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evaluating whether storing food creates resilient food systems**

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Food Stocks and Grain Reserves: Evaluating whether Storing Food Creates Resilient Food Systems

Abstract

Many are worried that the global food system is entering a period of intense volatility driven by a combination of climate change and population growth. One way to address this problem is for governments and the international community to store more food as a buffer against crisis. The purpose of this paper is to explore the role of food storage as a component of a robust food security strategy in the 21st century. We do this by first drawing on historical evidence and examples from ancient Rome and China, where pre-industrial government designed extensive systems that ensured adequate food storage to keep food systems stable. Next, we review the links between food storage and price volatility in the last 20 years and demonstrate that the size of food stores (and in particular grain reserves) directly relates to price volatility. Third, we explore three different types of policies designed to promote grain reserves, the U.S.'s 'ever-normal granary' policy, the EU's Common Agricultural Policy, and Strategic Grain Reserve in Africa. In this third section, we show how there has been a decline from state-owned strategic grain reserves in favor of a more market-oriented approach that is dominated by a handful of powerful corporations who maintain sophisticated supply chains. Because data on the amount of food supply these corporations hold in storage are proprietary secrets, it is impossible to assess how resilient or vulnerable this makes our food system. Finally, we conclude that over time food storage has fallen in and out of favor, criticized for being expensive yet often shown to play an important role in protecting poor consumers in times of food crisis. Given the lack of data on current levels of supply chain and household storage, more research is needed to evaluate the scale at which food storage systems should be implemented to ensure food system resilience as well as mechanisms to govern and manage them.

Keywords

Food security; food reserves; strategic grain reserves; food price volatility; economic shocks; food storage

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4 *“Civilization is only nine meals away from anarchy”* Lord Cameron of Dillington, head of the UK’s
5 Countryside Agency speaking in 2007
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8 9 **Introduction: the need for increased food stores?**

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12 Thanks to rising and volatile food prices, many worry that the global food system is ripe for disruption
13 (Foley et al. 2011; Fraser and Rimas 2010). According to this argument, the industrial monocultures that
14 sustain us are so specialized that they are vulnerable to pest outbreaks and changes in weather.
15 Decades of intensive production have drained the soil of organic matter, leaving us vulnerable to
16 drought and erosion. And recent policies, which have encouraged using corn for ethanol and have
17 allowed large financial institutions to develop speculative investment instruments based on commodity
18 prices, have further destabilized an already precarious food system.
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21 Some commentators worry that even the developed or industrialized world’s food systems are not
22 resilient enough. This issue was raised by Lord Cameron of Dillington, then head of the UK’s Countryside
23 Agency, who noted in 2007 that civilization is only nine meals – three days – “away from anarchy”
24 (Boycott 2008; Roberts 2013) . While Lord Cameron’s quote is not based on any analysis of the amount
25 of food that people and grocery stores actually store (as will be discussed below, there is almost no data
26 available on this topic through which to test Lord Cameron’s claim), this comment highlights
27 contemporary Western society’s complacency about always having access to food. Lord Cameron
28 pointed out that if food supplies are disrupted - via a problem in the logistics systems or a natural
29 disaster - stocks could quickly run out. Civility could quickly breakdown, with some pointing to the
30 aftermath of Hurricane Katrina in New Orleans as a vivid example of how people react in order to feed
31 themselves (Boycott 2008). Many scholars, therefore, have looked at the very volatile food prices since
32 2008 as a harbinger of things to come: rising commodity prices, deepening food insecurity, and political
33 unrest tied to food prices (Clapp 2014a).
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37 One strategy to reduce this vulnerability is to store food as a buffer against crisis. This is based on the
38 logic that food reserves will help keep prices stable and thus allow people to access food even during
39 periodic production / distribution crises. While this tool is receiving new attention amongst
40 governments globally and at the UN, especially after the 2007 – 2008 food crisis, storing food is not a
41 new idea (Action for a World Community for Food Reserves 2013; Bruins and Bu 2006; Zoellick 2011).
42 Storing food to protect people’s food access against the vagaries of a capricious environment and
43 uncertain politics is as old as civilization. But as will be discussed below, between the 1990s and the
44 2010s most countries, and the international system as a whole, stopped using strategic grain reserves
45 relying instead on less regulated private companies’ commodity chains to ensure that food reaches
46 consumers.
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49 The purpose of this paper is to explore how food storage can be a strategic tool to build food system
50 resilience. In this way, we build on an extensive literature dealing with the resilience of social ecological
51 systems (for a thorough review of these bodies of work please see Adger (2006) and Fraser and Stringer
52 (2009)) and define resilience in food systems as the ability to withstand shocks or stresses that can lead
53 to disruption of people’s access to food. In doing this, we attempt to provide answers to four key
54 questions: 1) Are grain reserves significant in determining food price? 2) How long will the current global
55 reserves of grain last in the event of a global crops failure? 3) Is it the amount of reserves or their
56 ownership that lead to resilience? 4) What policies can promote effective food reserves?
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To answer these questions, this paper proceeds in the following way. First, we start by establishing a broad historic context to food storage and demonstrate how policies designed to store food helped keep food systems stable in pre-industrial times. The second section of this paper reviews data that unpack links between food storage (and in particular grain reserves) and price volatility since 1990. This section also presents an analysis on how long current stocks could last if there were disruptions to food distribution systems today. In the third section, we explore the sorts of policies that governments can use to maintain and regulate food storage by reviewing three different types of grain reserve policies that were used in the 20th century. This section demonstrates that there has been a shift in the last 30 years away from public ownership of grain stocks to relying on private corporations and market forces to distribute food. Finally, we conclude that, from a global perspective, it is important to explore ways of promoting more publicly accessible food storage in the future as a way of increasing the resiliency of today's food systems.

Background: Historic Perspective on Food Storage and Food System Resilience

Throughout the history of early civilizations, food storage was a pressing concern for political leaders. Theories of how urban civilizations emerged in the first place typically focus on at least three key agricultural factors (Fraser and Rimas 2010; Pullen 1992; Stanislawski 1973). First, before urban life can takeoff farmers must be able to produce more food than they need for themselves or their immediate families and communities. Second, there must be a mechanism by which food is transferred from producers to consumers (for example, this could happen in some sort of marketplace or through more direct means in authoritarian governments). Finally, food must be preserved and stored in such a way that it can last the journey from farmer to city. Without these three factors, urban society, by which we mean high concentrations of people whose livelihoods do not come from primary production, is unlikely to take root.

Unsurprisingly, some of our best archaeological evidence for the importance of food reserves as a component of a stable and well-functioning food system comes from the Mediterranean as well as from China. For instance, the Minoan civilization from Crete was supported by a vibrant food trading empire where commodities such as olive oil and wine were stored in great volume and traded by seagoing vessels (See Harmon (2009) for an example from the Black sea)

It is in ancient Rome, however, that we truly see the link between food storage and Empire. Rome, being a landlocked city of approximately 1,000,000 people, was dependent on a vast hinterland for nutrition. It has even been argued that one of the motivations for the expansion of the Roman empire was to secure an ever-growing supply of fertile land that supplied the calories for the Roman appetites when local soils became degraded and unproductive (Fraser and Rimas 2010; Steel 2013). This resulted in a situation where the city of Rome was dependent on an area that stretched the length of the Mediterranean and ran from northern Europe through to northern Africa (Rickman 1980).

Grain grown in the Nile River was particularly vital for Romans' continued well-being (Evans 1981). The Roman government used a combination of engineering and bureaucracy to bring this food to the capital by inventing a standardized model of a grain warehouse, called an *horreum*, that was built in all major Roman settlements. The largest examples had scores of rooms built around a central courtyard and held enough grain to feed about 15,000 people. For instance, one example contained 225,000 ft.² of storage space, which was almost 10 times larger than the Colosseum (Rickman 1971).

We also have extensive evidence that throughout China's long history political rulers treated grain storage with the utmost of seriousness. For instance, in the 13th century the Mongol ruler Qubilai Khan built a comprehensive grain transportation and storage infrastructure to support his capital city. This city became, in the words of one historian, “the nerve center of military, political and economic enterprises unprecedented in magnitude, and with the swelling of its population grew the demand for food...” (Lo 1954 p 264). This urbanized population was particularly vulnerable to famine and deprivations caused by bad weather. The solution was to maintain an “ever-normal granary”, where the government bought grain if prices dipped below pre-determined levels (thus helping farmers) and sold it at pre-determined price ceilings (thus helping consumers). The government also repaired and extended the earlier system of canals, rivers and warehouses that had served previous dynasties. Ultimately, this resulted in the creation of the Grand Canal an engineering accomplishment that played a vital role in China's food security for centuries to come.

Further evidence for extensive state-sponsored grain storage in China comes from even earlier examples. According to Garret (2012) the Chinese *Book of Rites*, which dates from between the eighth to the fifth century BC, explicitly describes the importance of grain storage for state stability:

A country without food grain stocks for nine years requirement has insufficient reserves; with less than six years reserve the situation becomes tense; and with less than three years of stocks, the government will not survive.

This account echoes the story from the Hebrew Old Testament of the Pharaoh's dream that acts as a parable for the importance of food storage as a component of a secure food system:

Pharaoh said to Joseph, “In my dream I was standing on the bank of the Nile, when out of the river there came up seven cows, fat and sleek, and they grazed among the reeds. After them, seven other cows came up—scrawny and very ugly and lean. The lean, ugly cows ate up the seven fat cows that came up first....

Then Joseph said to Pharaoh, “Seven years of great abundance are coming throughout the land of Egypt, but seven years of famine will follow them... Let Pharaoh appoint commissioners ... to take a fifth of the harvest of Egypt during the seven years of abundance. ...This food should be held in reserve ..., to be used during the seven years of famine ... so that the country may not be ruined by the famine.”

Data and Results: Food Reserves and Food Prices Today

While the previous section demonstrates the importance of food reserves from an historic perspective, these issues are arguably as relevant today as in the past. To demonstrate this point, in this section of the paper we present data on the state of food storage and food reserves in the 21st century. We note, however, that most of the data available focuses on grain reserves and does not address food stores that may be held by companies or individuals. We begin with an assessment of global data before we turn to consider the situation in the U.S.

Global data

In terms of data, the Food and Agricultural Organization (FAO) of the United Nations publishes a yearly account of food production and utilization collected at the country level. This is the primary data set

available for analyzing food reserves and is based on work done by the FAO that tracks year-end stocks, which they calculated by adding each country's total annual production to their previous year-end stocks and subtracting yearly utilization and waste. These data represent a best guess at estimating food reserves for each country and these reserves are also referred to as "carryover stocks" or simply "stocks". The FAO data are useful in that they provide an annual assessment of global food supplies but are limited in that they do not provide an assessment of who owns these stocks nor how they are managed. Hence, any analysis of these data provides only a crude assessment of the current food reserve situation. Given these important caveats, these data suggest the following key results:

1. Global reserves, or carry-over stocks, for cereals have generally ranged between 400 and 600 million tonnes annually, which is between 18% and 23% of total annual food use.

FAO data suggests that for major cereal crops, carry-over stocks have ranged considerably since the 1960s. First, stocks rose over the 1970s, perhaps in response to the food and oil price shocks of the early 1970s, before plateauing in the 1980s. In terms of more recent trends, we note that stocks varied between 413 million tonnes (in 2007-8) and 565 million tonnes (which is the 2014-2015 forecast). When stocks are expressed as a percentage of the amount of grain we use, the largest global stock was in 2013-14 when the world had a cereal reserve that equaled 23.3% of its utilization. The lowest level since the early 1990s was 18.4% in 2007-8. See figure 1.

2. Food prices seem to be related to the size of these food reserves. This is particularly true for the period of time between 1990 and 2008 when it is clear that low reserves are linked with higher prices. Data since 2008, however, hints that this relation may be changing given that since 2008 food reserves have not been significant in determining price.

To explore this result in more detail, we begin with figure 2 that shows annual global grain reserves superimposed on the UN's food price index, which is a weighted average of the price of different commodity groups and, therefore, represents an aggregate snapshot of global food prices. In figure 2 we observe a small price rise between 1993 and 1995 that accompanied grain deficits in those years, and we note that between 2001 and 2009, all but one year was a grain deficit, and that this preceded the price shock of 2008. Together, these data suggest that low grain reserves may have been a factor in driving up prices in 2008 and leads to the hypothesis that grain reserves help reduce price rises. It is extremely important to note, however, that the data on grain reserves collected by the United Nations is incomplete. This data does not include household-level food storage, nor the food held in grocery retail warehouses etc. In many ways, these more local-level reserves are likely as important in terms of food system resilience as global grain reserves. However, there is no data on these locally accessible reserves and this represents a major gap in the literature.

3. There is significant variability in terms of our food reserves; both year-to-year as well as region-to-region data suggest reserves may fluctuate significantly.

To explore the hypothesis that grain reserves are significant in determining food price more fully, figure 3 shows the rolling five-year average for both grain reserves and the food price index between 1991-1995 and 2009-2014. This graph makes it clear that between 1991 and 2005 there was an inverse relation between grain reserves and price and we note that in the years that we ran consecutive grain deficits, we also experienced food price rises. These data seem to confirm the conclusion reached by Wright and Cafiero (2010) that low global reserves contributed to the 2008 run up in prices. Further evidence to this point is the fact that current (2015) prices have not gone up and are not expected to

rise very soon despite predictions of production deficit in Southeast Asia due to El-Niño (USDA 2014b). An analysis of FAO data on rice stocks in major rice exporting countries in Asia shows that these countries now hold huge rice stocks, which they have accumulated recently, particularly in 2005,06,07,08 and 2011 (See table 1). FAO data also shows that global rice stocks have continued to increase. Thus, the relative market stability especially in terms of rice price could be related to the high global and regional (Southeast Asia) stocks. However, figure 3 also suggests that the relationship between reserves and price may be changing and the inverse relation between prices and reserves from 1990 – 2005 does not seem to hold between 2005-2008. To explore this issue in more detail we used a regression analysis where food price was used as the dependent variable and grain stocks was the explanatory variable. Results of this analysis, which are displayed in table 2, show that overall grain stocks are significant predictor of price and that stocks and prices are inversely correlated between 1991 and 2005. However, since 2005 food stocks are not significant in explaining price. We will explore possible reasons for this in the discussion.

4. Data hint that the variability of country-level reserves may be increasing and growing more extreme. This may have implications for the overall resilience of our food system.

In terms of the variability of food reserves, the FAO data show that food reserves are extremely variable both from region to region as well as from year to year. Annual variation in global carryover stocks is shown in the bars of figure 2, with years where our reserve grew illustrated by bars that fall above the zero line. By contrast, bars that fall below the zero line illustrate deficit years. We note that since 2000 there have been six years with significant food deficits, three years with significant food surpluses, and five years where consumption and utilization were matched. This suggests that while the global food system is quite matched in terms of production and consumption, reserves are quite variable. When only the last 15 years are considered it seems that the majority of our current reserve is based on a small number of particularly good years.

On a related note, there is a tremendous amount of volatility at the regional level in terms of grain reserves. For example, figure 4 shows that although there were global grain deficits in 2002 and 2003 there were surpluses in Africa and South America in those years. The reverse was true in 2008. Within regions, there is also significant variability: although Africa as a whole ran a grain surplus in 2008, Eastern Africa was in a deficit situation that year. This variability is illustrated spatially in figure 5 where we note, for instance, that the United States and Canada both had significant surpluses in 2005. In 2006, however, both countries were in deficit. In 2007, the U.S. returned to surplus but Canada remained in a deficit.

There is also some evidence to suggest that grain reserves are becoming more volatile. In particular, table 3 shows the mean, standard deviation, and coefficient of variance for grain reserves in four-year intervals between 2003 and 2014. In particular, we note that between 2003 and 2014 the coefficient of variance for cereal reserves has risen significantly. This provides a preliminary suggestion that the world's food system may be becoming more volatile. Much like the first point, above, this is an issue that will be explored more fully in the discussion.

5. Current National Grain Reserves contain about 3 months worth of food.

Based on the current FAO cereal data, 2462 million tonnes of cereal were utilized in 2014 and the ending stock will be 604 million tonnes. This means if there were no further production of cereal, current reserves could be able to meet our needs for approximately 3 months. With respect to wheat, the

situation seems to be same. In the case of coarse grains, the situation is much worse; the current reserves of coarse grain would only serve for about two months. The situation for rice is better and current stocks would last for about 5 months.

U.S. Data

To explore these trends from the perspective of the U.S.A., we used data that comes from the USDA, which conducts both on- and off-farm surveys. The on-farm survey includes a sample of over 84,000 farm operators while the off-farm survey includes about 8,800 facilities with a total of 10.4 billion bushels of storage capacity (approximately 264 million tonnes of corn) (USDA 2014c). These data suggest the following key results:

1. Corn and soybean stores have grown by about 50% while wheat stores have been very erratic.

Figure 6 shows storage of corn, wheat and soya (USDA 2014c). Data were indexed to the average stocks between 1942 and 2010 allowing us to observe that stores of major grains have increased over recent years. In particular, corn and soybean stores have grown by about 50% since the early 1990s. Meanwhile, stores of wheat have been more variable since the mid-80s but lower in the mid 2000s. This confirms the analysis by Wright and Cafiero (Wright and Cafiero 2010) that the low level of cereal stocks in 2007-8 were significant contributors to the 2008 price spike.

Some of these increases may be due to governmental policy. In particular, the USDA has run a program called “The Farm Storage Facility Loan Program” since 2000. This initiative provides low-interest financing so producers can build or upgrade facilities to store commodities including grains, oilseeds, peanuts, pulse crops, hay, honey, renewable biomass commodities, fruits and vegetables (USDA 2014a). This program has been linked to their new *Know Your Farmer, Know Your Food (KYF2)* initiative aimed at strengthening local and regional food systems. There is also a growing recognition of the importance of food storage at state and county level. For example in Alaska, the state government plans to build two storage facilities that will contain rations to feed 40,000 people for seven days while also meeting the nutrition, health and cultural requirements of the state’s unique demographics (Bohrer 2013; Slavo 2012). In Hawaii, the department of agriculture has identified the need for adequate storage facilities to provide sellers and buyers one- or two-day supply margin. Similarly, New York’s capital district community has identified the creation of a variety of warehousing and storage options including commercial storage facilities and food hubs as a priority goal in building a resilient food system (Center For Economic Growth 2012).

2. Data is hard to obtain as most food stores belong to private companies.

While the policies just cited seem to demonstrate that the government is encouraging more grain reserves, most of the food stored in the US is privately owned by farmers, food processors, retailers, and (to some extent) consumers. Some, therefore, have argued that focusing on global grain reserves as an indicator of the amount of food stored in our food system is misplaced since most of the food we depend on is owned by a small number of extremely profitable corporations. Some experts propose that instead of focusing on grain reserves, it would be more appropriate to focus on the entire food system, including an assessment of the stocks and flows of food from farms through to processing facilities, warehouses and distribution centers (e.g. see: Hemenway 2014). While this may be true, we run into an almost complete lack of data on which to conduct such an analysis.

This change from public to private food storage is reflective of broader changes in the food industry more generally. Recent decades have witnessed a rapid process of concentration in the food supply chain that has led to the situation where consumers now depend on a very small number of corporations to supply their food year-round. Connor (2008) and Lang (2003) clearly illustrate the dramatic increase in food industry consolidation as mergers and acquisitions have led to fewer larger food processors and retailers since the early 1980s in all of the OECD where data is available. The former UN special Rapporteur on the Right to Food also cautioned about the increased concentration in globalized food chains where, for example, two companies (Nestle and Parmalat) controlled 53% of the Brazilian processing market in 1996, four retailers in the UK control 75% of the grocery market, and Walmart alone holds 6.1% of global retail sales (De Schutter 2010).

What this means for this analysis is that the information on food stores is mostly held by large food processing companies such as Cargill or Archer Daniels Midland, distributors such as Sysco or Gordon Food Service, as well as retailers such as Walmart. Consequently, the data needed to assess global food stores are proprietary secrets as these companies have an interest in using commodity markets to generate profit. Even more important than the stocks that they keep is the fact that the “just-in-time” business model has become the norm for companies along the food supply chain (Lee et al. 2012a). Companies such as Sysco and Walmart believe that this supply chain model, which is equipped with huge distribution networks that can draw inventory from multiple warehouses while taking advantage of real-time data on stocks, can keep shelves filled in the event of any disaster in the U.S. (Wohlsen 2012). But Mahantha contradicts this, and argues that such a system is extremely fragile and points to the UK truckers’ strike in 2000 and the aftermath of Hurricane Katrina in 2005 to illustrate how quickly problem may emerge when distribution systems are disrupted (Mahanta 2013).

3. The possible role of grassroots level food storage at household and community scales.

Given the almost complete lack of information on privately held food stores, and the huge role that private corporations play in the U.S. food system, it is perhaps unsurprising that what limited commentary is out there is often found in the grassroots. The Mormons represent one cultural group who has long advocated for food storage amongst the bundle of “needful things” that should be prepared and stored to be used in cases of adversity (The Church of Jesus Christ Of Latter-Day Saints 2014). Their website provides guidance on how to put together a three-month supply as well as a longer-term supply with food items which could last up to 30 years. There is also a large sub-culture of “survivalists”, people who are attempting to protect their families from the potential “collapse of Western Civilization” by maintaining large household food stores, water purification systems and solar power generators. This group exploded in popularity 15 years ago when there were numerous articles written about how to survive the Y2K debacle. Since then, interest in this topic has lessened but there are still some people who are motivated by the very real fear that our modern food system is vulnerable to disruption and that families must become self-sufficient.

In many ways, this is an extreme perspective and it is easy to dismiss such people as belonging to a radical fringe. In the absence of any real data on the U.S. food reserves, however, it is impossible to verify whether this is the case, and the questions posed by this group are essentially the same as the ones that motivated this paper. For instance, one survivalist blogger recently wrote on the blog “whatifits today”:

How much food do I really need to store? I suppose I need to ask the larger question. How much food will Boy and Girl raid from the cabinet during the middle of the night? OK, not really the larger question... How long do I think no food will be available or that I won't have time or opportunity to grow my own food? What's the worst case scenario compared to the best? What type of diet should I expect to keep in either of these scenarios? Do I want to store food for the future (disaster times)? ... Money does come into effect here with some of my decisions. Oh, and getting my food storage attacked by moths makes me rethink things too – how did they get into sealed containers that were frozen for weeks prior to packing?

See March 10th, 2014 entry for www.whatifitstoday.blogspot.ca

This blog, and many like it, explores at a household level the same fears that Lord Cameron expressed in the quote at the opening of this paper. Is our modern food system, with unclear reserves and stores, vulnerable to disruption? Given the seeming efficiency and abundance of the modern system, many people have stopped (or simply forgotten) how and why they need to store food (Post Peak Living 2009; Rawstorne 2011). Whether such commentators are fueling paranoia or raising legitimate concerns, we simply do not know, as there is a dearth of data and serious analysis through which to interrogate such fears.

4. Worries about declining “food literacy”.

Concerns around the decline in food storage could also be related to the broader issues of declining food knowledge and skills, from gardening to food preparation in western societies. In terms of household food production skills, in Guelph, Ontario, which fairly representative of mid-sized north American cities, CoDyre et al. (2015) note that the average vegetable gardener is not able to achieve high yields despite high inputs of labour and capital in part because of lack of knowledge around gardening. The study concludes that those who are not skilled cannot hope to grow a substantial portion of their own food without improving their skills in the garden (CoDyre et al. 2015). The decline in food knowledge and skills amongst Canadian students has also been linked to the decreasing interest and enrollment in Home Economics Food and Nutrition education in grade school (Slater 2013). In the U.S.A., declining food literacy is largely linked to the significant drop in home food preparation since around 1965 and there has been growing call for people to be reconnected with their food especially in relation to high levels of obesity (Jackson 2015; Smith et al. 2013). Caraher and Lang (1999) as well as Jaffe and Gertler (2006) note that contemporary technological developments have largely reduced the minimum cooking skills needed to those of simply re-heating and assembling food. Indeed now more than ever we seem to be living in a society where we do not need food knowledge and skills in order to survive.

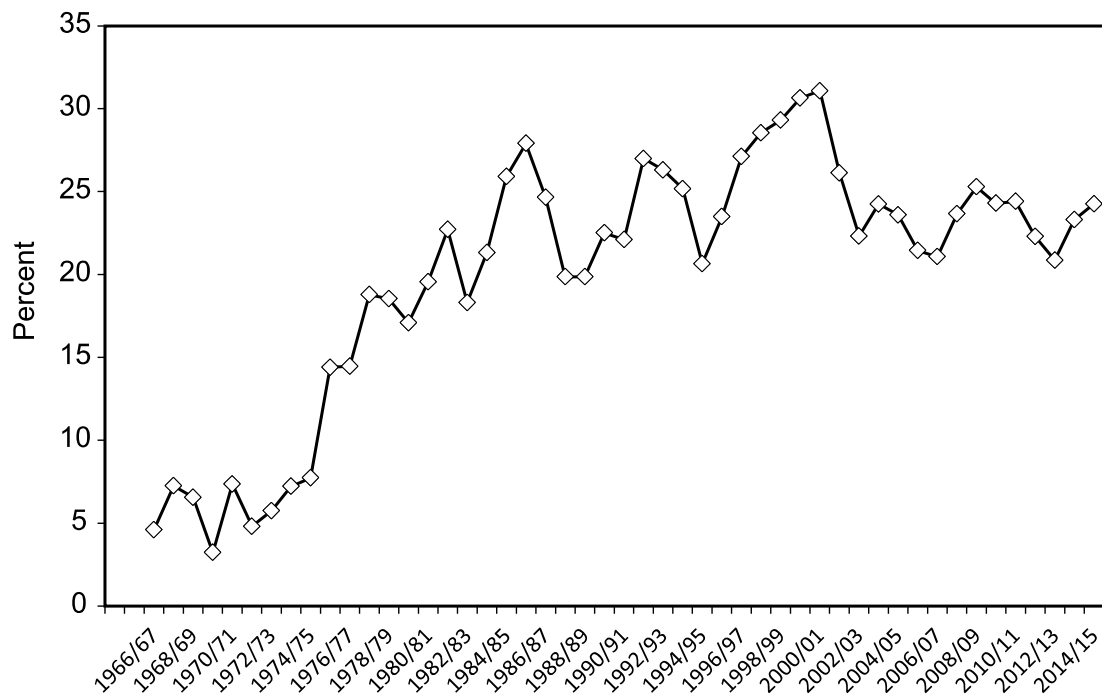


Figure 1. Global year-end cereal stocks expressed as a percentage (%) of total global cereal utilization (Source: FAO, 2014)

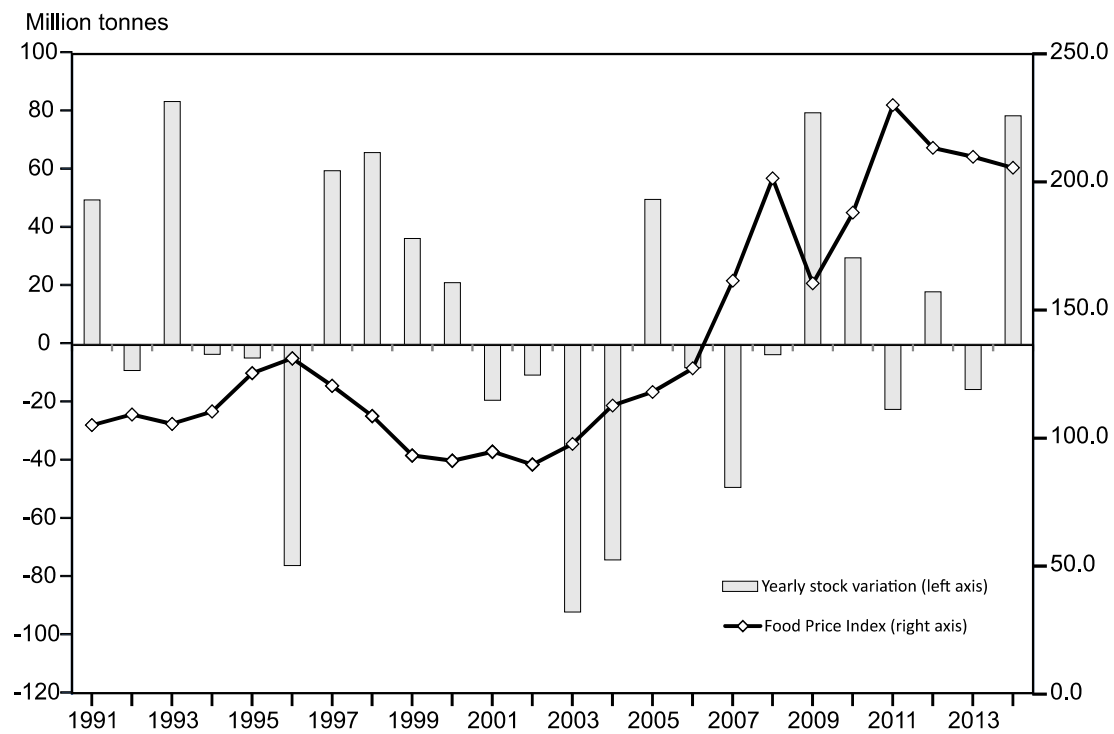


Figure 2: Global cereal stock variation (left axis) and food price index (right axis) (Source: FAO, 2014)

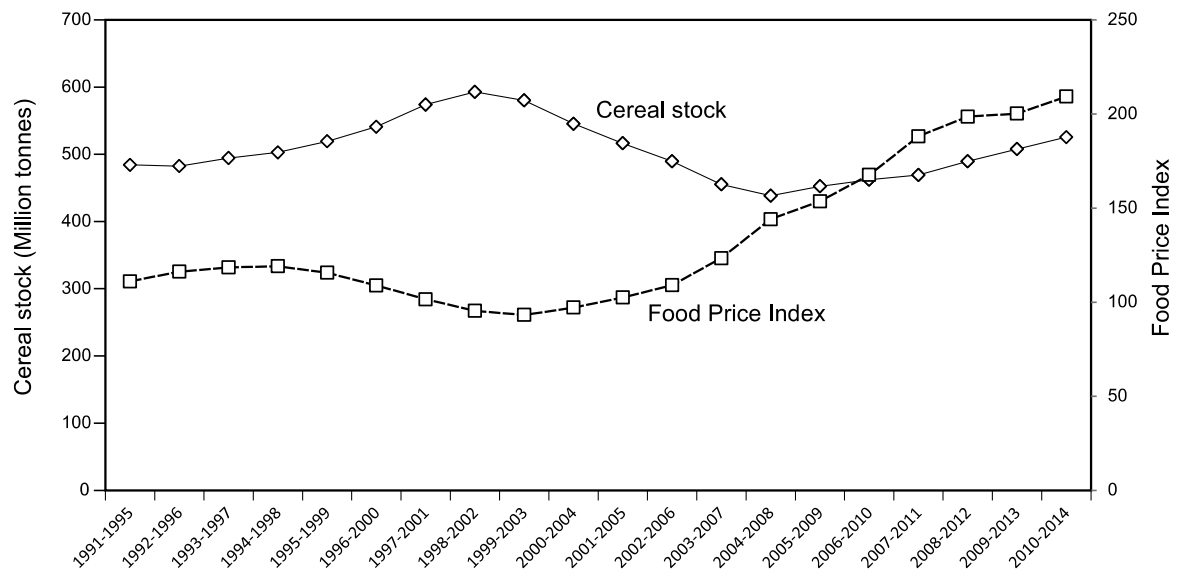


Figure 3: Global cereal stocks (left axis) and food price index (right axis) using a rolling five-year averages (Source: FAO, 2014)

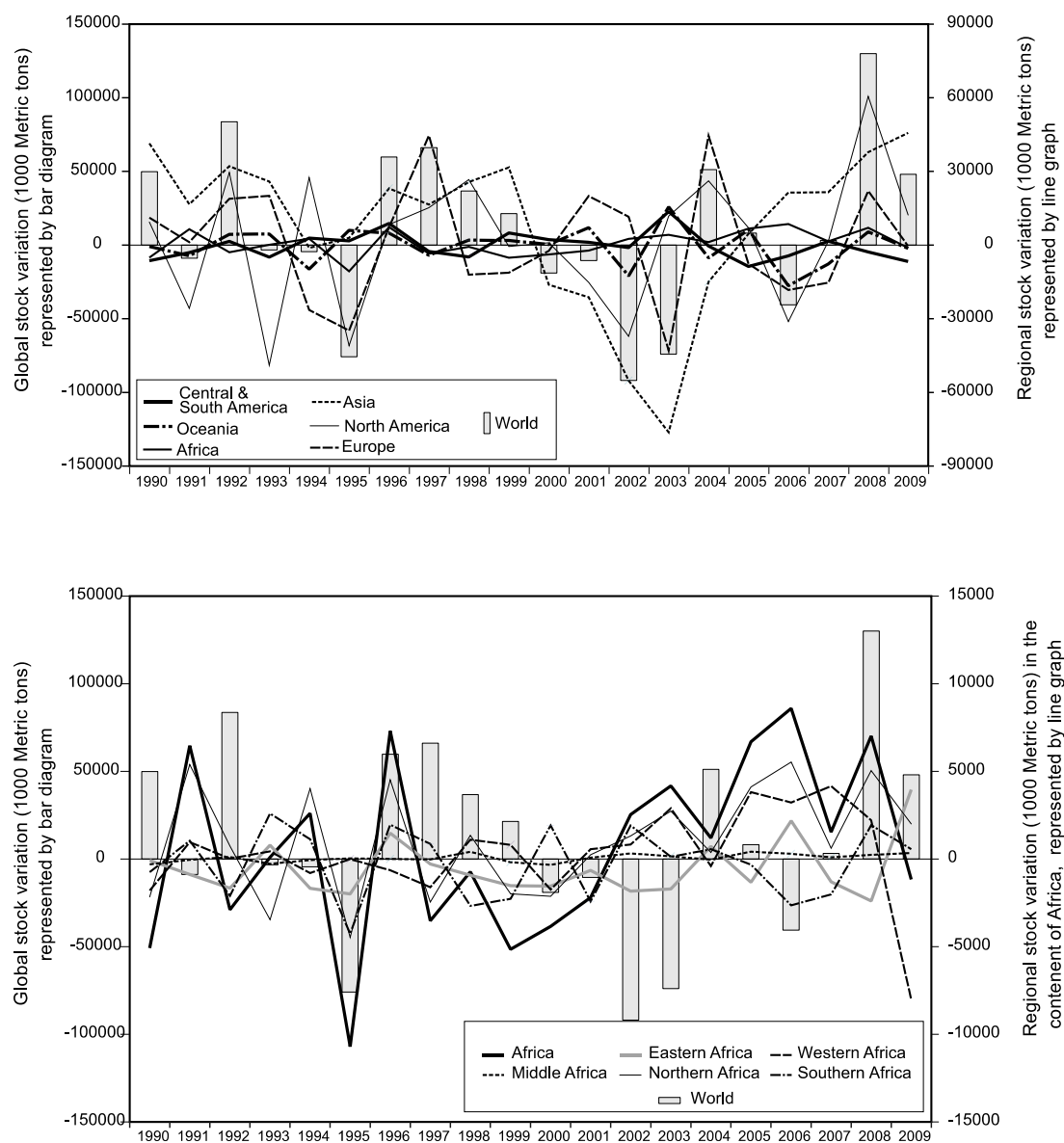


Figure 4: Stock variation of cereals (1990 - 2009): Global (upper graph), Continental Africa (bottom graph) (Source: FAO, 2014)

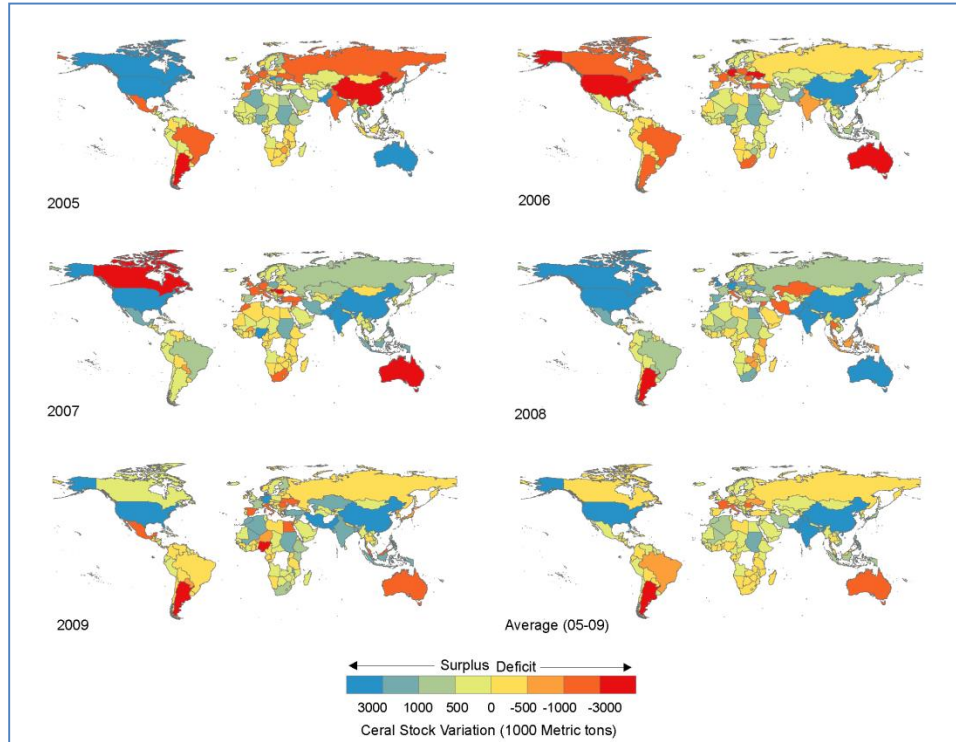


Figure 5: Spatial variation of cereal stock 2005 to 2009 and average of 2005-2009 (Source: FAO, 2014)

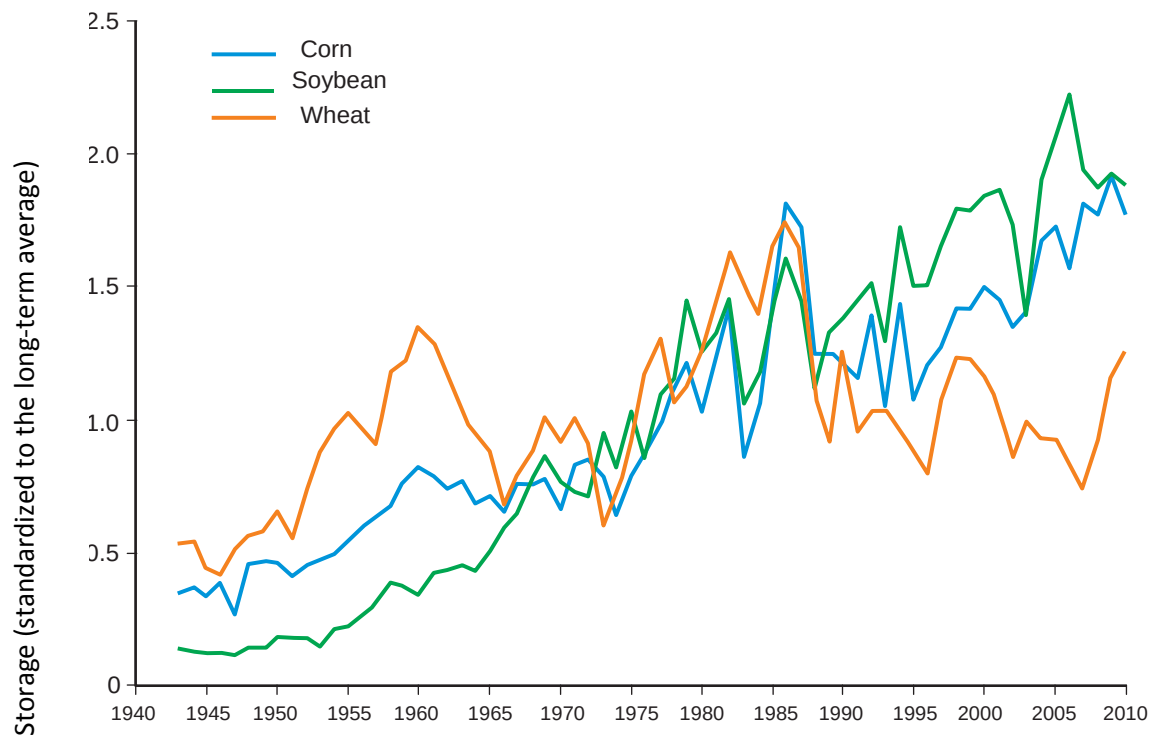


Figure 6: U.S. wheat, corn, and soy, storage trends standardized to the long-term average. (Source: USDA, 2014)

Table 1: An overview of rice stocks (mill equivalent in million tonnes) in major rice exporting countries (- indicates surplus) (Source: (FAO 2014))

	2011	2010	2009	2008	2007	2006	2005
<i>India</i>	-5000	500	4000	-4000	0	0	0
<i>Pakistan</i>		2204	-798	-1256	212	353	-228
<i>Thailand</i>	505	-1516	-253	1566	-303	-505	-1013
<i>Indonesia</i>	-1867	-1130	-507	832	-1860	-3	9
Total	-6285	58	2442	-2858	-1951	-155	-1232

Table 2: Regression analysis with food price as the dependent variable and food stock as explanatory variable (Source: (FAO 2014))

	1991-2000	1995-2005	2000-2010	2005-2014
<i>R squared</i>	0.442	0.695	0.059	0.142
<i>P value</i>	<0.05	<0.01	Not significant	Not significant
<i>Beta</i>	-0.131	-0.166	-0.210	0.285
<i>P value</i>	<0.05	<0.01	Not significant	Not significant

Table 3: The mean, standard deviation, and coefficient of variance for global grain stocks in four-year intervals between 2003 and 2014 (Source: (FAO 2014))

	2003-2006	2007-2010	2011-2014
<i>Mean</i>	-30.875	14.85	14.325
<i>SD</i>	64.90051	46.07881	54.32552
<i>CV</i>	-210.204	310.295	379.2358

Discussion: Policies to Promote and Manage Food Reserves

Given the importance of food reserves, it is important to assess what policies can promote them. Broadly speaking recent scholarship distinguishes between the following strategies:

- (1) Publicly-owned buffer stocks that are geared at protecting farmers from low prices and consumers from high prices.
- (2) Government-backed price guarantees to help producers from fluctuating commodity markets.
- (3) The use of food stores to reduce food insecurity in vulnerable populations through humanitarian aid or disaster relief.

However, each of these policy approaches contains considerable complexity and the 20th century experience of using these policies shows that using stocks and reserves to maintain a more resilient food system is extremely challenging. To explore these issues in more detail, the following section describes three pieces of public policy that were used in the 20th century to promote food storage.

The U.S.'s publically owned buffer stocks and the "ever-normal granary"

National-level food storage policies in the U.S. date back to the 1930s when, due to over-production and collapsing grain prices, F.D. Roosevelt's administration established U.S.'s first program to support farms (Ray and Schaffer 2004 See pages 131-5 in particular). The New Deal farm policy established a system of price supports, backed by a USDA managed grain reserve, in an effort to keep surplus grain off the market and hence support prices. This reserve, called 'the ever-normal granary', was defined by then Secretary of Agriculture Henry A. Wallace as:

...a definite system whereby supplies following years of drought or other great calamity would be large enough to take care of the consumer, but under which the farmer would not be unduly penalized in years of favorable weather. (Davis 1938)

In years of good harvest, when the market price dropped below the federal government target price, farmers had the option of storing their crop and using its value as collateral to take a loan rather than sell the harvest at the low price. If market prices improved, farmers could sell their grain at the better price and simply repay their loans. However, if markets failed to improve, the grain could then be handed over to the government's 'ever-normal granary' as repayment for the debt. The U.S. Department of Agriculture (USDA) would then hold the grain until prices rose above a ceiling to protect consumers. This would, theoretically, ensure food cost remain "ever normal" (Ray and Schaffer 2004).

Coupled with the desire to keep farmers and rural communities viable, Wallace's 'ever-normal granary' was also based on his belief in the need to guarantee consumers access to affordable food. In this way, he was directly inspired by the story of Joseph in the Old Testament quoted in a previous section of this paper (Sumner et al. 2010). As Pollan notes, while this was not a perfect system, it delivered good results at several levels. In particular, it ensured farmers received a fair price for their grains and reduced the incentive to dump products on the market when prices dropped (thus further depressing prices). Also, the ever-normal granary stock was often sold back to the market generating a profit for the government (Pollan 2003).

Despite these apparent successes, the program was cancelled in the 1970s under President Richard Nixon and President Gerald Ford. Then, the Secretary of Agriculture, Earl Butz, pushed for free market de-regulation of agriculture reversing many of the New Deal policies including the elimination of the ever-normal granary. This policy shift was significant as it aimed at encouraging farmers to rely more on the market and less on government storage (Lipton and Pollack 1996; Morley 2008). The implications of this change are discussed in more detail below.

Guaranteed prices: EU's Common Agricultural Policy (CAP)

Some of the logic behind the U.S.'s 'ever-normal granary' policy is also found as part of the organizing principles behind Europe's Common Agricultural policy (CAP). CAP was initiated in 1957 with the signing of the Treaty of Rome by France, Germany, Italy, Netherlands, Belgium and Luxembourg. At the time, CAP's aim was to:

...ensure a fair standard of living for the agricultural community in particular by increasing the individual earnings of persons engaged in agriculture; to stabilize markets; to ensure the availability of supplies; to ensure that supplies reach consumers at reasonable prices... (Zobbe 2002 p 4).

The central instruments to achieve these policy goals were (1) a guaranteed "intervention price" for commodities, such as cereals, sugar, beef and milk; combined with (2) trade instruments including variable import levies and export refunds (Josling 2008). The guaranteed intervention price ensured that commodities had a stable and predictable value for producers and traders. Prices were further supported by "interventions stock schemes" that were funded by the EU and allowed the central government to buy the surplus stock off the open market when prices were lower than desired. Surplus stocks were either stored in public storage facilities or the producer/trader could store the surplus stock in private facilities. At a later date, when the market recovered, or for specified end uses such as crisis relief, the surplus would then be sold.

These measures meant that CAP successfully met its primary objective of helping the EU become self-sufficient from the 1970s onwards (McMichael 2005). These policies also meant that the EU had to contend with almost permanent surpluses of the major commodities, as farmers had no incentives not to over-produce since they were guaranteed to be able to sell everything they produced to the government for a good price.

In addition, at the time, the U.S. was also producing surpluses of butter, milk, cereals, and beef and global commodity prices plunged due to this over-production. As a result the EU bought ever-more quantities of food and CAP grew as a proportion of the EU's budget (McMichael 2005). While this meant that the world was enjoying large food reserves, this did not necessarily translate into a more stable and resilient food system. More specifically, CAP became an extremely expensive piece of policy that resulted in the government owning so-called 'butter mountains' and 'milk lakes', all of which had to be disposed of. One way of reducing these unwanted volumes was through subsidizing exports to food importing regions, particularly in the global south where these commodities further depressed prices and hurt the economies of countries dependent on agriculture for a much larger percentage of their GDP than North American or European countries. In this way, CAP, and in particular disposing of Europe's surplus food is now seen as one factor that has undermined food security and economic development in Africa in particular (Hassett and Shapiro 2003).

CAP funded public stocks reached their highest levels in the early 1990s at which point the EU brought in measures to limit surplus through fixed quotas on milk production, by imposing penalties for over production, and limiting the area of crops or numbers of animals. The "MacSharry reform", for example, started the shift from product support through intervention prices, to producer support through income support (Daugbjerg 2003). Reforms have gradually led to the disappearance of stocks. For instance, by 2007 butter stocks had disappeared; however with the economic downturn in the summer of 2007, the EU started buying commodities at guaranteed prices and stocking again as a way of helping producers (Castle 2009).

Humanitarian and Disaster Relief: Strategic Grain Reserve in Africa

While the U.S. and EU examples just described illustrate the way that public policy and market forces interact to influence food reserve policy, Africa's experimentation with a "Strategic Grain Reserve" policy, ostensibly designed as a way of helping reduce the impacts of famine, focuses on the role of food reserves for humanitarian assistance. The establishment of strategic grain reserves stems from the events of the early 1970s, when a prolonged drought in the Sahel resulted in a series of disastrous harvests throughout the region. Furthermore, regional food needs were not easily met by importing grains as world prices were high (Murphy 2009). Developing country governments concluded that world markets were not a sufficiently secure source in an emergency; thus there was a need for them to create an appropriately-sized food security stock with the help of aid agencies such as the Food and Agriculture Organization of the United Nations and bilateral donors (Murphy 2009).

The resulting "strategic grain reserves" aimed to serve four purposes:

- (1) To correct the basic market failure of aggregate food markets;
- (2) To smooth out volatile prices;
- (3) To complement or replace the private sector; and
- (4) To prepare for food emergencies (Lines 2011; Murphy 2009).

In the event of crop failure or soaring prices on local markets, grain from the reserve could be sold and the reserve later replenished through purchases from domestic market following good harvest. In this way, the strategic grain reserve acts as the ever-normal granary in that any monies for the purchases are generated from sales from the reserve. However, unlike the U.S. and EU policies, the Strategic Grain Reserve is distinct in that whenever stocks are distributed they are either given away free to needy people or at highly subsidized prices. In this way, the strategic grain reserve is a device to protect vulnerable population groups under relief programs during food emergencies. It was also expected that donors would assist African countries in replenishing the reserves after a crisis (Murphy 2009).

If well managed, grain reserves can serve as an effective public safety net. However, for a number of reasons this system came under fierce criticism in the 1980s and 1990s. In particular, corruption and mismanagement, along with the resurgence of a free-market attitude in the UK and the U.S. (aka the so-called "Washington consensus") undermined faith in this potentially useful tool. The 2001 famine in Malawi illustrates these issues. That year, this poor southern African country experienced some unusual late rains. This flooded fields and caused the unripened grain to rot. The government turned to the Strategic Grain Reserve to release the backup food onto the markets and keep prices low. But the silos that were supposed to house the reserve were empty. In all likelihood some of the grain had been stolen by corrupt officials who hid it in unmarked bags and released the food into the markets when prices were sky high, though this allegation remains unproven in the courts of law and remains in the domain of speculation (Devereux 2002).

But blame also falls to a shift in public policy. In the months before the crisis, the International Monetary Fund had encouraged the Malawian government to reduce the size of its reserve. This was done as part of a structural adjustment program linked with refinancing Malawi's sovereign debt. The IMF officials had argued that it is far more efficient to sell the strategic grain reserve and invest the proceeds in something productive for the economy rather than storing an expensive asset that only depreciates over time. Then, in times of need the government should simply turned to international commodity markets

to import the food they needed. But the people of Malawi learned the failure of this logic as they proved unable to afford the price when they needed it most(Devereux 2002: See in particular pages 70 and 71).

By the time of the Malawian famine almost all that was left of the Strategic Grain Reserve program was some defunct infrastructure. This brief episode from Malawi's history illustrates a larger phenomena that was unfolding across much of Africa, as the UN itself admitted, by 1997 "for many countries the strategic grain reserve... tended to exist in theory rather than in practice" (Lynton-Evans 1997).

While the experience of one small African nation may seem remote from the food systems that support developed countries such as the U.S., what is important to remember is that by the 1990s all of these food / grain reserve policies were being wound down. The U.S.'s ever-normal granary, the EU's price guarantee, and Africa's Strategic Grain Reserve Policy have all been replaced with a set of more free-market driven principles where it is assumed that the smoothly functioning market offers a better deal to consumers. While this may be true during times when food is plentiful, and even this is debatable, as the considerable literature on food sovereignty attests (See Chappell et al. 2013), this reliance on the market raises troubling concerns over the resilience of the food system(Fraser et al. 2005).

Conclusion: the merits of government intervention versus de-regulated markets

In many ways, the modern debate over food stores harkens back to 16th and 17th century debates on the role of the free market as the most efficient mechanism for allocating resources. At that time in England, food was not governed by market forces but by a series of government regulations that stipulated everything from the price of grain to the size of loaves of bread(Ross 1956; Webb and Webb 1904). Government agents even inspected granaries and bakeries to ensure that merchants were not holding back grain in times of dearth, thus trying to ensure that the poor always had access to food.

While ostensibly protecting poor consumers, the "Assize of Bread" as these policies and laws were known, was seen as expensive and inefficient by the early disciples of the free market. For instance, early economists such as Adam Smith argued against the *Assize of Bread*, suggesting that rather than helping the poor it actually hurt them by keeping prices low (and therefore consumption high) during times of scarcity. For Smith, the best system was a free market that would create an incentive for some sellers to hold onto supplies during a shortage in the hopes of higher profits later in the year. Under such a regime, prices would rise at first, but then foreign merchants would bring food into the market – the key here is the free movement of food with middlemen facilitating the flow(Smith 1835 See page 346). As one early economist wrote: "Let corn flow like water, and it will find its level..." by which he meant that if the price of grain is left to a de-regulated market then rising prices will cause producers to increase production while falling prices will signal to farmer to reduce production(Thompson 1971 p 89).

This is a point that has been debated extensively for generations and seems to emerge whenever there are crises in the food system. For instance after leaving office in the 1870s former U.S. President Ulysses S. Grant traveled through China during a time when there was a bad famine. Upon observing the ravages of food deprivations, Grant was witnessed to remark the following:

...In America, there could be no famine such as had recently been seen in China...If the crops failed in one State, supplies could be brought from others at little extra expense in money and time" (J. T. Headley, The Travels of General Grant, Philadelphia 1881, quoted in Davis(2001 p 5))

A similar example comes from India during the peak of the British Empire when Lord Elgin, a senior colonial officer, funded the creation of railway and telegraph lines across India to reduce the chance of

famine in remote areas. The logic was that if an area experienced a crop failure then the communications infrastructure would ensure officials found out about this quickly and the transportation network would allow food to be easily imported.

These two 19th-century examples display the same logic as the 20th/21st century authors of the Washington Consensus (or the early modern economists who were critical of the *Assize of Bread*). Namely, trade and communication are more efficient ways of addressing food supply short-falls than government intervention and storage schemes such as the Ever-normal Granary policy or the Strategic Grain Reserve program. However, such free-market measures seem only to succeed in cases when the people in need can actually afford to import the food. During a famine in the late 19th century in India (much like in Malawi in 2001) when crops failed, and in the absence of any government managed food storage strategy, the people most desperate for food were the least able to buy it. This point was made clear in a letter from a regional official in India from 1876 that reads, “it was apparent to the government that facilities for moving grain by rail were rapidly rising prices everywhere...” (quoted in Bhatia(1963)).

As a result, and building on the examples explored in this paper, it is plausible to conclude that over a long period of history using food reserves as a strategic policy tool has fallen in and out of favor. In particular, evidence from the last 15 years suggests that, at a global level in particular, many of the major economic forces in the world are not currently treating food as a strategic resource. For instance, Wright and Cafiero (2011)note that by 2007 "aggregate stocks of major grains declined to minimal feasible levels ” (p 61) thus creating an ideal circumstance for price volatility. In particular, they conclude that minimal global stocks in 2006 and 2007 made prices very sensitive to the Australian drought, the US bioethanol policy and widespread financial speculation in commodity markets(Clapp 2014b). As such, many experts are concerned that policies to promote global and national food stocks have fallen away over the past 20 years to the point where today, many worry we are just one bad harvest away from a major humanitarian catastrophe (Lee et al. 2012b).

However the pendulum seems to be shifting back and calls are now growing for nation states and international institutions to consider grain as a strategic resource like oil and establish sizeable reserves that would be used to keep prices level during periodic price and production shocks. This already is happening, and at the beginning of this paper we noted a number of Asian countries like India, Thailand and China have increased their rice stocks. While there is a considerable discussion as to who should own such stocks, and how they should be governed, the fact remains that having robust stocks is a crucial strategy to promote a resilient global food system (for background reading see: (Action for a World Community for Food Reserves 2013)). For example, Robert Zoellick, the former president of the World Bank, argued for this point in 2011:

The world tends to be wary of large food stocks, but ... [in places where] the infrastructure is weak, such as in the Horn of Africa, it may make sense to have food stocks perhaps run by the World Food Program so that we can get support where it is needed most quickly. (Zoellick 2011)

Many experts, therefore, conclude that maintaining adequate food storage remains just as important today as in the past. With over half of the world's population now living in cities, the majority of humanity is dependent on food produced in a remote hinterland and therefore requires a functioning transportation and storage infrastructure to obtain their daily bread. This highlights the need to reflect on the quote by Lord Cameron that we used to open this paper – and we believe we should question the resilience of a system that holds only a small amount of food in reserves and that places all of its faith in a small number of private corporations to maintain global food security.

This leads us to our final point, and in particular our assessment of the U.S. data: we simply do not know if there is need to radically increase levels of household and food supply chain storage to promote resilience. The almost complete lack of data on this topic is worrying and so we would like to conclude this paper with a call for more research that evaluates not only the importance of food stores but also that explores at what scale these should be implemented as well as how they should be governed and managed.

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