relating this to the previous year's use.

Indeed, either of these schemes could probably function as a stand-alone policy option. However, voluntary option contracts would take the sting out of them.

There are two additional factors that would need to be considered in more detail in implementing such a scheme.

- The scheme requires flexibility on the part of the refiners and blenders to switch to producing higher octane gasoline. This needs to be looked at more closely.
- The impact of such a scheme on perceptions of supplier reliability and client relations may need to be discussed further with the ethanol industry to look for appropriate solutions.

Other knock-on effects may also need to be taken into account.

- While a temporary diversion of grain away from biofuels would increase the availability of maize and wheat for other uses, livestock producers would face a reduction in the availability of DDGS for livestock feed, which would need to be sourced elsewhere.
- Less ethanol production means more use of fossil fuels, unless replacement ethanol is imported, which could put upwards pressure on petrol prices.[63] This could be particularly accentuated if the spike in food prices is caused wholly or partially by a rise in oil prices.

Overall, this appears to be an option that could be an important companion to any scheme of flexible mandates or partial waivers and would bring with it some additional advantages, acting as a sharper policy instrument that would deliver benefits for global food prices and for the poor with fewer negative impacts for domestic producers than a stand-alone flexible mandate. However, it would also need to be accompanied by complementary policies to over-ride the impact of blending economics when the relative prices of oil, ethanol and maize combine to make it more attractive to produce and consume ethanol than gasoline.

[63] Assuming that OPEC does not increase production proportionally.

6 Conclusions and recommendations

This study has highlighted the potential for grain diversion from animal feed and biofuels in different contexts, identifying the constraints to the operational viability of such a scheme.

6.1 Why diverting grain from animal feed at national level might achieve little

It is increasingly clear that national proposals for grain diversion as a means of smoothing prices stumble on the problem of trade for price takers on the international market. Measures to restrict demand from feedlots and release grains for human use will, unless trade is controlled, merely change the trade balance for grains without changing prices in the country.

To make grain diversion work to lower cereals prices in any given country would, therefore, require some trade intervention, including tariffs and quotas for net exporters and import subsidies for net importers. The challenges escalate rather quickly to a point where the original problem becomes lost to sight. Trade measures would more or less defeat any international project for grain diversion, because it is precisely trade spillovers from national markets that would head off price spikes on world markets. In the case of net exporters, such as South Africa, trade restrictions would have negative impacts on neighbouring countries, which themselves have large numbers of poor and vulnerable people.

It is hard to imagine how to achieve the interesting proposal of coordinated grain diversion across the main consuming countries. Coordinated storage has the advantages that everyone knows what it is and how it might be achieved, but it is very little used despite being considered an option in some form or other for the better part of 70 years. Grain diversion would be a great deal less transparent and more easily derailed by special interests.

Landlocked countries: an exception

Nationally, however, a qualification may apply to countries with high costs of transport to the world market, where these allow a wide price band to form in domestic markets within which changes in domestic demand and supply alone will affect prices. This qualification makes only a small difference to the analysis for Mexico or South Africa but it does open the intriguing possibility that grain diversion might be an option for landlocked economies, even if these are, in most cases, economies where few cereals are fed to livestock. So, in more detail, what options do such countries have?

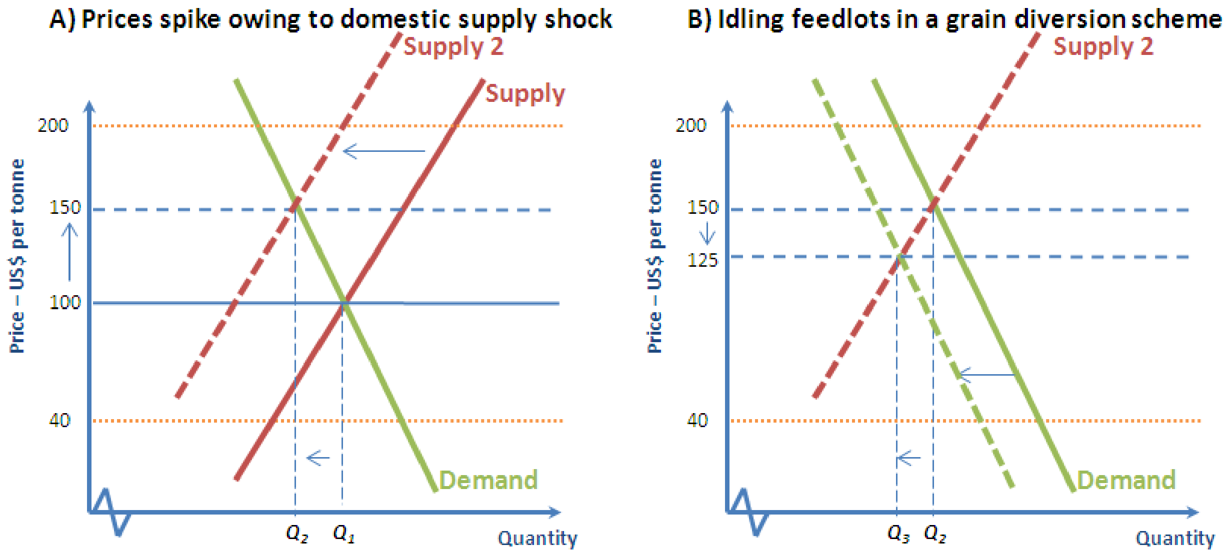
For a landlocked country, the costs of shipping cereals from international to domestic markets can be very high, creating a large band between import and export parity prices, so that in most years prices are set by domestic supply and demand. This means that measures to restrict demand from animal feed temporarily could succeed in moderating price increases, without the need to resort to controls on trade.

This, of course, is only an option if a significant fraction of cereals are fed to animals. Of the landlocked African countries that were filtered from the initial selection of case studies, only Malawi has a moderate portion of cereals going to animal feed, at 14% (FAOSTAT, 2007 data). However, this should increase in the future, and may be augmented if biofuel production plans are implemented. As such, it may be an option worth exploring now before biofuel industries become too powerful a lobby.

Malawi’s cereal market is modelled in Figure 6.1 The dotted orange lines represent the maize import parity price of US$200 a tonne, and export parity price of US$40 a tonne. Under this scenario, prices are normally set by local supply and demand and can, therefore, vary widely from season to season. In Panel A, prices spike locally – supply has moved back to the dotted red line, so the amount demanded falls, while prices have risen from US$100 per tonne to US$150 per tonne. The quantity supplied and the quantity demanded moves from Q1 to Q2 as poorer people eat less maize or inferior substitutes.

Panel B shows how a grain diversion scheme might work under this scenario. The demand curve shifts back to the green dotted line, while supply remains unchanged, creating a new equilibrium with a quantity supplied and demanded of Q3. This should bring the price down to US$125, dampening the price spike.

Figure 6.1 Grain diversion scheme in a country with large import/export parity price bands



Source: Authors' construction.

But can enough grain be diverted from feedlots to do this? To counter the effects of a bad harvest, we would have to shift an equivalent amount of grain from livestock to human use. With only 14% of grains in play, then only small harvest fluctuations could be offset and anything more than small variations would require unfeasibly large reductions in livestock output. Therefore, this is not much of an option for Malawi.

Few landlocked low income countries have more than 14% of their grain going to livestock. Kyrgyzstan (45%) and Tajikistan (22%) are the lone exceptions. Grain diversion may be an option, although given their closeness to large the wheat exporters of Kazakhstan and the Russian Federation, their import parity prices from these countries may not be quite so high and grain diversion might, therefore, achieve little.

Other landlocked countries that are not low income include Paraguay but, here again, positioned as it is between Argentina and Brazil – countries with fairly good infrastructure – the import parity price may not be very high in relative terms. Bolivia then remains as the only landlocked country that makes substantial use of grains for animal feed, at 30%, where grain diversion might be possible on a scale to offset price spikes.

6.2 Direct cash transfers to poor and vulnerable people — a more workable proposition?

As the case studies in Mexico and South Africa have demonstrated, cash transfers to grant recipients to provide compensation for higher maize costs may provide a more viable and administratively simpler means of targeting poor and vulnerable households during a crisis than diverting grain from animal feed. Such transfers could be increased and extended using existing systems, such as Mexico's *Oportunidades* and South Africa's existing comprehensive social grant system, to include an emergency food payment. This is likely to be easier to enact and more immediately effective in directly reducing the real prices faced by the poor for countries that have such programmes in place. However, this may not be the case for all countries and, in some cases, cash has proved hard to target and subject to corruption.

6.3 Diverting grain from biofuels — a possibility?

Could a scheme to divert grain from biofuels, either through flexible mandates or through incentives to divert grain directly work for price setters on the international market, like the US and the EU? It appears to be technically feasible, in terms of grain substitutability, particularly in the case of maize; the legal basis for waivers exists in both cases and has been tested over the past few months; the volumes involved could also have a significant impact on international prices, at least in the short term and particularly in the case of the US.

At first sight, this appears to be an option that could be an important, indeed necessary, companion to any scheme of flexible mandates or partial waivers, particularly in a situation where economics are driving the use of ethanol more than the mandates themselves, as is the case in the US today. However, these very economics can also undermine the effectiveness of grain diversion, and it may need to be complemented by additional policies, such as a variable tax on ethanol sales or quantitative limits on ethanol production related to previous years.

As mentioned, there are several other factors that would need to be considered in more detail in implementing such a scheme.

- The scheme requires flexibility on the part of the refiners and blenders to switch to producing higher octane gasoline. This needs to be looked at more closely.
- The impact of such a scheme on perceptions of supplier reliability and client relations may need to be discussed further with the ethanol industry to look for appropriate solutions.
- other knock-on effects may also need to be taken into account, including the impact on the availability and cost of DDGS and the potential impact on petrol prices.

6.4 Triggers

Several possible triggers have been suggested to set in motion changes in biofuels mandates or the diversion of grain from animal feed.

- The food price, although the key point is the vulnerability of poor consumers and their access to food rather than the price itself (Wright, 2011a).
- The current, or short-term forecasted level of available inventories (Laborde, 2011). Low levels of inventories would trigger the reduction of biofuel or animal feed consumption, while high levels would increase the consumption of agricultural feedstock for non-food use.[64]
- A combination of variables that relate to prices or to the current or forecast short-term level of inventories, or to other indicators that may emerge from the Agricultural Market Information System initiative (FAO, 2011).

An alternative could be the level of the world price for maize and wheat, when it breaches a certain threshold. Given that any measure would be temporary to deal with temporary disequilibria, then the formula might be a comparison of the average price for the last three months compared to the average price for three years prior to this period. For example, when the running quarter shows an increase of more than 50% on the previous 36-month moving average, this could prompt action. Measuring recent change against a running average avoids

[64] Work is being done on this for the Agricultural Market Information System initiative (AMIS). Stocks:use ratios have also been advanced as triggers under the proposed RFS Flexibility Act.

the trap of setting a fixed indicative price for cereals that would be inflexible as demand and supply shift through time.

Several issues need to be taken into account when thinking through the most appropriate indicator to use, related mainly to the cause of the price spike as grain prices could rise because of a shortfall in production or because input prices have increased due to a hike in oil prices.

References

Abram, J. (2012) *Farm Bill Passes Senate*, June 21, 2012. The Huffington Post: http://www.huffingtonpost.com/2012/06/21/farm-bill-senate-vote-food-stamps_n_1616307.html

Abbott, P., Hurt, C., Tyner, W.E. (2011) What's Driving Food Prices in 2011? In: *Issue Report*, Farm Foundation, 2011.

Agricultural Marketing Resource Centre (2012) Available at: http://www.agmrc.org/renewable_energy/

Agrimoney (Nov 2011) *Frost-hit Mexico faces record corn imports*. Agrimoney.com. Available at: http://www.agrimoney.com/news/frost-hit-mexico-faces-record-corn-imports--3788.html

Angelucci, M. and Attanasio, O. (Sep 15, 2011) *The demand for food of poor urban Mexican households: understanding policy impacts using structural models.* UCL working paper. London: University College London. Available at: http://www.homepages.ucl.ac.uk/~uctpjrt/Files/Angelucci%20Attanasio_102011.pdf

Animal Feed Manufacturers Association (2011) Chairman's Report 2011, Centurion, South Africa: Animal Feed Manufacturers Association. Available at: http://www.afma.co.za/imgs/AFMA%20%20Chairman's%20Report%202010_2011%20(for%20web).pdf

Armstrong, P., Lekezwa, B., Siebrits, K. (2008) *Poverty in South Africa: A profile based on recent household surveys.* Stellenbosch Economic Working Papers: 04/08. Available at: http://ideas.repec.org/p/sza/wpaper/wpapers52.html [accessed 23/3/2012]

Babcock B, (2011) *The Impact of US Biofuels Policies of Agricultural Price Levels and Volatility*. Geneva: International Centre for Trade and Sustainable Development. Available at: http://ictsd.org/downloads/2011/12/the-impact-of-us-biofuel-policies-on-agricultural-price-levels-and-volatility.pdf

Barquera, S., Hotz, C., Rivera, J., Tolentino, L.,Espinoza, J.,Campos, I.,Shamah, T. (2006) *Food consumption, food expenditure, anthropometric status and nutrition-related diseases in Mexico*. In FAO, 2006. The double burden of malnutrition: Case studies from six developing countries. FAO Food and Nutrition Paper. Rome: United Nations Food and Agriculture Organization.

Bartley, J., Hart, K., Swales, V. (2009) *Exploring Policy Options for More Sustainable Livestock and Feed Production. Institute for European Environmental Policy. Available at: http://www.ieep.eu/assets/419/sustainable_livestock_feed.pdf*

BBC News (Feb 1, 2007) *Mexicans stage tortilla protest*. Available at: http://news.bbc.co.uk/1/hi/6319093.stm

Biomass Technology Group (BTG) (2004) in USDA GAIN Report, 2006.

Brown, L. (1992) *Sorting Out New Water, Real Water and Paper Water*, presented at UCLA Conference *Buying and Selling Water in* California, Sacramento, 12 November 1992.

Bureau for Food and Agricultural Policy (2012) *The South African Agricultural Baseline 2011*. Available at: http://www.bfap.co.za

CEI and ActionAid (2011) *Submission to the EPA of a request for correction of information*, October 13, 2011. Available at: http://www.epa.gov/quality/informationguidelines/documents/12001.pdf

Chávez-Martín del Campo, J.C. and Villarreal Páez, H.J. (2009) *The Impact of Food Price Increases on Poverty in Mexico*. Monterrey: Universidad de Guanajuato and ITESM, Monterrey. Available at http://www.nip-lac.org/uploads/H_ctor_Juan_Villarreal_P_ez.pdf

De Gorter, H. and Just, D. R. (2010) *The Social Costs and Benefits of Biofuels: The Intersection of Environmental, Energy and Agricultural Policy*. Applied Economic Perspectives and Policy (2010) volume 32, number 1, pp. 4–32.

de Janvry, A., Sadoulet, E., Gordillo de Anda, G (1995) *NAFTA and Mexico's maize producers*. World Development, 23: 8.

De Schutter, O. (2012) *Report of the Special Rapporteur on the right to Food, Mission to South Africa*, New York: United Nations General Assembly.

DEFRA (2012) *Can Biofuels Policy work for Food Security?* Discussion Paper, May 2012. London: Department for the Environment, Food and Rural Affairs.

Department of Agriculture (2006) *Food Security Information Brief 1: Food insecurity in Sekhukhune* [Online] Available at: http://www.fanrpan.org/documents/d00498/FIVIMS_Info_Brief1_Food_insecurity_Sekhukhune.pdf

Department of Agriculture (2010) *A Profile of the South African Broiler Market Value Chain* [Online] Available at: http://www.nda.agric.za/docs/amcp/broilermvcp2010-11.pdf

Department of Agriculture (2011) *Market Value Chain Profile 2010-2011* (Maize). Available at:http://www.nda.agric.za/

Department of Agriculture, Forestry and Fisheries of South Africa, Food Price Monitoring Committee (2003) *Final Report of the Food Price Monitoring Committee*, [Online] Available at: http://www.nda.agric.za/docs/GenReports/FPMC/default.htm

Department of Water Resources (1991) *California's Continuing Drought: 1987-1991 – A summary of impacts and conditions as of December 1 1991.* Sacramento: State of California Department of Water Resources.

Department of Water Resources (2009) *California's Drought: Water Conditions & Strategies to Reduce Impacts, Report to the Governor, March 30 2009.* Sacramento: State of California Department of Water Resources.

Devereux, S., Vaitla, B., Hauenstein Swan, S. (2008) *Seasons of Hunger*. London: Pluto Press

Dinar A., Rosegrant, M. and Meinzen-Dick, R. (June 1997) *Water Allocation Mechanisms- Principles and Examples.* World Bank Publication. Available at: http://water.worldbank.org/publications/water-allocation-mechanisms-principles-and-examples

EC (Agriculture and Rural Development) (2010) *Prospects for Agricultural Markets and Income in the EU, 2010-2020*, December 2010. European Commssion. Available at: http://ec.europa.eu/agriculture/publi/caprep/prospects2010/index_en.htm

Europa (undated). *How Much the CAP Costs*. Available at: http://ec.europa.eu/agriculture/capexplained/cost/index_en.htm

FAO (1992) *Maize in human nutrition.* Rome: United Nations Food and Agriculture Organization. Available at: http://www.fao.org/docrep/T0395E/T0395E06.htm

FAO (1993) Maize in human nutrition. Rome: United Nations Food and Agriculture Organization. Available at: http://www.fao.org/docrep/T0395E/T0395E00.htm

FAO (1994) *Grain Storage Techniques – Evolution and Trends in Developing Countries*. FAO Agricultural Services Bulletin, Agriculture and Consumer Protection Department. Rome: United Nations Food and Agriculture Organization. Available at: http://www.fao.org/docrep/t1838e/T1838E00.htm#Contents

FAO (1997) *White maize: a traditional food grain in developing countries.* Rome: United Nations Food and Agriculture Organization.

FAO (2006) *Livestock's Long Shadow.* Rome: United Nations Food and Agriculture Organization.

FAO (2007) Poultry in the 21st Century, Bangkok. Rome: United Nations Food and Agriculture Organization.

FAO (2009) *Agribusiness Handbook – Red Meat.* Rome: United Nations Food and Agriculture Organization.

FAO (2010) *Nutrition Country Profiles: Mexico*. Available at http://www.fao.org/ag/agn/nutrition/mex_en.stmFAO (2012) Global Information and Early Warning System Country Briefs: South Africa, 26 June 2012. Rome: United Nations Food and Agriculture Organization. Available at: http://www.fao.org/giews/countrybrief/country.jsp?code=ZAF

FAO et al.(IFAD, IMF,OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF). 2011. *Price Volatility in Food and Agricultural Markets: Policy Responses, June 2011.* Rome: United Nations Food and Agriculture Organization.

FAO GLiPHA (2012) *Global Livestock Production and Health Atlas*. Rome: United Nations Food and Agriculture Organization. Available at: http://kids.fao.org/glipha/# Accessed March 2012.

FAO and WHO (2006) *Understanding the Codex Alimentarius.* Rome: United Nations Food and Agriculture Organization

Fatka, J. (2011) *Bipartisan Representatives Introduce RFS 'Safety Valve' Bill*. Farm Futures, October 07, 2011. Available at: http://farmfutures.com/blogs.aspx/bipartisan-representatives-introduce-rfs-safety-valve-bill-2683

Gertler, P. de Janvry, A., Levine, D. I., Sadoulet, E. (undated) *PROGRESA/Oportunidades*. Berkeley: University of California at Berkeley. Available at: http://cega.berkeley.edu/projects/progresa-oportunidades/ (Accessed 2012)

Libecap, Gary D., Grafton, R. Quentin, Edwards, Eric C., O'Brien, R. J. and Landry, Clay, A Comparative Assessment of Water Markets: Insights from the Murray-Darling Basin of Australia and the Western US (June 6, 2011). ICER Working Paper No. 8/2011. Available at SSRN: http://ssrn.com/abstract=1858723 or http://dx.doi.org/10.2139/ssrn.1858723

Gunderson, C., Yañez, M.,Valdez, C.,Betsey Kuhn, B. (July 2000) *A Comparison of Food Assistance Programs in Mexico and the United States.* Food Assistance and Nutrition Research Report No. 6. Washington D.C.: Economic Research Service.

Hall, K., Wright, G. (2010) *A Profile of Children Living in South Africa in 2008.* Studies in Economics and Econometrics, 34(3): 45-68.

Hamilton, J., Whittlesey, N., Halvorsen, P. (1989) *Interruptible Water Markets in the Pacific Northwest*, American Journal of Agricultural Economics, vol. 71, pp.63-75.

Hanak, E., Lund, J., Dinar, A., Gray, B., Howitt, R., Mount, J., Moyle, P., Thompson, B.. (2011) Managing *California's Water from Conflict to Reconciliation.* Public Policy Institute of California. San Francisco, CA.

Harrington, P. (Jan 18, 2007) *Calderon Caps Mexican Tortilla Prices to Help Poor,* (Update6) Bloomberg. Available at: http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aEDJqirnTf_U

Heartland Science (2005) *Agriculture & Food: Yellow Dent Corn.* Available at: http://www.heartlandscience.org/agrifood/pdf/yelcorn.pdf

Helming, J.F.M., Pronk, A., Woltjer, G. (2010) *Stabilisation of the Grain Market by Flexible Use of Grain for Bioethanol*. LEI Report 2010-039, May 2010. LEI (part of Wageningen UR). The Hague.

Howitt, R.E., Moore, N.Y., and Smith, R.T. (1991) *A Retrospective on California's 1991 Emergency Drought Water Bank.* Prepared for the California. Dept. of Water Resources.

Huang, Jikun, Jun Yang, Siwa Msangi, Scott Rozelle, Alfons Weersink (Oct 2009) *Global Biofuel Production and Poverty in China*. Biofuels & the Poor. Working Paper 3. IFPRI; Washington, DC.

IEEP (March 2009) Final Report for Friends of the Earth. London: Friends of the Earth.

IFIF and FAO (2010) *Good Practices for the Feed Industry.* Implementing the Codex Alimentarius Code of Practice on Good Animal Feeding. FAO Animal Production and Health Manual No. 9. Rome: United Nations Food and Agriculture Organization and the International Feed Industry Federation.

IFPRI, Welthungerhilfe and Concern Worldwide (2010) Global *Hunger Index: The challenge of hunger: Focus on the crisis of child undernutrition.* Bonn, Washington D.C. and Dublin: International Food Policy Research Institute, Welthungerhilfe and Concern Worldwide. Available at: http://www.ifpri.org/sites/default/files/publications/ghi10.pdf

INEGI (2007) *Instituto Nacional de estadistica y geografia*. Censos Agricola, Ganadero y Forestal 2007. Available at: http://www.inegi.org.mx/sistemas/TabuladosBasicos/Default.aspx?c=17177&s=est

International Energy Agency (2004) USDA GAIN Report, 2006.

International Feed Industry Federation (IFIF): http://www.ifif.org/

IRIN (10 Nov 2010) *Orange maize to curb vitamin A deficiency.* Johannesburg: Integrated Regional Information Networks. Available at: http://irinnews.org/PrintReport.aspx?ReportID=91049

Israel, M., Lund, J.R. (1995) Recent California Water Transfers: Implications for Water Management, *Natural Resources Journal,* Vol. 35, pp 1-32.

Jessen, H. (2011) *Seeking Sound Corn: Quality Matters - Do ethanol plants need to improve their grading practices?* Ethanol Producer Magazine, September 12, 2011.

Juarez, B. (2008) *Mexico: Grain and Feed: Mexico Announces Support Program for Sinaloa White Corn*. 11 December, 2008. United States Department of Agriculture's Global Agricultural Information Network. Available at: http://www.fas.usda.gov/gainfiles/200811/146306401.pdf

Juarez, B., Branson, A. (March 14, 2011) *Mexico: Grain and Feed Annual: February Freeze Impacts Marketing Year 2010/11 Crop Production Forecast.* United States Department of Agriculture's Global Agricultural Information Network, Economic Research Service. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Mexico%20City_Mexico_3-14-2011.pdf

Juarez, B., Gonzalez, C. (2010) *Food Security and Nutrition in Mexico*. Global Agricultural Information Network, United States Department of Agriculture. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Food%20Security%20and%20Nutrition%20in%20Mexico_Mexico_Mexico_7-9-2010.pdf

Juarez, B., Hansen, E.W. (March 2012) M*exico Grain and Feed Annual: Prolonged Drought Devastates Grain and Feed Sector.* Global Agricultural Information Network, United States Department of AgriculturReport, 3/30/2012. Available at:

http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Mexico%20City_Mexico_3-30-2012.pdf

Kleyn, R. *Nutritional Strategies and Opportunities for the Broiler Industry in South Africa*. SPESFEED (Pty) Ltd, Rivonia, South Africa Available at: www.spesfeed.co.za

Koch, J. (2011) *The Food Security Policy Context in South Africa Country Study No. 21*, Brasilia: International Policy Centre for Inclusive Growth.

Laborde, D. (2011) *Domestic Policies in a Globalised World: What you Do is What I Get. Consequences of biofuel mandates for global price stability.* Available at: http://www.foodsecurityportal.org/sites/default/files/A_brief_overview_of_Foodsecurity_and_Biofuels_1.pdf

Leroy, J. L., Gadsen, P., Rodríguez-Ramírez, S., González de Cossí, T. (2010) *Cash and In-Kind Transfers in Poor Rural Communities in Mexico Increase Household Fruit, Vegetable, and Micronutrient Consumption but Also Lead to Excess Energy Consumption.* Journal of Nutrition, 140: 612 – 617. 2010.

López-Calva, L.F.,Rodríguez-Chamussy, L., Miguel Székely, M. *Poverty Maps and Public Policy in Mexico.* World Bank (2007). World Bank, Washington, D.C. Available at http://siteresources.worldbank.org/INTPGI/Resources/342674-1092157888460/493860-1192739384563/10412-10_p188-207.pdf

Louw, A., Geyser, M., Schoeman, J. (2011) *Pork and Broiler Industry Supply Chain with Emphasis on Feed and Feed-related Issues*, Markets and Economic Research Council, National Agricultural Marketing Council [Online]. Available at www.namc.co.za

MacDonald, J.M., McBride, W.D. (2009) *The Transformation of US Livestock Agriculture – Scale, Efficiency and Risks*. Washington D.C.: United States Department of Agriculture.

Maré F., Nell, W., Willemse, B. (2010) *Maize prices in South Africa: Can the producer increase revenue by marketing grain through cattle?* Conference Paper presented at the Joint 3rd African Association of Agricultural Economists and 48th Agricultural Economists Association of South Africa Conference. Cape Town, South Africa, September 19-23, 2010.

Martins, J.H. (2005) *The household food budget of the wealthy and the poor in South Africa*, Journal of Family Ecology and Consumer Sciences, 33.

McCarl, B., Parandvash, G. (1988) *Irrigation Development Versus Hydroelectric Generation: Can Interruptible Irrigation Play a Role?* Western Journal of Agricultural Economics, 13(2): 267-276.

Mckenzie, David (2001) *Are tortillas a Giffen Good in Mexico*. Stanford University, Economics Bulletin. Available at: http://siteresources.worldbank.org/DEC/Resources/EB01O10003A.pdf

McGurty, J., Robinson, M (2012) U.S. Ethanol Mandate: Repealing Fuel Standard Would Not Free Up Much Corn, Experts Say. Available at: http://www.huffingtonpost.com/2012/08/24/ethanol-mandate-corn-drought_n_1826740.html

Meat Trade News Daily (2010) *South African Feedlots* [Online]. Available at: http://www.meattradenewsdaily.co.uk/news/050310/south_africa___cattle_feedlots_.aspx

Mejia, M., Peel, D.S.(June 2009) *White Corn and Yellow Corn Production in Mexico: Food versus Feed?* Denver: Livestock Marketing Information Centre.

Mercier, S.A. (1994) *The Role of Quality in Corn Import Decision-making*, Agricultural Economic Report No. 684. Washington D.C.: United States Department of Agriculture.

Meyer, S.,Paulson. N (2012) RIN Values: What Do They Tell Us about the Impact of Biofuel Mandates? September 6, 2012. Available at: http://www.farmdocdaily.illinois.edu/2012/09/rin_values_what_do_they_tell_u.html

Michelsen, A., Young, R. (1993) *Optioning Agricultural Water Rights for Urban Water Supplies During Drought*, American Journal of Agricultural Economics, 75.4, 1010-020, Print.

Msangi, S., Rosegrant, M.W. (Feb 2011) *Feeding the future's changing diets: Implications for agricultural markets, nutrition, and policy*. IFPRI 2020 Conference Paper 3. Available at: http://www.ifpri.org/sites/default/files/publications/2020anhconfpaper03.pdf

Municipal and Industrial Water Shortage Policy Central Valley California Project, Environmental Assessment (Oct 2005). Bureau of Reclamation, Sacramento, CA.

Muñoz, E.C., Rosado, J.L., López, P.,Furr, H.C.,Allen, L.H. (2000) *Iron and zinc supplementation improves indicators of vitamin A status of Mexican preschoolers*. American Journal of Clinical Nutrition, Vol. 71, No. 3, 789-794.

Muzhingi, T.,Gadaga, T.H.,Siwela, A.H.,Grusak M.A.,Russel, R.M.,Tang G. (Aug 2011) *Yellow maize with high β-carotene is an effective source of vitamin A in healthy Zimbabwean men.* American Journal of Clinical Nutrition. August 2011 vol. 94 no. 2 510-519

National Agriculture Marketing Council (2003) *The South African Food Cost Review 2002*. Available at: www.namc.co.za

National Agriculture Marketing Council (2007) *The South African Food Cost Review 2006*. Available at: www.namc.co.za

National Agriculture Marketing Council (2009) *The South African Food Cost Review 2008*. Available at: www.namc.co.za

National Agriculture Marketing Council (2010) *The South African Food Cost Review 2009*. Available at: www.namc.co.za

National Agricultural Monitoring Council (2012) *Quarterly Food Price Monitor February 2012.* Available at: www.namc.co.za

NREL (National Renewable Energy Laboratory) (2000) *Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks.* NREL, Colorado, USA. Available at: http://www.nrel.gov/docs/fy01osti/28893.pdf

OECD (2009) *Policy Responses in Emerging Economies to International Agricultural Commodity Price Surges,* OECD Food, Agriculture and Fisheries Working Papers, No. 34. Paris: OECD Publishing. Available at: http://dx.doi.org/10.1787/5km6c61fv40w-en

Oliver G.C. (2008) *An analysis of South African Beef Supply Chain: From Farm to Fork.* Masters Thesis, University of Johannesburg.

Peel, D.S., Mathews, Jr. K.H., Johnson, R.J. (August 2011) *Trade, the Expanding Mexican Beef Industry, and Feedlot and Stocker Cattle Production in Mexico.* Washington D.C.: United States Department of Agriculture and the Economic Research Service.

Peterka, A. (2012) *Livestock groups urge EPA to waive ethanol mandate*. Tuesday, July 31, 2012. Available at: http://www.governorsbiofuelscoalition.org/?p=3397

Polansek, T. (June 7, 2011) CBOT corn outlook: Up as Mexico makes long-range purchases. Dow Jones Newswires. Available at: http://www.agprofessional.com/resource-centers/corn/outlook/CBOT-corn-outlook-Up-as-Mexico-makes-long-range-purchases-123356248.html

Ravindran, V. (undated) *Poultry Feed Availability and Nutrition in Developing Countries*, FAO Poultry Development Review. Rome: United Nations Food and Agriculture Organization. Available at: www.fao.org/docrep/013/al708e/al708e00.pdf

Reuters New Agency (2012) *S. Africa further cuts 2012 maize crop forecast,* Reuters Africa Online 24 April 2012. Available at: http://www.reuters.com/article/2012/04/24/ozatp-safrica-maize-estimates-idAFJOE83N0AB20120424?sp=true

RFA (Renewable Fuels Association) (2012) *2012 RFA Pocket Guide to Ethanol.* RFA, Washington, DC.

Robinson, T.P., Thornton, P.K., Franceschini, G., Kruska, R.L., Chiozza, F., Notenbaert, A., Cechi, G., Herrero, M., Epprecht, M. Fritz, S., You, L., Conchedda, G, See, L. (2011) *Global livestock production systems*. Rome: United Nations Food and Agriculture Organization and International Livestock Research Institute, 152 pp.

Schafer, E. (2012) *Proposed RFS Changes Spark Food Vs. Fuel Debate, Feed & Grain*, March 8, 2012. Available at: http://www.feedandgrain.com/article/10619547/proposed-rfs-changes-spark-food-vs-fuel-debate

Scott, S. (2008) *California Water Law and Policy*, Chapter 7: Foreign, Developed and Salvaged Waters, Vol 1, Release No 13, October 2008, Lexis Nexis.

Shamah Levy, T; Curiel A.A., Cuevas Nasu, L.,Chávez Villasana, L.,Avila Arcos, M.A., Fernández Mendoza, C. (March 2003) *The tortilla subsidy in Mexico: a nutritional or economic program?* Caracas: Archivos Latinoamericanos de Nutrición. Available at: http://www.ncbi.nlm.nih.gov/pubmed/12942865

SIAP-SAGARPA (YEAR?) Cultivos de interés. *Mexican federal government*. Available at: http://www.siap.gob.mx/index.php?option=com_content&view=article&id=14&Itemid=20

Simmonds, D.H. (1989) *Wheat and Wheat Quality in Australia.*. Collingwood: CSIRO Publishing.

Smith, N. (2012) *Farm Bill has a Long History*, August 03, 2012. Available at: http://bismarcktribune.com/news/columnists/nick-smith/farm-bill-has-a-long-history/article_aba3b0ba-dd89-11e1-884d-0019bb2963f4.html

The Economist (Jan 24, 2008) *Mexico and NAFTA. Tariffs and tortillas: trade is not to blame for the poverty of Mexican farmers*. Accessed at: http://www.economist.com/node/10566845

The Economist (Jan 6, 2011) *Food in Mexico: Centéotl's pricier feast: The tortilla-makers cry wolf*. Mexico City. Accessed at: http://www.economist.com/node/17851501?story_id=17851501&utm_source=streamsend&utm_medium=email&utm_content=13208969&utm_campaign=Food%20News%20Friday%2C%20January%207

The Ohio State University Fact Sheet (2003) *Bushels, Test Weights and Calculations.* Columbus: Department of Horticulture and Science. Available at: http://ohioline.osu.edu/agf-fact/0503.html

Taljaard, P.R. (2003) Econometric estimation of the demand for meat in South Africa (Doctoral dissertation, University of the Free State, South Africa).

Tyner, W., Taheripour F., Hurt, C. (2012) *Potential Impacts of a Partial Waiver of the Ethanol Blending Rules*. Calumet and Oak Brook: Purdue University and Farm Foundation, August 16, 2012. Available at: http://www.farmfoundation.org/news/articlefiles/1841-Purdue%20paper%20final%208-14-12.pdf

Umbach, K. W. (1994). Agriculture, water, and California's drought of 1987-92 : background, responses, lessons. Sacramento, Calif.: California Research Bureau, California State Library.

USDA (2008) *Republic of South Africa, Grain and Feed Annual 2008.* Washington D.C.: United States Department of Africulture *Foreign Agricultural Service 3/10/2008*. Available at: http://www.fas.usda.gov/gainfiles/200803/146293891.pdf

USDA (2010) *Grain and Feed Annual report for corn, wheat and rice.* Washington D.C.: United States Department of Agriculture Foreign Agricultural Service. Available at: http://gain.fas.usda.gov/Pages/Default.aspx

USDA (2011) Poultry and Products Voluntary Report for the Republic of South Africa. Washington D.C.: United States Department of Agriculture . Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Poultry%20and%20Products%20Voluntary%20Report_Pretoria_South%20Africa%20-%20Republic%20of_9-22-2011.pdf

USDA GAIN (May 25 2011) *Market Concentration in Selected Agricultural and Food Subsectors*. Washington D.C.: United States Department of Agriculture Global Agricultural Information Network. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Market%20Concentration%20in%20Selected%20Agricultural%20and%20Food%20Subsectors_Mexico_Mexico_5-25-2011.pdf

USDA (2006) *EU-25, Sugar; The Economics of Biofuel Production in the EU*. Washington D.C.: Global Agricultural Information Network (United States Department of Agriculture Foreign Agricultural Service). May 17, 2006.

USDA (2011) *EU-27 Annual Biofuels Report*. Washington D.C.: Global Agricultural Information Network (United States Department of Agriculture Foreign Agricultural Service), June 2011.

USDA (March 2012) *World Agricultural Supply and Demand Estimates.* Washington D.C.: United States Department of Agriculture. Available at: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1194

Wiggins, S.,Compton, J., Keats, S. (2010) *Preparing for future shocks to international staple food prices*. ODI Research Report. London: Overseas Development Institute. Available at: http://www.odi.org.uk/resources/details.asp?id=5095&title=preparing-future-shocks-international-staple-food-prices

Wiggins, S., Keats, S. (Feb 29th 2012) *Food Prices January February 2012 update*. Little movement in cereals spot & futures prices. Maize stocks a concern. London: Overseas Development Institute. http://www.odi.org.uk/resources/docs/7609.pdf

Wikipedia (Accessed 2012) *Tortilla Price Stabilization Pact*. Available at: http://en.wikipedia.org/wiki/Tortilla_Price_Stabilization_Pact

Wint, W., Robinson, T. (2007) *Gridded Livestock of the World, 2007*. Rome: United Nations Food and Agriculture Organization. Available at: http://www.fao.org/docrep/010/a1259e/a1259e00.htm

Wright, B. (2009) *A Note on International Grain Reserves and Other Instruments to Address Volatility in Grain Markets*, FAO / WB / EBRD Working Paper, technical background paper to World Grain Forum 2009, St. Petersburg, Russian Federation, June 6-7, 2009.

Wright, B. (2011a) *Addressing the biofuels problem: food security options for agricultural feedstocks*, in Prakash, Adam, ed., Safeguarding food security in volatile global markets. Rome: United Nations Food and Agriculture Organization.

Wright, B. (2011b) *Biofuels and Food Security: Time to Consider Safety Values?* IPC Policy Focus paper, February 2011. Washington D.C.: International Food and Agricultural Trade Policy Council.

Zahniser, S., Coyle, W. (May 2004) *U.S.-Mexico Corn Trade During the NAFTA Era: New Twists to an Old Story.* Washington D.C: United States Department of Agriculture Economic Research Service. Available at: http://www.ers.usda.gov/publications/fds/may04/fds04d01/fds04d01.pdf

Annexes

Annex A. Range of policy options for dampening price spikes

Table A-1 presents and compares the different options that have been considered or implemented for dampening price spikes on national markets for cereals (Wiggins et al., 2010).

Table A-1 Options for dampening price spikes on national markets for cereals

	Measure	Advantages	Disadvantages
NOT TRADING	**Self-sufficiency – avoiding international trade**	Potentially effective. Removes risk of adverse policy from trading partners.	Usually very costly since it forgoes the gains from trade. It also requires governments to invest substantial portions of their budgets in agriculture. In small countries, self-sufficiency will require large stocks to be held.
	Macro-economic policy	Rise in exchange rate could dampen price rise.	Risks creating a trade deficit and slowing growth. Not a realistic option for most LICs.
TRADING – BORDER MEASURES	Export restrictions	Can dampen prices. Reassures the populace.	Only applies in countries with export surplus, and may be inefficient where borders are porous. Depresses incentives to farmers in-country. May exacerbate international price spikes. May be difficult to lift.
	Import liberalisation	Simple to implement. Can lower prices.	Many countries have only low tariffs on imports of staples, so not feasible. Loss of government revenue. May be difficult to reverse.
	Import facilitation[65]	Can maintain supply if private or public traders lack funds.	May be costly. May be subject to unexpected delays. May be attached to excessive conditionalities.
	Hedging with futures and options	Should reduce variability and cost of importing over the medium-term.	Difficult to sell politically.
	Barter and seeking special deals	Useful where forex is short. Can allow countries to deal with exporters who have restrictions.	Lack of transparency and reversibility.
TRADING – MARKET MEASURES	Price controls by fiat	Low cost to the government. Shows government to be acting.	Discourages local production, exacerbating the problem. Can be difficult to enforce and difficult to end.
	Release of stocks for purposes of price stabilisation	Response can be rapid. Cheaper than purchasing from international market at times of international price spikes.	Stockholding can be costly in infrastructure, spoilage, and locked-up capital. Reduced incentive to private sector storage (particularly where state rules about procurement and release are not transparent or predictable). Temptation to be used for patronage.
	Removal of food / fuel tax	Rapid, simple to do.	In many developing countries there is little scope to reduce taxes on staples. Reduces government revenue.
	Use of food / fuel subsidies	Effective.	Can be very expensive – particularly fuel subsidies. Lack of targeting may mean benefits leak heavily to those who do not need them.[66]
	Divert feed / fuel to food	Potentially lower costs than other measures as implemented for limited periods of time.	Only feasible in countries with major use of grain for animal feed and industry – mainly middle income and above, and not the lowest income most vulnerable countries. Untried.
	Regulating	Can be politically popular.	Few developing countries have futures markets for

[65] This refers to two separate types; credit to traders and help from international bodies such as IMF.

[66] Some forms of import facilitation, such as subsidies to private traders or importers, combined with agreements on the price at which they should release supplies to the market, as was seen in Sierra Leone in response to the international food price spike (see Wiggins et al., forthcoming) can be considered food subsidies.

	Measure	Advantages	Disadvantages
	speculation	May dampen escalation of prices to some extent.	staples. Removes a risk management tool for producers and stifles market development. Likely to have little effect on prices.
	Limiting private stocks	Can be politically popular as it scapegoats 'hoarders'.	Discourages private stockholding and may exacerbate shortages in the future.
	Help with farm inputs	Can increase productivity and production of food or cash crops.	Much depends on timing – expensive if comes too late. May attract unfair rent seeking. May misallocate scarce inputs and reduce productivity.
	Raise farm procurement price	Removes a large element of producer risk and encourages investment.	Much depends on the timing. Speculative anticipatory response could destabilise market.

Source: Adapted from Table 3.1 in Wiggins et al., 2010.

Annex B. Additional data on consumption of maize and wheat

Box B-1 Comparing white and yellow maize for human consumption

There is very little difference between the macro-nutritional properties of yellow and white maize, in terms of moisture, protein, fat, ash, crude fibre, and carbohydrates: See Table B-1.

Table B-1 Composition of raw yellow and white maize and home-made tortillas

		Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrates (%)	Calories per 100 grams
Maize	Yellow	12.2	8.4	4.5	1.1	1.3	73.9	370
	White	15.9	8.1	4.8	1.3	1.1	70	356
Tortillas	Yellow	47.8	5.6	1.3	0.8	0.6	44.4	212
	White	47.8	5.4	1	0.8	0.7	44.5	204

Source: From Table 16 in FAO (1992).

Yellow maize may have an advantage in micronutrient delivery, as yellow-dent corn (used in most yellow-maize hybrids) is high in vitamin A (Heartland Science, 2005). There are also varieties of yellow maize bio-fortified with β-carotene. Beta-carotene fortified yellow maize is a relatively new variety and people may be reluctant to take it up owing to its colour: see Figure B.1a.

Figure B.1a Yellow maize bio-fortified with β-carotene

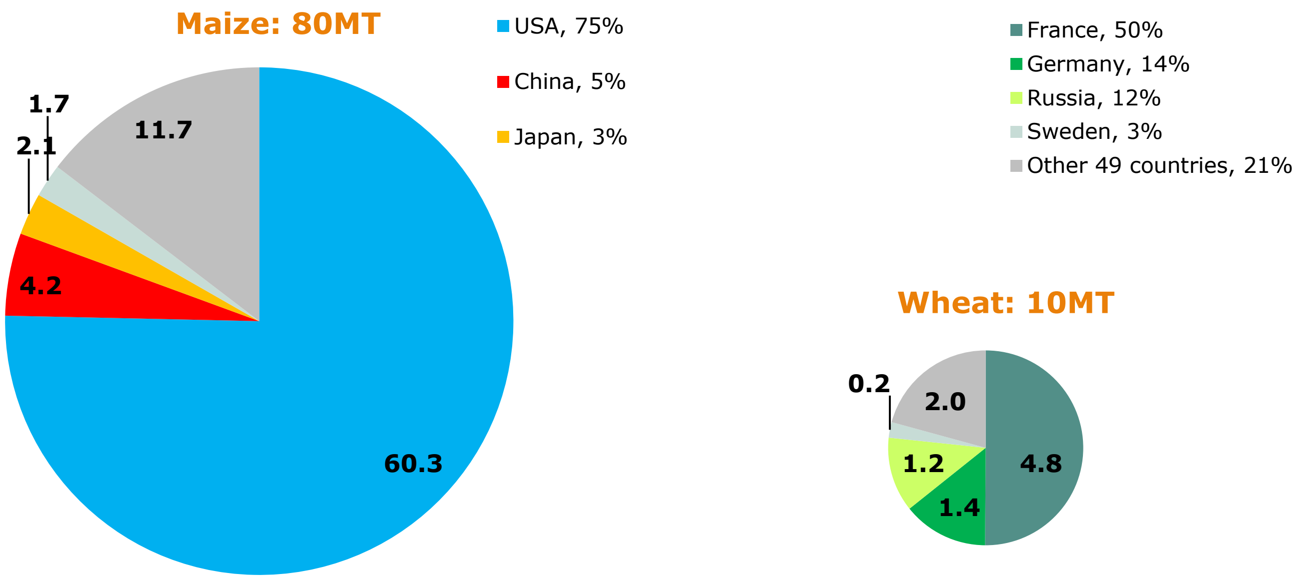
Source: IRIN, 2010 Photo credit: Robyn Allscheid Stevens/ HarvestPlus.

Recent studies show that yellow maize with high β-carotene is a good source of vitamin A:

- In eight healthy Zimbabwean men, 300 g of cooked yellow maize containing 1.2 mg β-carotene that was consumed with 20.5 g fat... provided 40-50% of the adult vitamin A Recommended Dietary Allowance (Muzhingi et al., 2011).
- In Mexico 23% of children under 12 are vitamin A deficient (FAO, 2010).

The intended food influences choice of maize however. Processing into tortillas is reportedly easier with white maize because of the different qualities of starch.

Figure B-1 Top countries for industrial use of maize and wheat globally, 2007



Source: With data from FAOSTAT. **Note**: Data are not available after 2007.

The US share is even larger now, as the production of maize for biofuel consumption has been growing very strongly there since 2007. China, on the other hand, has shelved ambitious plans to expand biofuel production there for the time being (Huang, 2009).

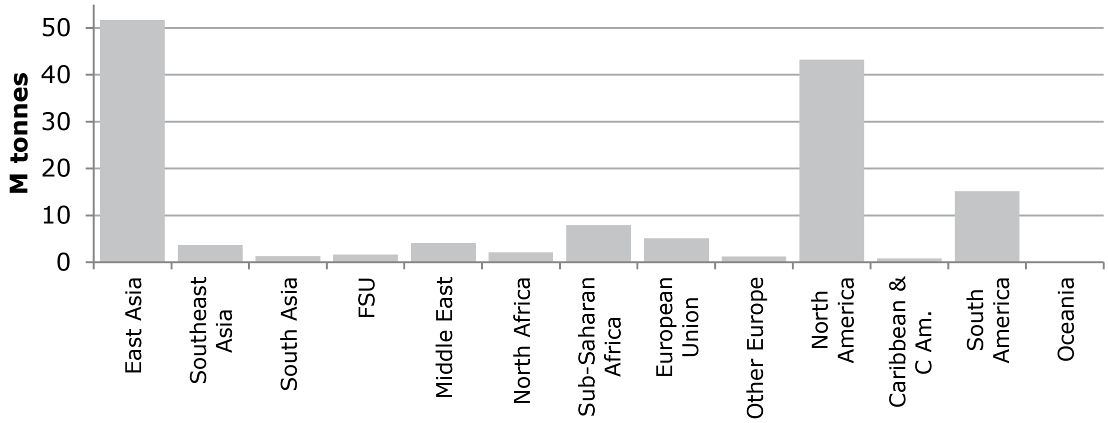
Table B-2 Maize and wheat consumption as % of global, average 2008/09 –2010/11

% of Global	Feed	FSI	All
MAIZE			
East Asia	28.5	17.3	24.0
South-East Asia	4.6	2.6	3.8
South Asia	2.0	3.8	2.7
Former Soviet Union	2.4	0.5	1.7
Middle East and North Africa	6.0	1.3	4.2
Sub-Saharan Africa	1.7	13.2	6.3
European Union	9.5	4.5	7.5
Other Europe	1.6	0.2	1.0
North America	30.6	51.5	39
Caribbean and Central America.	1.1	1.0	1.1
South America	11.8	3.9	8.7
Oceania	0.1	0.0	0.1
WHEAT			
East Asia	10.7	20.4	18.6
South-East Asia	1.8	2.1	2.1
South Asia	0.8	21	17.4
Former Soviet Union	21.3	9.8	11.8
Middle East and North Africa	4.9	16.3	14.3
Sub-Saharan Africa	0.1	3.7	3.1
European Union	49.3	12.8	19.3
Other Europe	0.7	0.9	0.8
North America	7.0	7.1	7.1
Caribbean and Central America	0.1	0.6	0.5
South America	0.6	4.6	3.9
Oceania	2.7	0.7	1.1

Stocks of maize and wheat

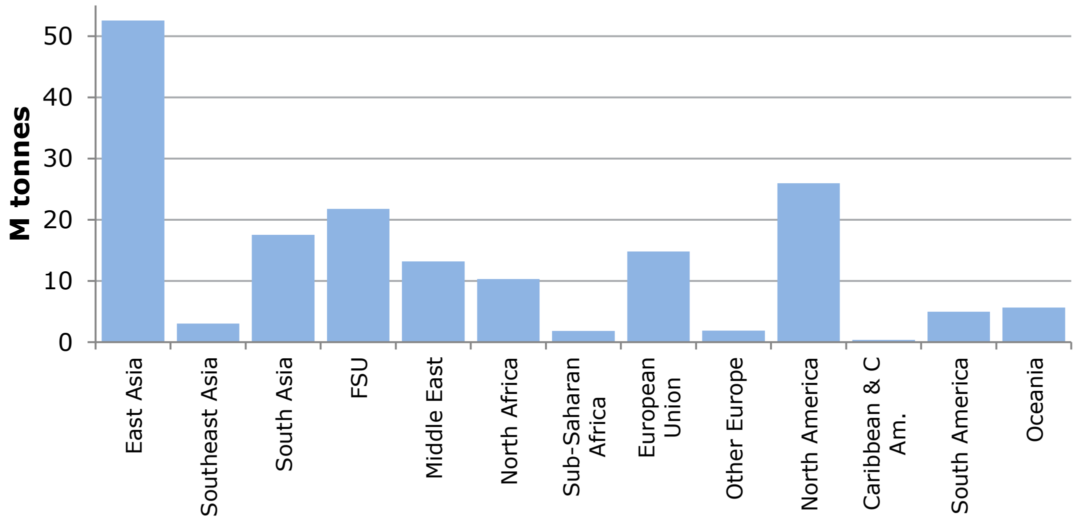
As **Error! Reference source not found.** and **Error! Reference source not found.** demonstrate, most maize and wheat stocks are held in East Asia and North America, although significant stocks are also held in other regions.

Figure B-2 Average ending-year maize stocks held by region, 2007/08 - 2010/11



Source: With data from USDA FAS. Note: FSU = Former Soviet Union.

Figure B-6 Average ending-year wheat stocks held by region, 2007/08 - 2010/11



Source: With data from USDA FAS.

Note: Stock data are often calculated as a residual of production, consumption, and trade, and are, therefore, subject to considerable error. Data to differentiate levels of stocks held for human or animal consumption are not available. Note: FSU = Former Soviet Union.

Annex C. Technical and operational issues in grain diversion

This annex analyses the role of cereals in animal feed, based on the expansion of intensive production systems, identifying the prevalence of different systems and livestock and the type of cereals that are used in their diets. This highlights the different levels of integration and contractual relationships prevalent among intensive livestock production systems.

It then highlights the economics of livestock production to identify key issues that are relevant for establishing compensation levels.[67] Finally, it discusses differences between grains used for animal feed and human consumption to understand the degree of flexibility to switch grains between the two uses.

The role of cereals in animal feed

The rise of intensive production systems

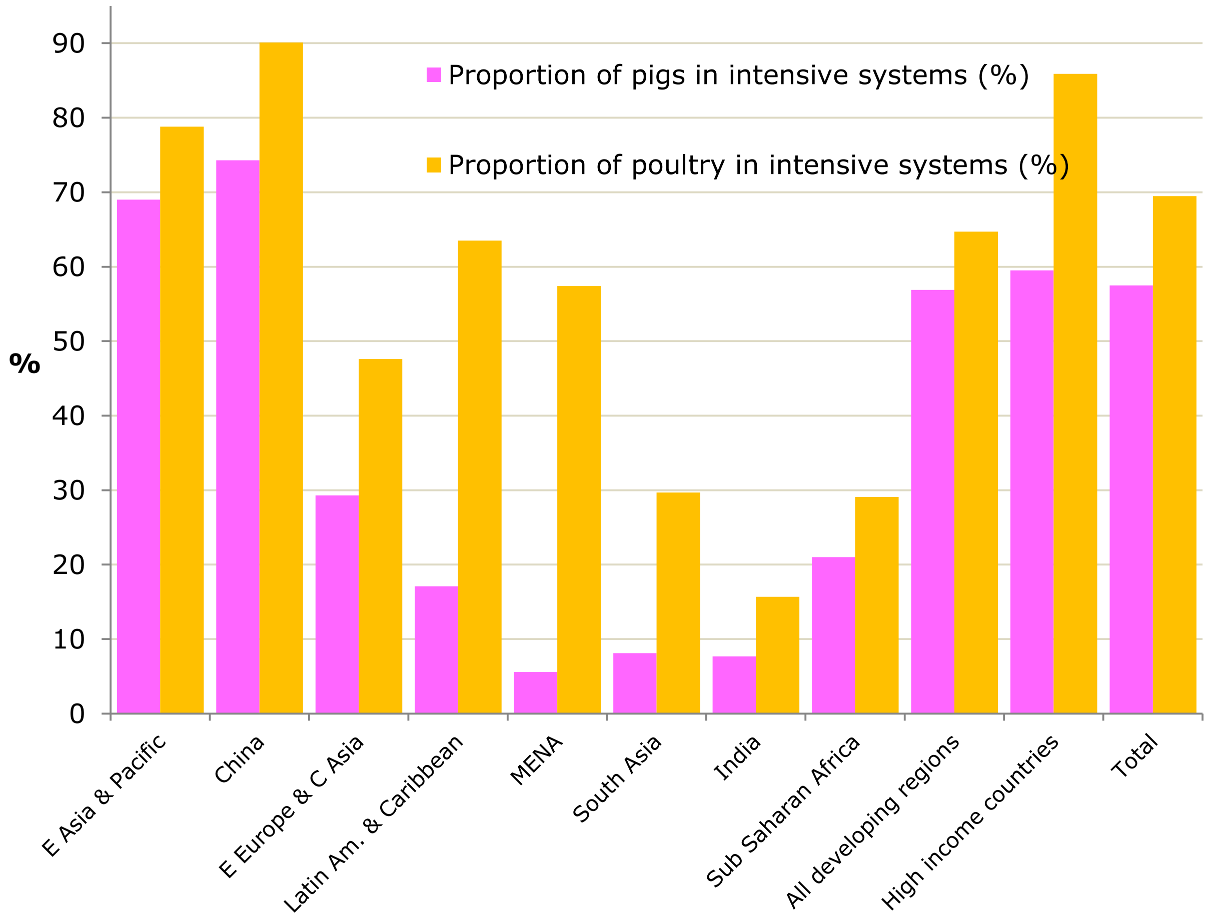
Most animal production in developed countries now takes place under semi-intensive or intensive production systems, whereby livestock are fed in confined conditions (barn, house or fenced feedlot) to increase weight or milk production and achieve certain meat or milk characteristics. Intensive production systems have been used increasingly in developed countries starting in the 1960s and 1970s, with corresponding increases in the size of operations (USDA, 2009; Institute for European Environmental Policy, 2009).

The rising reliance on intensive systems has been mirrored in developing countries with strong economic growth over the past decade, as mixed or extensive systems in certain regions struggled to meet the accelerated demand for meat (FAO, 2006). Indeed, livestock production is growing fastest in the developing world, particularly in Asia and Latin America. Increased output has been achieved mainly through the intensification of production systems and through a shift towards poultry and pigs with much slower expansion of beef production; dairying has also increased in both scale and intensification (FAO, 2006; FAO/IFIF, 2010).

Error! Reference source not found. presents the proportion of poultry and pigs produced under intensive farming systems in 2005. As the figure demonstrates, developing countries as a whole produced over 55% of their pigs and nearly 65% of their poultry under intensive farming systems in 2005. The use of intensive production systems for pigs and poultry is concentrated in Asian countries, particularly China, which produced around 90% of their poultry using intensive systems and nearly 75% of pigs. Latin America produces over 60% of its poultry using intensive feeding systems but less than 20% of its pigs are grown using industrialised feedlots.

[67] The economics of biofuel production are discussed in the section on potential for grain diversions from biofuel production in the US and EU as production is so heavily concentrated in these two areas.

Figure C-2 Proportion of pigs and poultry farmed intensively by region, 2005



Source: Constructed with data from Table 5.3 & Table 5.4 in Robinson et al., 2011. Note: MENA = Middle East & North Africa.

The emphasis on pigs and poultry has arisen partly because they are more suited to intensive production than cattle (ruminants). They have a much higher feed conversion rate than ruminants, which results in reduced feed costs per kg of meat. In an efficient pig production system, a pig for slaughter can put on one kg in live weight using less than three kg of feed (FAO, 2009); poultry can gain one kg of weight for between two and four kgs of grain, while cattle per head can put on one kg in live weight using around seven kg of feed (Rosegrant et al., 1999 in FAO, 2006).

Characteristics of intensive production systems

Intensive livestock farming or animal feeding operations are the practice of putting large numbers of animals in a confined space and feeding them prepared food rather than allowing them to graze and forage on land. A more specific definition is the use of a 'lot or factory where animals are confined and fed for at least 45 days in any 12-month period and where crops, vegetables, forage growth or post-harvest residues are not kept in the normal growing season over any part of the lot or factory' (USDA, 2009).

Intensive livestock farming became possible with the advent of large increases in productivity and production of grain in the 1960s and 1970s. This made it possible to feed large numbers of animals in one location, thus cutting transportation costs. Improvements in animal breeding and feeding methods enhanced the response of animals' weight to intensive feeding while the use of vaccines and antibiotics addressed some of the health issues associated with having high numbers of animals concentrated in confined spaces.

Prior to this, farms often used mixed production systems, combining crop production and livestock production. Indeed, livestock production was often a complementary activity that allowed farms to use underutilised assets and time outside the crop growing season. Farmers grew their own feed for cattle that they had purchased and fed them until they were ready to sell onto the market, usually at prices agreed with buyers at the time of sale.

The larger, more intensive livestock production systems that have emerged over the last 50 years are characterised by the use of a grain-based diet for feeding animals and a high degree of specialisation in single stages over the series of different stages of developing livestock (FAO, 2006; USDA, 2009). Operations have also become more tightly coordinated along the chain of production, and are often governed by formal contracts in more advanced systems (USDA, 2009), rather than spot/cash market transactions. However, this can differ between types of livestock as discussed below.

Poultry

Where intensive production systems have been in force for many years, in countries such as the US and in the EU, intensive poultry or broiler[68] production systems tend to be highly integrated operations. In the US, so-called 'integrators' own and operate hatcheries, feed mills and slaughter/processing plants, contracting out 'grow-out' operations to farmers. Integrators provide chicks and feed to farmers who, in turn, provide labour, equipment and housing.

Arrangements between integrators and grow-out farmers have become governed increasingly by formal contracts, whereby the farmer receives a base payment for services with an additional incentive payment made when performance exceeds the average of all contracted farmers (linked to high weight gains and low mortality rates). Contracts normally stipulate volumes and prices and will last a minimum of 45 days, the length of time needed to take a flock to slaughter weight.

Although it varies across countries and production systems, cereals account for around 60%–65% of a typical diet in the poultry sector (Garnett, 2007 in Bartley et al., 2009; FAO, 2006). In the EU, the main cereals used are wheat and barley. However, the type of cereal used can differ markedly: the predominant feedgrain used in poultry feeds worldwide is maize (Ravindran, undated; FAO, 2006) particularly in China, Brazil and the US; wheat is the most important in the EU, while both maize and sorghum are used in Mexico, depending on the region.[69]

Pigs

Similarly to poultry production, those involved in feeding pigs to prepare them for slaughter tend to specialise in a single stage of production, linked by integrators using production contracts. Integrators can provide feedlot operators with feeder pigs and feed, while the feedlot operator provides housing, labour and management.

Contracts typically involve a base payment for services with additional payments linked to high performance for predetermined volumes.

Between 60% and 80% of pigs' diets consist of cereals, with oilseeds, such as soya, and pulses accounting for most of the remainder by mass (Bartley et al., 2009; FAO, 2006). In line with trends in the poultry sector, the type of cereal varies across regions: while maize is the primary source of grains in pigs' diets, particularly in the US, Brazil, China and Japan, wheat and barley are the principal source in the EU, while Mexico uses maize, sorghum and a small proportion of wheat.

[68] Poultry produced for meat.

[69] The components of rations can change rather quickly as feed manufacturers adjust the mix to produce a nutritional outcome in energy, protein and minerals achieved by least-cost ingredients.

Beef and Dairy
Production systems for beef and dairy are much more varied across countries and regions than for poultry and pigs. Intensive bovine production, normally involving feedlots, is prominent only in North America and in some Far East countries such as Japan (FAO, 2009).

Within intensive production systems, there is often less specialisation in single stages than for poultry and pigs.

Beef cattle are usually shipped to feedlots when they are 6–12 months old, where they are fed rations of grain, silage, hay and/or protein supplements (USDA, 2009). Calves can go to a stocker operation beforehand where they are fed a mixture of pasture forage and concentrated feed for three-eight months. In a typical feedlot, 95% of a cow's diet is often comprised of cereals.

In countries such as the US, where intensive production systems are an important part of cattle production, production has shifted from smaller farmer-feedlots to larger commercial feedlots, which buy all or most of their feed ingredients and maintain feedmills and food delivery systems onsite. The level of integration and type of ownership is more varied than for poultry and pigs, with feedlots being owned by meatpackers, larger diversified farms or specialised cattle feeding businesses, which sometimes deal with feed production as well (USDA, 2009).

Some cattle feeders own their cattle and market them, while others perform outgrowing services on the basis of production contracts, where cattle feeders are paid for their services.

The economics of livestock production

While proportions vary between livestock sectors, the bulk of costs are from feed.

Poultry
The purchase of broiler houses forms the lion's share of the fixed cost of growing the chicks. However, feed costs form the largest proportion of total costs (USDA, 2009; Ravindran, undated) if feedlot capacity is used at close to full capacity.

Pigs
Like poultry, the main fixed cost for a feedlot operator is the pig housing, accounting for 67% of fixed costs (FAO, 2009). However, if feedlot capacity is used at close to full capacity, variable costs are by far the highest proportion of total costs, at 81%, with feed costs making up 75% of variable costs or 61% of total costs.

Beef
Cattle feeding requires a significant investment in physical capital. Feedlots use mechanised equipment for feed milling, handling, and storage, and for manure removal, storage, treatment and transport. This has created the incentive for year-round production in order to spread fixed costs across more animals. However, the majority of costs are variable, including the cost of purchasing calves and feed.

Characteristics of food, feed and industrial grains

The meaning of quality
While all grain users want grain of 'good quality', quality can be interpreted in different ways by different users, depending on its end use for that particular enterprise or individual (FAO, 1994; Simmonds, 1989). Growers want varieties that are high yielding and resistant to pests and diseases, while millers will look for grains that are clean, easy to mill and have high milling yields (i.e., high quantities of flour that can be extracted from the grain) and good suitability for consumer needs. Processors want flour that will be suitable for a particular use, such as

bread, cakes, pasta, noodles, etc. in the case of wheat, while consumers will value flavour, aroma, texture, nutritional value and cost (Simmonds, 1989).

Grain quality is influenced by different factors, including:

- the variety or type of grain
- climatic and soil conditions
- cultivation practices
- harvesting techniques
- post-harvest storage, handling and processing.

Setting quality standards

The qualities of different grains are usually expressed in specifications or gradings. There are at least 330 specifications for cereals and cereal products at national and international level (over 50 countries or regions) of which at least 12 are applicable globally (FAO, 1994).

International quality standards are set by bodies, such as the *Codex Alimentarius* Commission (Codex) which operates a committee to formulate standards on cereals, pulses and legumes and the International Association for Cereal Science and Technology (ICC). Key standards are enshrined in documents, such as the *Codex Alimentarius* or International Organisation for Standardisation (ISO) standards.

National quality standards are defined and established mainly by a national standards institution which may issue specifications for commodities as well as methods of testing. Many countries adopt or modify international standards, such as the ISO standards or the *Codex Alimentarius* into their national system. (See also FAO/IFIF, 2010 for national codes (RSA, Mexico, Brazil)).

Quality standards under bodies such as the *Codex Alimentarius* Commissions were designed to protect the health of consumers and ensure fair trade practices. While this originally targeted food directly consumed by humans, the BSE crisis in the early 1990s triggered a new focus on the safety of animal feed. This resulted in a Code of Practice on Good Animal Feeding, which applies to the production and use of all goods used for animal feed and feed ingredients whether produced industrially or on an individual farm (WHO and FAO, 2006).

Quality characteristics

While general standards specify characteristics and levels related to soundness and food safety, further classification and grading identify other characteristics more linked to particular end uses as well as price differentiation. Key general characteristics include:

- moisture content
- test weights[70]
- percentage of damaged grains/kernels
- mycotoxins
- colour
- aroma
- foreign matter

Beyond these general characteristics, most assessments are specific to a particular commodity or end use, as discussed in the following sections.

70 The bulk density, also called the test weight, reflects the density of the grain, i.e., whether the grains have filled out completely and whether they have small spaces inside the grain. This is usually measured in terms of kg/hectolitre or pounds/bushel.

Wheat

General quality criteria

Table C-1 presents the general characteristics considered to be minimum standards for human consumption in the Codex standard for wheat and durum wheat. According to the table, moisture content should not exceed 14.5%, depending on the destination, and the wheat should have a minimum test weight or bulk density of 68 kg/hectolitre (70 kg/hectolitre for durum wheat). Damaged grain should constitute no more than 12.5% of total grains. The standard also establishes minimum levels for organic and inorganic matter.

Table C-1 Codex standard for wheat and durum wheat Codex Stan 199-1995

Factor/description		
	Wheat	**Durum wheat**
Moisture content[71]	14.5%	14.5%
Minimum test weight: the weight of a hundred litre volume expressed in kilograms per hectolitre.	68	70
Damaged grain, of which:	12.5% max	12.5% max
- Shrunken and broken kernels: broken or shrunken wheat or durum wheat which will pass through a 1.7 mm x 20 oblong-holed metal sieve for wheat and through a 1.9 mm x 20 oblong-holed metal sieve for durum wheat.	5.0% m/m max	6.0% m/m max
- Damaged kernels (including pieces of kernels that show visible deterioration due to moisture, weather, disease, mould, heating, fermentation, sprouting, or other causes.)	6.0% m/m max	4.0% m/m max
- Insect bored kernels: kernels which have been visibly bored or tunnelled by insects	1.5% m/m	2.5% m/m
Edible grains other than wheat and durum wheat (whole or identifiably broken)	2.0% m/m max	3.0% m/m max
Filth	0.1%	0.1%
Inorganic material	0.05%	0.05%
Ergot	0.05%	0.5%

Source: Codex Alimentarius.

More specific quality criteria and end uses

Beyond these general characteristics, additional quality criteria are used to determine the suitability of different types and grades of wheat for different uses, as well as establish price premia, namely:

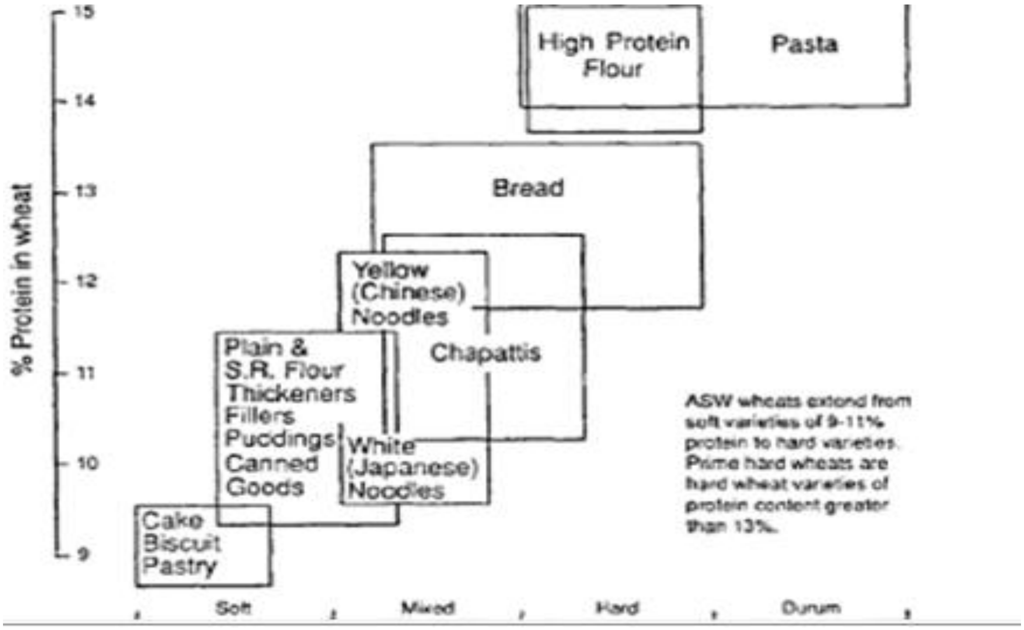
- variety
- protein content, the single most important influence on processing quality, with high protein varieties being valued for pasta and bread, and varieties with low protein contents used for cakes, biscuits and pastry

[71] Lower moisture contents are required for certain destinations, in relation to the climate, and duration of transport and of storage.

- hardness, with hard wheats used for pasta and bread, and soft wheats used for cakes, biscuits and pastry
- milling quality, including the yield[72] and the colour
- dough strength
- quality criteria related to the amount of sprouted wheat in the delivery, often reflected in the 'falling number'.[73]

Figure C-3 demonstrates the balance between hardness and protein content for different end uses (Simmonds 1989).

Figure C-3 Protein content and hardness required for different end uses of wheat



Source: Simmonds (1989).

In leading wheat-producing and exporting countries, with highly developed and stratified classification and grading systems, very stringent quality characteristics are required of premium grade wheats. In Australia, which has 24 grades of wheat, the premium grade wheat requires minimum protein contents of 13–14%, complete absence of sprouted wheat and falling numbers of over 300. Most milling-wheat classifications require test weights of between 68 kg/hl and 74 kg/hl and all are required to have a moisture content of no more than 12.5%.

Feed wheat - the residual

In such systems, feed wheat tends to be the low grade, residual wheat that does not reach the qualities or soundness levels required for milling or general purpose wheat.[74] In Australia and the US, there is a single grade of feed wheat. While the moisture content for feed wheat is the same as for other grades of wheat, there are striking differences with other quality parameters, including:

[72] The percentage of flour that can be recovered, often between 72% and 82%.

[73] The falling number refers to a grain quality test which measures the degree of weather damage in wheat based on the ability of an enzyme released during seed germination to liquefy a starch gel. Strength of the enzyme is measured by falling number with a larger number indicating a lower degree of enzyme.

[74] Wheat that does not reach the levels of key parameters, such as protein content, of other grades of milling wheat but is suitable for milling and blending with other wheats.

- protein content, which is not required to be specified
- falling number, for which a minimum level is also not specified
- colour, which can be up to 50 units, 10 times the maximum level defined for good quality milling wheat (general purpose wheat can have up to 15 colour units)
- field fungi, which can be four times as great as for milling wheat and twice that of general purpose milling wheat
- sprouted grains, for which no maximum level is imposed
- unmillable material, including whiteheads, chaff and foreign seeds, which can have up to four times the levels of high grade milling wheats and twice that of general purpose wheat.

Grain of feed-grain standards also tends to have a lower test weight. In Australia, it is required to have a test weight of 62 kg/hl to classify as feed grain.

Nonetheless, while such wheat may not contain the ideal characteristics for milling, technically, it is usually fit for human consumption.[75]

Maize

General quality criteria
Table C-2 presents the general characteristics considered to be minimum standards for human consumption in the Codex standard for maize. According to the table, moisture content should not exceed 15.5%, depending on the destination, and damaged or blemished grain should constitute no more than 7% of total grains. The standard also establishes minimum levels for organic and inorganic matter.

Table C-1 Codex standard for maize (corn) Codex Stan 153-1985[76]

Maximum tolerances (% m/m):	
Abnormal or foreign odour	0
Moisture content	15.5
Blemished grain	7
of which:	
Diseased grain	0.5
Broken kernels	6
Other grains	2
Foreign matter	2
of which:	
Inorganic matter	0.5
Filth	0.1
Toxic or noxious seed, heavy metals, microorganisms or poisonous or deleterious substances	free from amounts hazardous to health

[75] Communication with AHDB.
[76] Including characteristics listed in the Annex to Codex Stan 153-1985

Source: Codex Alimentarius Commission.

The Annex to the *Codex Alimentarius* includes additional standards on colour and kernels of other shapes:

- yellow maize should contain no more than 5% by weight of maize of other colours
- white maize should contain no more than 2% by weight of maize of other colours
- flint maize and dent maize should each have a maximum by weight of 5% of maize of other shapes.

More specific quality criteria and end uses

Unlike wheat, maize is a more homogenous product: emphasis in quality standards is placed on cleanliness and the percentage of damaged or broken kernels, with little distinction made in relation to other characteristics. Table C-3 presents the grades used in the US, which produces nearly 40% of global maize production, for the maize produced there for domestic consumption and export.

Table C-2 US maize (corn) grades

Grade	Minimum test weight per bushel (pounds)	Maximum limits of:		
		Damaged kernels		Broken corn and foreign material (%)
		Heat-damaged kernels (%)	Total (%)	
US No. 1	56	0.1	3	2
US No. 2	54	0.2	5	3
US No. 3	52	0.5	7	4
US No. 4	49	1.0	10	5
US No. 5	46	3.0	15	7

Source: USDA.

As the table demonstrates, US grades do not appear to characterise grains according to end-use needs apart from the level of broken corn and foreign material (BCFM), moisture and test weights. This appears to result from the fact that the majority of grain is used for feed or biofuels, where quality is less of an issue than price, and buyers generally opt for grades 2 and 3. However, even with feed grain, quality is still an issue and feed manufacturers are concerned with BCFM, moisture content, aflatoxin, crude protein content and hardness/ susceptibility to breakages (Mercier, 1994).

While food uses aim for generally higher quality (Grades 1 and 2) different end uses demand different characteristics (Mercier, 1994):

- corn starch, HFCS and ethanol producers will look for maize with a high starch content
- oil producers will prioritise maize with a high oil content
- millers processing maize for flour, mainly for tortillas, will prefer maize with low levels of damaged kernels (FAO, 1993).

Outside the US, the main distinction in terms of end use is between yellow and white maize. As Table C-4 demonstrates, there does not appear to be significant differences in nutritional value between yellow and white maize: the main difference is in the moisture content with only a small variation in protein content.

Table C-3 Approximate composition of white and yellow maize

Product	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrates (%)	Calories per 100 g
Maize							
White	15.9	8.1	4.8	1.3	1.1	70.0	356
Yellow	12.2	8.4	4.5	1.1	1.3	73.9	370

Source: FAO (1993).

However, yellow maize tends to be preferred for livestock feeding as it gives poultry meat, animal fat and egg yolk the yellow colour valued by consumers in many countries (FAO, 1997).[77] White maize is not used to produce ethanol or high-fructose corn syrup (HFCS).

In addition, there are distinct consumer preferences, usually for white maize, with some resistance by consumers of white maize to switching to yellow maize. This may be due to issues of quality, particularly where yellow maize has been imported for food when it was originally intended to be used as feed, or because of lack of knowledge of the properties of white maize relative to yellow maize (FAO, 1997). Such preferences can be very specific to each particular country, making generalisations hard.

[77] In Mexico, where relatively large quantities of white maize are fed to animals, the colour deficiency is corrected by adding carotin as a colouring agent to the compound feed mix.

Annex D. Lessons from other Sectors – the case of the Drought Water Bank in California

Schemes whereby water and electricity have been diverted from one use to another at times of scarcity can provide useful lessons for thinking about how to operate a grain diversion scheme in practice. This section presents the experience of California's diversion of water from irrigation of agricultural crops to urban use during periods of acute water shortages.

California faces periodic acute water shortages and sustained pressure on water resources. In 1991, a Water Drought Bank was established by the Californian State Government during a period of acute water shortage using water supply option contracts to allow additional use of pumped ground water for irrigation use and divert surplus surface water to urban areas and other areas experiencing critical shortage. This experience is well documented and provides useful analogies for thinking about a similar scheme for diverting grain.

Background and context

Sources and uses of water - a mismatch

With its large and diverse agricultural sector that uses around 80% of the state's 'developed' water,[78] California faces challenges in water allocation between the principal sources of water in the northern and eastern mountains and the greatest demand areas in the dry western and southern areas of the state.

Use of ground water[79] is common and typically year-to-year fluctuations are smoothed through a system of reservoirs and aqueducts (Umbach, 1994). Another important feature of the Californian water system is that all water supplied from the north to the south must pass through the Sacramento-San Joaquin Delta[80], which physically constrains movement of water, increasingly so because of heightened concern about endangered species residing in the area (Israel and Lund, 1995).

Institutional Framework

The physical (geological) and human (administrative and institutional) infrastructure of water, developed through the California State Water Project (SWP), the federal Central Valley Project (CVP), and numerous smaller local projects, have created a highly integrated and intricate water resources system governed by a large number of diverse water management agencies. These, in turn, are ruled by a complex set of laws, regulations, judicial rulings, contracts and coordinating agreements (Israel and Lund, 1995).

The federal government plays a key role in water management, mainly through the Bureau of Reclamation, which owns the CVP. The Californian State is responsible for regulating and developing water resources, and protecting the natural environment. Between them, the SWP and CVP provide around 30% of the state's surface water needs with the remainder provided by a range of state contracted and private providers.

California has around 3,000 water suppliers, both public and private, and water delivered to an individual house or farm will have been contractually or physically handled by several hierarchically layered supply agencies, from state or federal reservoir to regional wholesaler to water districts. This is a complex system which has impeded transfer schemes in the past, although state-run drought banks had previously existed, for example during the 1977 drought (Israel and Lund, 1995).

[78] Developed water refers to water added to native supplies from non-tributary or foreign sources (Scott, 2008).

[79] Groundwater is water that is found underground in the cracks and spaces in soil, sand and rock, stored in, and moving slowly through, layers of soil, sand and rocks called aquifers. http://www.groundwater.org/gi/whatisgw.html

[80] The Sacramento-San Joaquin Delta, the single most important link in the state water system, is a natural estuary of more than 738,000 acres and home to more than 750 species of plants and wildlife. The Delta conveys water from Northern California rivers to pumping facilities in the southern Delta. http://www.calwatercrisis.org

Triggering water saving and diversion
Between 1987 and 1992, California experienced drought, during which the state initiated a Drought Water Bank to purchase water for resale to needy areas. The State Governor called upon the state Department of Water Resources (DWR) to establish a clearing house for facilitating water marketing transactions (DWR, 1991). In February 1991, the Governor of California established the drought water bank, which the DWR managed. The establishment of the Water Bank was triggered through monitoring of water availability across a range of variables: precipitation, snowpack, reservoir storage, runoff forecasts and groundwater basin conditions (DWR, 2009) and well as water quality and environmental factors such as wildlife preservation. This set of parameters, showing water supplies from various sources were reaching critical levels, is used to trigger decisions on drought declaration and subsequent provisions for water supply. Sellers made water available to the bank by fallowing land (and switching some crops to less water-intensive crops) through a contracting system (see section below on contracts), through using ground water in lieu of surface water or transferring water stored from local reservoirs

As part of the exchange and transfers response, the state established Drought Water Banks, which operated in 1991 and 1992 to divert water to areas of highest need (Umbach, 1994). These Drought Emergency Water Banks were the US's first large water transfer programmes in which the state served as the predominant broker for water trades.

Between 1992 and 2009, there was no Drought Water Bank until the State Governor declared that California was officially in drought and nine counties in the farm-rich Central Valley to be in state of emergency because of low water supplies. The Bank was set up once again to buy water from farmers and local agencies upstream of the Delta and made it available for sale to public and private water systems expecting to run short (DWR, 2009).

Results
Within a few months of being established in 1991, the scheme had acquired 820,000 acre-feet of water through willing sellers and the state was successful in establishing important links with local water interests and local governments which would also facilitate future programmes (Lund and Israel, 1995).

The 1991 bank was deemed broadly successful. Operational flexibility of both the SWP and CVP allowed conveyancing of water through the Delta with minimal additional impacts to fisheries, a concern for increased water transfer volume. That flexibility, combined with heavy March rains in 1991 and the Water Bank, enabled the State to meet all critical needs for water in its fifth year of drought (Umbach, 1994).

How the approach works

Institutional framework
The Drought Water Bank established in 1991 was managed by the DWR using redirected staff. A temporary Water Purchasing Committee, established by the DWR, negotiated terms and conditions of a model contract for purchasing water and special legal provisions were made giving water suppliers authority to enter contracts with DWR for transfer of water outside their service areas.

Voluntary contracts - the basis for transactions

Types of contracts
The Drought Water Bank entered into a total of 351 contracts in 1991 through three types of transactions (Umbach, 1994):

- fallowing (328 of the contracts and 53% of the water) under which to be eligible, land had to have been farmed in the previous year, or set aside under the federal Farm Commodity programme (Israel and Lund, 1995)

- ground water (19 contracts and approximately 30% of the water) which functioned by allowing land owners to irrigate crops with ground water and transfer their surface entitlements to the Water Bank
- purchase of stored surface water, mainly from Yuba Country Water Agency (4 contracts, 17% of the water).

Enforcing these contracts required monitoring water sources and usage by, for example, using well logs and meters for ground water use, to ensure that land owners used new non-surface water and that ground water pumped to replace surface water was not taken from nearby surface-water sources (Brown, 1992).

Terms and conditions

The main policy incentive for water suppliers to engage in the bank was effective contracting and pricing, managing risk for both buyer and seller at the same time as ensuring pricing that is appropriate to supply and demand requirements. The DWR bought water from water rights holders (including farmers) for US$125 per acre foot,[81] a price agreed after analysing farm budgets, talking to potential sellers and buyers and consulting with agricultural economists (Israel and Lund, 1995); it then sold it to SWP contractors at US$175 per acre foot plus conveyance costs. The selling price included all acquisition and administrative costs borne by DWR, as well as costs incurred to satisfy outflow requirements for moving water through the Sacramento-San Joaquin Delta (Lund and Israel, 1995). A 50% deposit was required from buyers, with full payment prior to water delivery, with most Bank water being delivered by SWP facilities and SWP contractors purchasing water paying primarily for the energy to pump water to the contractor’s area (Israel and Lund, 1995). Non-SWP contractors were charged an additional fee to cover a proportional share of the capital and annual operation and maintenance costs of SWP facilities used in the transfer (Israel and Lund, 1995).

Key characteristics of successful contracts

State involvement has been important in terms of coordinating contracting, ensuring that legal frameworks – particularly concerning rigidity over geographical constraints on water usage – can be revised or suspended during times of extreme need, and also in identifying and prioritising areas of water need.

In terms of calculating option payments, in addition to purchaser incentives, such as the escalator clauses, both buyer and seller require realistic knowledge of water values, the probability and severity of drought and the total contract cost, including transaction costs of negotiating and adjudicating temporary water transfer (which needs to cost less than the purchaser’s next most costly water supply alternative) in order for effective pricing to be established (Michelson and Young, 1993).

Further provisions are suggested by Michelson and Young, 1993, to improve the likely success of options, particularly concerning contract terms and provisions (see Box 2.1). For example, various considerations are required in setting the cost each time the option is exercised. Shorter advance notices raise seller opportunity costs and thus the exercise price. Escalator clauses can be used to adjust prices protecting sellers from inflation. Similarly a right of first refusal allows the seller to retain the option of selling water before contract termination whilst maintaining water security for the buyer who has the option to match the offered price.

[81] The original price was rejected (Michelsen and Young, 1993).

Box D-1 Principal provisions of water supply contracts

Michelson and Young (1993) detail a model of a Water Supply Option Contract as that used by the Water Bank – a formal agreement between buyer and seller to transfer water during occasional critical drought periods. Such a contract contains key provisions that aim to make the contract mutually beneficial to both buyer and seller and enable water diversion to proceed on a voluntary basis.

- The option guarantees the seller a minimum (exercise) price and guarantees the buyer supply of water in time of need, as well as the option not to purchase if they choose.
- Premium over exercise price for retaining option of guaranteed sale at set price at some point in the future.
- Escalation over time to take into account inflation.
- To motivate early seller participation, the 1991 Water Bank contracts contained price escalator clauses, ensuring that if the price extended to a similar seller had increased by a specific date beyond the originally agreed price, the seller of the early participation option would receive the higher of the two prices (Israel and Lund, 1995). A water supply contract assumes that the probability and severity of drought is anticipated to be within acceptable limits of risk for both parties.
- Under the option contract, the seller retains rights over the water, meaning that for an option system to be effective, property rights over water must be definable and transferable for market exchange. This assumes that the latter may require amendments to legal water rights rigidities (Michelson and Young, 1993), and that the farmer's willingness to sell or lease water is not taken as admission of him not having beneficial use for the water, and thus conceding rights to it, under certain states' laws (Hamilton et al., 1989).
- Agricultural operations must also be capable of temporary suspension, so the scheme necessarily excludes perennial (and high value) crops and most livestock.
- Finally, a successful water supply contract is predicated on the fact that the total cost of the option would be less than the next most costly alternative.

Important differences with grain diversion

Water diversion schemes differ from potential grain diversion schemes in various aspects.

- The physical transfer of water is far more costly than the transfer of grain. Water markets tend to be locally focussed and there is very limited potential for international (or between regions of the same country) transfer of water resources. In California, there are significant constraints on the volume of water which can be moved from north to south in a fixed period of time. As international trade appears to be a key factor undermining the feasibility of a grain diversion scheme for countries that are price takers, this is a key difference that contributes to the success of the water diversion.
- At the same time, little additional infrastructure needs to be created for the transfer of water,[82] unlike grain, which might require additional storage capacity.
- While water is not differentiated as much as grain, in terms of quality specifications, it is more differentiated by location and there are wider implications of increasing movements of water in terms of water quality and also environmental impact.

[82] Measurement capacity may be needed, as well as possibly the cooperation of several parties.

Annex E. Notes on potential case study countries

Figure E-1 Notes on potential case study countries

CLUSTERS	NOTES
1) Africa: South, North, and West	
Upper middle-income: South Africa	**South Africa** has high per capita maize and wheat food (46% of calories) consumption and also cereals for feed use. Hunger is relatively low but poverty incidence moderate. High inequality (GINI) indicates pockets of deep poverty. Very variable production. Small net importer (probably because of wheat as exports maize). Cereal production varies a lot from year to year.
Lower middle-income: Egypt	**Egypt** has high wheat and maize consumption for food (50% of calories) and also cereals for feed use. The hunger index is low, but poverty is moderate. It is a relatively large importer of maize and wheat and holds moderate stocks
2) America: North and Central, and the Caribbean	
Upper middle-income: Mexico Costa Rica Dominican Rep. Panama	**Mexico** has high consumption of maize and wheat (40% of calories) and feeds a large amount of cereals to animals. It has a low hunger index but high poverty. It holds low stocks and cereal production is not very volatile. Inequality is high. **Of the other UMI countries**, maize and wheat provide 11% to 19% of people's calories. Hunger is relatively low but poverty moderate to high (50% in the Dominican Republic) and inequality is high. Feed use of cereals is high. They are all large net importers. Only Panama holds large stocks.
Lower middle-income: Guatemala Honduras El Salvador Nicaragua	**Of the LMI countries** in Central America, Guatemala and Honduras have the highest relative food use of maize and wheat. Hunger is highest in Guatemala and relatively high in Nicaragua. Poverty is high in all four countries. El Salvador has the highest proportion of cereals for feed, followed by Guatemala. Nicaragua uses relatively few cereals for feed, but it does use a large portion of starchy roots for feed. Nicaragua also holds very high stocks. Honduras has moderate stocks and the other two countries have relatively low stocks.
3) South America	
Upper middle-income: Colombia Peru Brazil Ecuador Venezuela	**Of the UMI countries** in South America, Venezuela has the highest maize and wheat share of food (29%). Ecuador has relatively low food of maize and wheat (14%). It also has the lowest feed use of cereals for this cluster (20%). Brazil uses 50% of cereals supplied for feed. Colombia, Peru, and Ecuador are relatively large net importers. They hold moderate levels of stock (except for Venezuela and Ecuador which hold relatively low levels of stock.

Lower middle-income: Paraguay Bolivia	**Paraguay** like Argentina, is a net exporter, but with higher poverty and lower proportion of feed grain use. It holds very high stocks. Wheat and maize supply 34% of calories in **Bolivia**. 30% of cereal supply is used for feed. The country has high poverty, high hunger, and high inequality. It is a moderate net importer of maize and wheat and holds moderate stocks of these cereals.
4) Asia, Central and West *All are lower middle-income countries*	
Central Asia: Turkmenistan Uzbekistan	Indicators across the two **Central Asian** countries are similar, with about 55% of food calories coming from wheat/maize. Turkmenistan does however use a much higher proportion of cereals for feed (57%) compared to Uzbekistan's 27%. Production is more volatile in Turkmenistan. They are both small net importers and stocks are reportedly low.
Western Asia: Armenia Georgia	**Georgia** is a higher food user of wheat and maize, though use in Armenia is still high. Poverty is moderate in both countries, and higher low in Georgia but moderate in **Armenia**. Cereals used for feed is lower in Armenia (17%) compared to Georgia's 21%. They are relatively high net importers with low stocks.

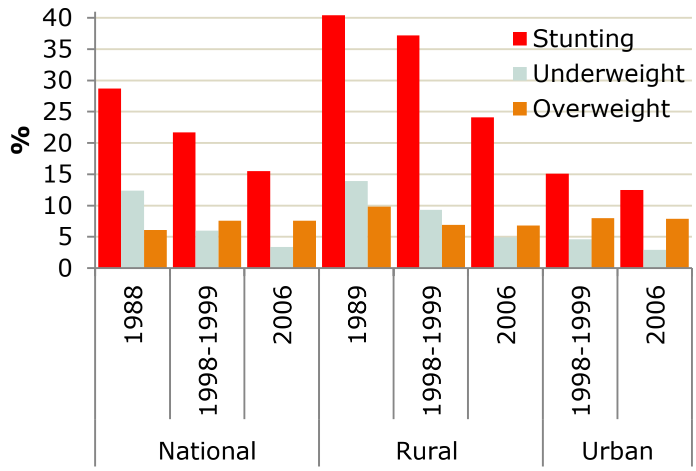
Note: *UMI = Upper Middle-Income. LMI = Lower Middle-Income by World Bank criteria.

Annex F. Additional material from the case studies — Mexico

Figure F-1 Mexico, administrative regions

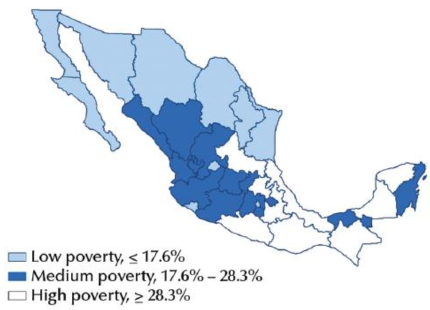
Source: Adapted from Wikimedia commons and Wikitravel.

Figure F-2 Malnutrition of children under five in Mexico, 1988-2006



Source: With data from WHO

Figure F-3 Poverty mapping in Mexico, data from 2000

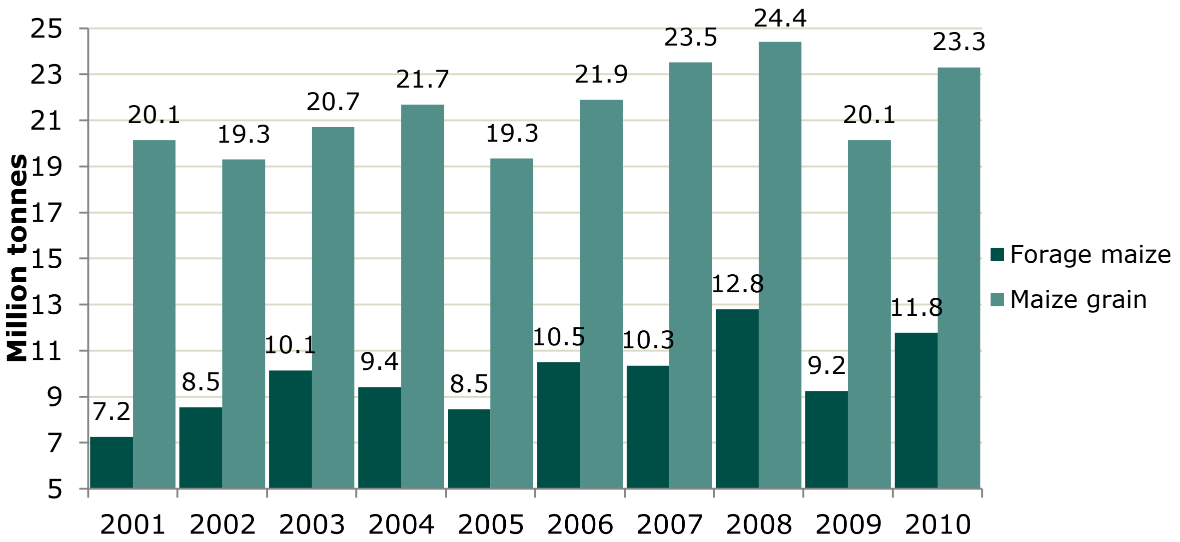


Source: From Lopez-Calva et al., 2005

Figure F-4 Under-five stunting by state, 2006

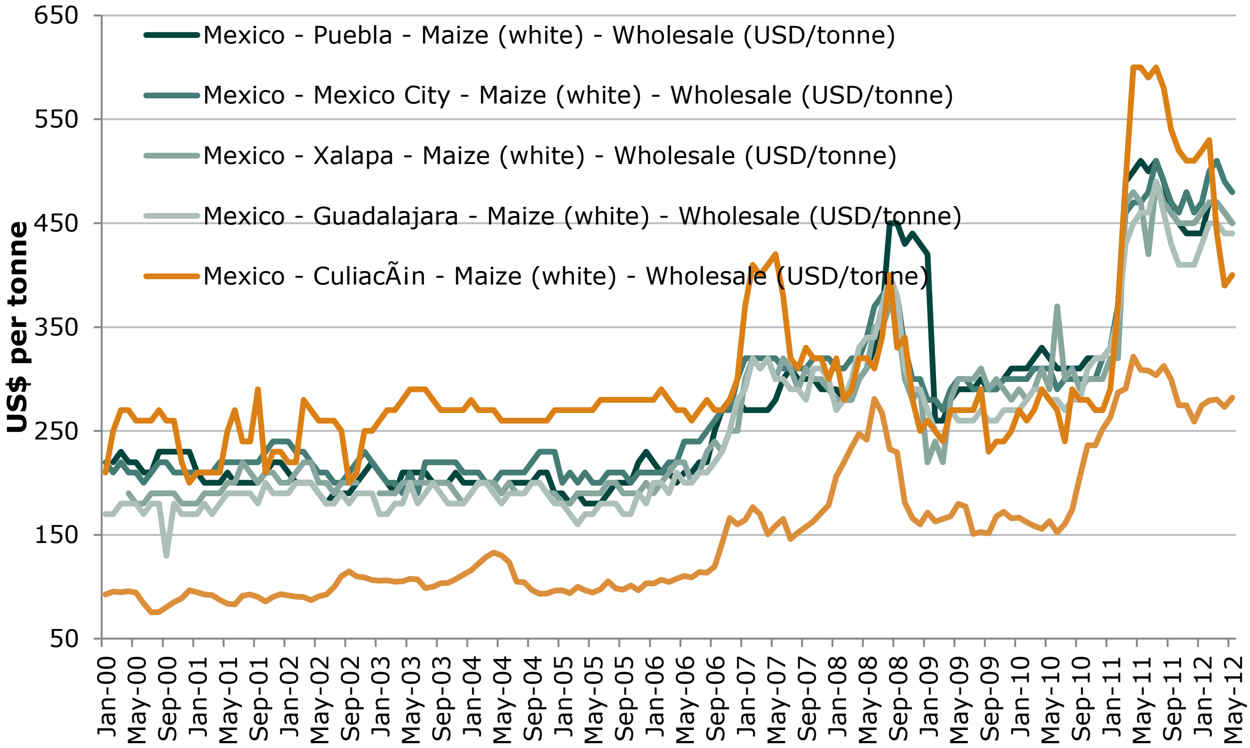
Source: Constructed with data from WHO. Map from Wikimedia Commons

Figure F-5 Whole crop maize and grain maize production in Mexico, 2001-2010



Source: With data from SIAP-SAGARPA. **Note**: Forage Maize = whole crop maize.

Figure F-6 Monthly maize prices in Mexico and the United States, January 2000 - May 2012

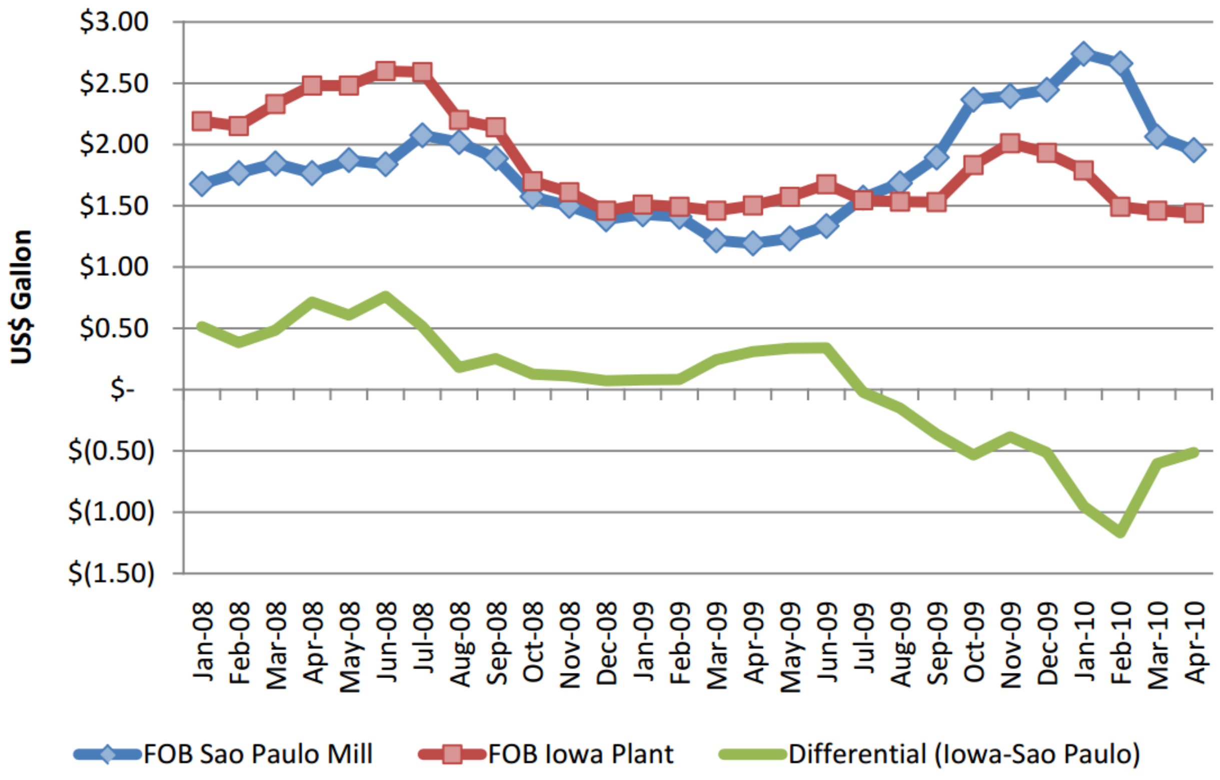


Annex G. United States – Brazil ethanol trade

The US and Brazil are the two largest ethanol producers and exporters in the world, accounting for 85% of global production (Reuters, 2012). The two countries use different feedstocks: Brazilian ethanol is made using sugarcane whereas the US uses maize.

Trade patterns between the two countries have shifted significantly over recent years. The previous one-way trade of cheaper Brazilian ethanol to the US has evolved into a more complicated picture, with both countries supplying each other's market. Prior to 2010, Brazil did not import any ethanol from the US, meeting its own demand through domestic production. However, due to rising sugar demand and prices, which caused producers to switch a larger proportion of sugarcane to sugar, Brazil faced a shortfall in domestic production of ethanol and higher prices of ethanol, and started importing US ethanol in 2010 (USDA, 2011). Figure G-1 below illustrates the increasing price of Brazilian ethanol compared with a falling US price (FOB Iowa Mill) between 2008 and 2010. As US maize-based ethanol became cheaper, this substituted more expensive domestic ethanol.

Figure G-1 Ethanol Prices, FoB Iowa Plant vs. Sao Paulo Mill, 2008-2010



Source: RFA (2010). Iowa prices are from USDA-AMS; Brazilian prices from CEPEA.

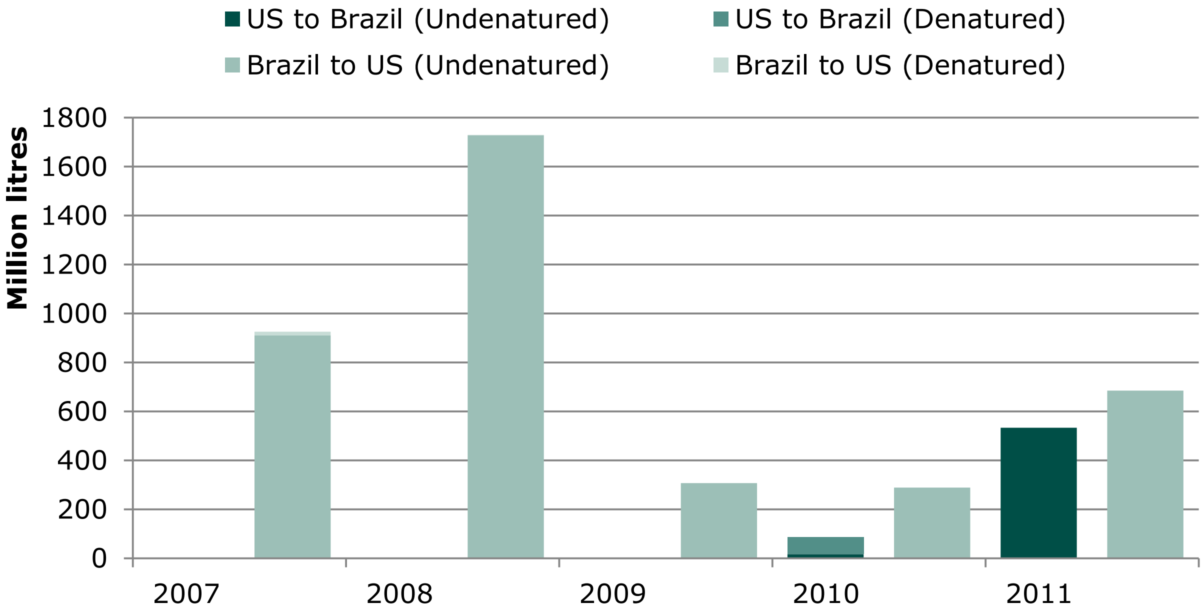
The shifting pattern in trade in ethanol between the two countries is illustrated in Figure G-2 below. In 2007 and 2008, Brazil exported large volumes of ethanol to the US (almost all undenatured). However, as competitiveness of Brazilian ethanol fell in 2009–2010, the US imported less ethanol and started to export ethanol to Brazil, with volumes reaching 533 million litres in 2011.

However, in 2011, Brazilian exports to the US started to rise again, leading to a situation where both countries were exporting a functionally-identical product to each other. This trend has continued, with Brazilian exports to the US reaching the second highest rate of 63,000 barrels per day in August to September 2012.

There are two main reasons for this change.

- Brazilian sugarcane-based ethanol qualifies as 'advanced biofuels' (biofuels achieving a certain level of greenhouse gas reductions) under RFS2 for which there is a specific mandate under US Environmental Protection Agency regulations. To date, it has been the cheapest and one of the only sources of advanced biofuels available.
- A more recent driver is the removal of the tariff previously levied on imports of Brazilian ethanol into the US, which was eliminated at the end of 2011.

Figure G-2 Trade flows in ethanol between the United States and Brazil



Source: UN Comtrade (2012). **Note:** Trade figures are not reported by purpose. Following RFA (2010), it can be assumed that all denatured ethanol is used for fuel, and small amounts of undenatured ethanol may be used for industrial chemical use.

The EPA is due in November 2013 to decide whether to go through with raising the renewable fuels mandate for this category of advanced ethanol to 1.75 billion gallons next year. Some think that Brazil will be able to meet this increased demand; however, others point to the difficulties that Brazil has been having over the past three years, with investment dropping significantly and drought reducing forecast production.

Sources:

USDA, 2011. U.S. on Track to become World's Largest Ethanol Exporter in 2011 [Online] Available at https://www.fas.usda.gov/info/IATR/072011_Ethanol_IATR.asp

EPA, 2011. EPA Finalizes 2012 Renewable Fuel Standards [Online]. Available at http://www.epa.gov/otaq/fuels/renewablefuels/documents/420f11044.pdf

Renewable Fuels Association, 2010. The Paradox Of Rising U.S. Ethanol Exports: Increased Market Opportunities at the Expense of Enhanced National Energy Security? [Online] Available at http://ethanolrfa.3cdn.net/650a769ab9c9a94c36_r9m6iviy6.pdf

Reuters (2012) Brazil Ethanol Returns to US as Biofuel Rules Pave Way, September 20, 2012 [Online] Available at http://www.reuters.com/article/2012/09/20/us-ethanol-brazil-exports-idUSBRE88J14J20120920

Annex H. Additional material from the case studies – South Africa

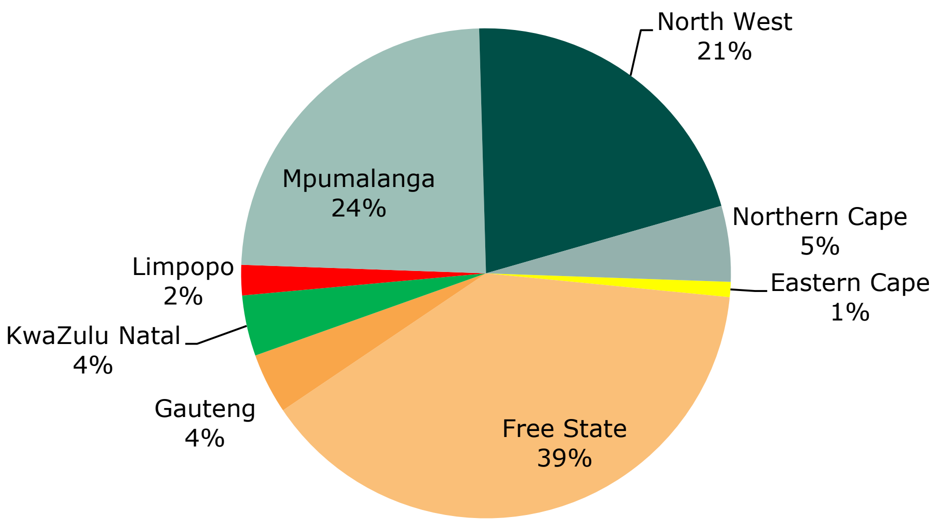
This annex provides additional background information on the South African grains and livestock sectors, which are not perceived to be of direct relevance to grain diversion prospects in South Africa, yet which may be useful for consideration of the options and implications. This includes additional information on maize production and storage and brief overviews of the poultry and feed manufacturing sectors. An indicative calculation of the costs of compensating farmers for reducing maize feed consumption is also included.

Additional information on the maize value chain

Distribution of maize production across South Africa

Maize production is concentrated in the three provinces of Free State, North West and Mpumalanga provinces, which account for approximately 85% of production.

Figure H-1 Distribution of maize production across South Africa, 2008-2009



Source: Sout African Grain Information Service

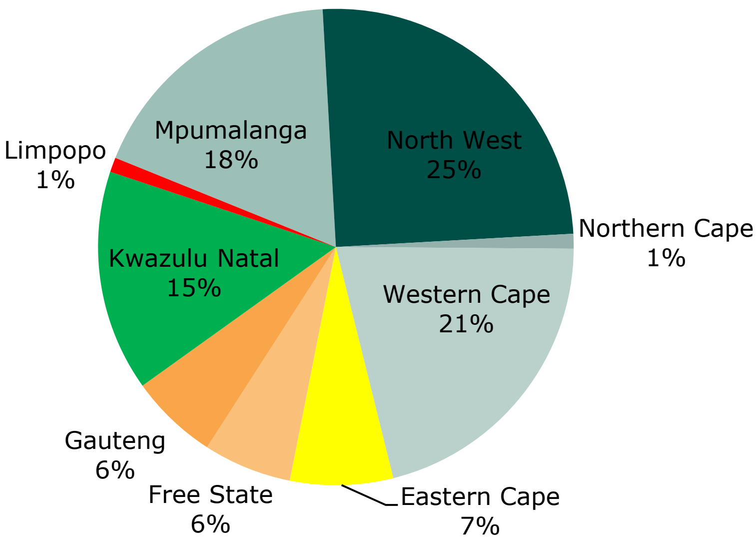
Storage of maize stocks

Private companies own 85% of the total storage capacity for grains, which is currently 16.3 million tonnes spread across 432 silos. Some 60% of these are owned by 17 silo owners, of which the top three, AFGRI, NWK and SENWES Group, own 73% of capacity within the national grain storage market (DoA, 2011).

Overview of the poultry sector

The broiler sector is made up of hatcheries, broiler farmers, contract growers and abattoirs, and the formal broiler sector contributes to 93.6% of total poultry production. North West, Western Cape, Mpumalanga and Kwazulu Natal account for 79% of total production (DoA, 2011).

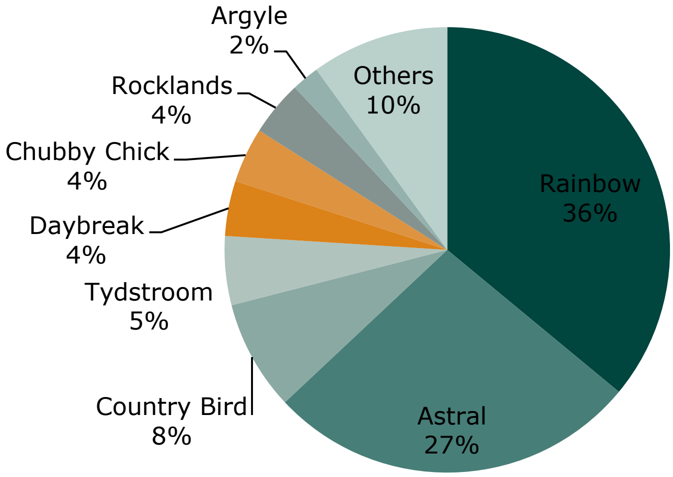
Figure H-2 Distribution of broilers across South Africa, 2009



Source: Data from Louw et al. (2011).

The market is dominated by two companies, Rainbow and Astral, which together account for 63% of national broiler production, producing 4.4 million and 4 million birds per week respectively. A third, Country Bird produces 1.3 million birds per week (Figure). These three companies have integrated production chains, and the chicken production companies (and growers) are contractually bound to buy feed from their own feed manufacturers (NAMC, 2010). While the major companies produce their own day-old-chicks, they also produce more than they require and sell excess chicks to smaller competitors.

Figure H-3 Market shares of large commercial broiler producers, 2005



Source: Department of Agriculture (2010).

Between 80% and 90% of broilers are produced on farms owned by processors, with the remaining 10% raised by contract growers who are responsible for feeding the broilers at a different location, using inputs supplied by the processors (Kleyn, undated). For a grower to be profitable, more than 100,000 chickens must be produced per 54 day cycle (Louw, 2011) and the high required levels of capital intensity and operational capital makes the sector difficult for new entrants.

There is also a high degree of integration between broiler producers and feed manufacturers. The Table below shows the percentage share in the chicken meat production markets that feed manufacturers hold; three feed manufacturers hold 81% of the broiler market.

Table H-1 Percentage market share in poultry industries of major feed manufacturers, 2005

	% Market share		
Feed producer	Broilers	Broiler breeders	Layers
Meadow	24	41	20
Afgri	24	11	19
Epol	33	36	24
Senwes	9	8	3
Alzu	1	-	7
Kanhym	-	-	11
Others	9	4	16
Total	100	100	100

Source: Louw et al. (2011).

Overview of feed manufacturers in South Africa

With the shift in livestock production from extensive to intensive systems, the feed sector has emerged in South Africa as a large industry. AFMA represents 111 members producing 60% of the feed in South Africa. Market concentration in the feed market is high, with five companies sharing over 80% of feed sales in South Africa. As illustrated above, the majority of this goes into broiler production.

Due to the high volume of the inputs, feed manufacturers procure 80% of these on spot markets and use future markets to manage risks. Contracting is done between one and nine months in advance, although most feed manufacturers only contract three months in advance (NAMC, 2010; Kirsten, personal communication.). This is partly because the feed sector is highly sensitive to changes in consumer demand for meat. A fall in the disposable income of consumers affects demand for feed, as livestock farmers cut back production or shift to other sources of feed. For example, during the global financial crisis, sales of feed to the poultry sector fell by 1.3% and sales to the red meat sector by 8.6%. The larger drop in demand from the beef sector suggests beef has a higher elasticity of demand (it is more of a luxury than chicken) and the greater ease with which beef farmers can substitute one type of feed for another.

Indicative calculation of costs of implementation of compensation for a mandated reduction on maize feed consumption

To establish the scale of fiscal expenditure of grain diversion relative to compensation of the poor via cash transfers (the most likely alternative option, other than restricting exports) estimated costs are calculated below, using scenarios for the first price rise in 2007 (see Figure 4.4). Although highly stylised, a comparison is useful to demonstrate what the costs would be if additional grain could be translated into lower prices faced by the poor (i.e. if exports of grain did not occur). It provides a benchmark for comparing policy options and for establishing a preliminary estimate for government outlay. In reality, an option contract or auction system is likely to be lower cost and using the market mechanism would forego the need for detailed cost analysis.

Compensating cash-grant recipients for higher prices

Table H-2 presents rough calculations for the cost of providing additional cash to the social grant recipients through cash transfers in the absence of grain diversion.[83] To compensate for the cost of increased maize prices for the first price rise in 2007 (Figure 4.4) recipients would need to receive 13.3 Rand per person per month to completely compensate their full monthly consumption of 16kg of maize meal. For the total grant receiving population,[84] this would cost around $23.9 million per month.

Table H-2 Comparative costs of compensation via cash transfer versus grain diversion

Relevant figures for maize price compensation for January to June 2007	
• Number of social grant recipients in South Africa = 15 million. • Monthly maize consumption of poorest quintile (urban) = 532g per person/day*30 days=16kg. • Total monthly consumption of maize meal by social grant recipients= 240,000 tonnes. • Increase in daily cost of maize meal portion experienced by poorest quintile (January – June 2007) = 0.43 Rand.	
Cost of additional cash transfer to offset 12-month price increases	
Increase in cost of maize over a month	0.43R *30 days= 13.3R/ month
Total cost of compensation over a month	= 13.3R * 15,000,000 = 200,000,000 Rand =$ 23.9 million

Source: All figures from NAMC 2009, population figures from Stats SA.

Compensating feedlots for reduced consumption

To reduce livestock consumption of maize, a grain diversion scheme would need to compensate feedlots for their foregone margins over the price at which they purchase maize, plus a small percentage (2%) for fixed costs.[85] To calculate indicative sums of compensation needed, levels of feedlot profitability under different scenarios are provided in Table H-3, taken from a modelling study by Maré and colleagues (Maré et al., 2010). These scenarios are for a feedlot of 493 cattle, based upon a situation of low maize prices (beginning of 2010) but can be used for illustrative purposes for previous years. For the baseline scenario when the beef price is R26/kg and maize price is R1,100 per tonne, the profit margin for the feedlot is R210,107. The authors report that for under this scenario, the margin over the maize price achieved by the feedlot is R484 per tonne of maize (Table H-4).[86]

Table H-3 Margin after interest with different maize and carcass prices for a feedlot of 493 cattle

	Price of beef for A2/3 quality (R/kg)				
Maize price (R/tonne)	24.00	25.00	26.00	27.00	28.00
900	81,566	189,906	298,256	406,606	514,956

[83] If grain diversion were used in addition to cash transfers and were successful in dampening price spikes, it could stabilise government spending on cash transfers.

[84] This assumes full compensation for increased costs of maize meal, for all 15 million recipients. This is an unlikely scenario but useful for indicating comparative costs.

[85] These cover labour fuel and maintenance (Maré et al., 2010).

[86] See Annex A in Maré et al. (2010) for the calculation of this.

1,100	-6,594	101,756	210,107	318,456	426,806
1,300	-94,744	13,606	121,957	230,306	338,656
1,500	-182,894	-74,544	33,807	142,156	250,506
1,700	-271,044	-162,694	-54,343	54,006	162,356
1,900	-359,194	-250,844	-142,493	-34,144	74,206

Table H-4 Feedlot margin over maize price under baseline scenario

Price of maize	R/tonne	1,100
Gross margin over maize	R/tonne	484
Value of maize marketed through beef production	R/tonne	1,584

Source: Maré et al. (2010).

For the first price rise of 2007, when maize prices rose from R1,600 to R1,900, beef prices would have had to been above R27/kg (i.e. the best case scenario reported in the last column of Table) for the feedlot to be profitable. Below this price, the feedlot operates at a loss. Assuming that the margin over maize reported in is directly proportional to feedlot profitability (i.e. a 10% reduction in feedlot profitability results in a 10% fall in the margin over maize), margins at this beef price would be R373/tonne ($44) at most, falling to R169/tonne ($20) if the maize price reached R1,900 (

Table).[87]

Table H-5 Costs of compensating feedlots for margins over maize

	Beef price (Rand/ kg)	Maize price (Rand/ tonne)	Feedlot profit (Rand)	Percentage of reference profitability (%)	Feedlot margin over maize (R/ tonne maize)
Reference	26	1,100	210,107	100	484
Best case scenario, Jan. 2007	28	1,700	162,356	77	373
Best case scenario, April 2007	28	1,900	74,206	35	169
Note: The change in the feedlot margin-over-maize is calculated by multiplying the reference margin-over-maize reported in Maré et al. (2010) by the percentage reduction in profitability. The cost to compensate for 40% of maize used by feedlots over 1 month = 33,000 tonnes*373R= R12.3 million.					

Source: Figures adapted from Maré et al. (2010).

To reduce the price of maize meal by 50%, roughly 10% more maize is needed on the food market.[88] In South Africa, this would require additional 33,000 tonnes of maize per month. The cost of compensating feedlots for this volume, using expected margins state above, would therefore be up to R12.3 million, or $1.5 million per month, less than the estimated costs of additional cash transfers.

[87] These are likely to be considerably lower with lower beef prices. For instance, the margin over the cost of maize if the maize price rose by R400 from the base scenario (and the beef price stayed at R26/kg) would be R77/tonne or $9). As feedlots become unprofitable if maize prices go above this, compensation would no longer be necessary stop feedlots from consuming maize.
[88] Assuming consumers' own price elasticity demand for maize is highly inelastic at 0.2.