A TEEBAgriFood Analysis of the Malawi Maize Agri-food System

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Front Matter: Discussion Notes

This study was presented twice during the "The Future of Food: True Cost Accounting for Transformative Change," held in Brussels, Belgium from April 8th-10th, 2019. The format for presentation was small group discussion. Approximately 20 audience members hailed from a variety of organizations and geographies. Observations and critique made by the audience were noted and organized into three broad categories: Data, Analysis, and Transformation.

Data

- Audience members suggested that an analysis of multiple scenarios may have added to the usefulness of the report. The original proposal for this study did include a scenario analysis but lack of data frustrated carrying it out. Though there is ample data in relation to soil and crop management, a key goal of the Malawi maize study was to look at maize in more systemic terms and in relation to current debates. This lack of *recorded* data, which prevents constructing realistic scenarios, could be mitigated through participatory scenario construction in collaboration with people who rely on the current maize system.
- It was suggested that more data on agrobiodiversity should be included. As a key quality of resilient agroecosystems, it is important to highlight the role of agrobiodiversity in human wellbeing, which also provides an opening to better discuss how it could be fostered. (It is important to note that during the initial review of this study, a reviewer made the author aware of raw data on the agrobiodiversity of Malawian agroecosystems. This data could serve as an input into ensuing studies.)

Analysis

- Participants appreciated an explicit attention to the power dynamics that shape the Malawian maize system, and how those power dynamics articulate. They noted the necessity of being more explicit about this in TCA going forward
- It was noted that not all costs and value should be monetized, but that some *must* be monetized because they influence how people are able to use the analysis to enact change.
- One participant noted that the Malawian FISP is often cited as a success story by other African countries, but that the analysis in this study complicates that assessment.
- There is danger of discussing the negative costs related to maize without also addressing the benefits of the current system. The study could be improved by a cost-benefit balance.
- Participants appreciated the use of the framework to tell a story, which they distinguished from other studies that were more focused on quantification.

Transformation

- Hivos collected data on maize agroecosystem management in Zambia and used it to generate multiple scenarios. The results of that analysis is now being used to engage policymakers, which could result in policy changes.
- It was not clear how the analysis will be used or shared, and therefore not clear what the potential is for it to be considered in current policy debates.
- In some cases and with some audiences it will be necessary to quantify the ways in which good agrifood systems management reduce *risk.* It is important to engage financial institutions and link to financial policies. For example, in Kenya, microcredit institutions link loans to the adoption of climate smart practices.

- It was noted that viable, active, and effective social movements exist, which are enabling transformations to more sustainable and equitable systems. These could provide insights on political entry points for reform, as well as help to understand how donors, such as USAID, Gates, and EU, are influencing the system. Likewise, it may be useful to better document the stocks and flows of CGIAR investments and resources, and what might be accomplished by investing more in extension services and seeds.

The Malawi Maize Agrifood System

On May 18, 2018, Malawian Minister of Finance Goodal Gondwe presented the 2018-19 National Budget to the Malawi parliament for approval. On page 45, he read the following:

> *"Mr. Speaker Sir and Honourable Members, Government will continue with the implementation of the Farm Input Subsidy Program (FISP) in the 2018/19 growing season. The program has been allocated K41.5 billion[1] which will reach out to one million beneficiaries for both fertilizer and seeds. This is an increase from the 2017/18 revised figure of K33.2 billion. The private sector will continue to retail fertilizer under the FISP to complement the role of ADMARC and SFFRFM in this Program." (MANA Online, 2018)*

With that, the government of Malawi once again committed to the widely debated, extensively analyzed, controversial-but-perennial Farm Input Subsidy Programme, or FISP as it is popularly known. FISP, a program that targets about half of Malawian farm households, is the centerpiece of Malawian agricultural policy and has as its objective to bring about maize self-sufficiency through fertilizer and seed subsidies. It has been maligned as being inefficient and expensive (each year it consumes anywhere from 50-75% of Malawi's agriculture budget, and suspicions of graft are common) but, overall, as John Mazunda (2013) notes, it is "widely credited for bringing about macro-level food security in Malawi."

In Malawi, maize is the preferred staple and foundation of the agrifood system. Grown by the majority of farmers on small plots of lands and commonly eaten as porridge called nsima, maize occupies a life-sustaining place for Malawians. The centrality of maize to economic, social, and personal wellbeing is reflected in the Chewa maxim, *Chimanga ndi moyo*: Maize is life. Likewise, policymakers' funding allocations to maize production suggests wide agreement that maize is central to wellbeing in Malawi. However, though maize output has increased due to FISP, micro-level food insecurity is widespread and diets are poorly diversified (Bezner Kerr, 2013; Mazunda, Kankwamba & Pauw, 2018). Malawian officials acknowledge this reality publicly and in policy documents, such the 2016 National Agriculture Policy and the implementation strategy for that policy, 2018 National Agriculture Investment Plan, which states "Malawi has over-concentrated on maize self-sufficiency for food…" and recognizes the necessity of diversification (MoAIWD, 2016).

Why might lawmakers continue to fund maize production at such high levels even though they are acutely aware of the problems associated with maize-centricity? Many observers blame the politicization of FISP and the perception by Malawian lawmakers that they are politically bound to

[1] At an exchange rate of 1USD=720MK, this translates to 57,657,309.79 USD

provide yearly subsidies (Chinsinga & Poulton, 2014). While true, the emphasis on maize is also emblematic of wider, more deeply entrenched ideological positions that have guided agricultural development for the last 40-50 years, which are expressed in the practices of international development institutions and the analytical frameworks that measure progress.

Much of agricultural development is motivated by a production imperative based on the notion that dramatically increased yields is the requisite first step in a modernization process that would enable countries to both meet food requirements *and* drive industrialization and economic growth. At the heart of this imperative is a dream that emerged alongside the scientific breakthroughs of the Green Revolution, articulated here by Norman Borlaug (1995, p. 129):

> *We too dream of a commercial African agriculture made up mainly of small-to intermediate-sized family farms that use modem science-based technologies. We envisage these farms clustered around bustling villages and towns that provide rural families with access to clean water, schools and health facilities, as well as markets and stores. Private sector agribusinesses facilitate the commerce of these communities, supplying farmers with the equipment, products and services they need to run a modem and productive commercial food-producing sector.*

While this dream never materialized in the way many policymakers and researchers imagined, it *has* transformed agrifood systems by shaping agendas, investments, and research. As it relates to maize, public and private agricultural research organizations devote millions of dollars every year to developing improved varieties and cropping techniques while programs to develop grains and other kinds of staples that are more consistently reliable under variable production conditions and in a context of environmental change receive a fraction of that. Western economists have long seen maize as "a ray of hope" to Africa's food security crisis (Eicher & Byerlee, 1997, p. 248), and policy advisors commonly assert that raising maize productivity and improving the performance of maize input and output markets is sine qua non for achieving food security, e.g. "National food security in Malawi depends on improving performance of maize markets" (Jayne, Sitko, Ricker-Gilbert, & Mangisoni, 2010, p. 4).

Not surprisingly, outcomes that are inconsistent with, or irrelevant to, this major narrative are 'hidden,' framed as 'external' or ancillary to the primary goals. Nevertheless, such outcomes are consequential and have an impact on people in numerous ways. In this paper, we examine some of those uncounted outcomes through the application of the TEEBAgriFood Framework.

The central assertions of this report are:

(1) The focus on maize is disproportionate to the benefits it currently or can reasonably be expected to provide, especially in light of the devastating and widespread predicted impacts of climate change;[2]
(2) Maize-centricity is held in place by prevailing assumptions, values, and analytical frameworks that prevent citizens, policymakers, and development economists from perceiving how and why maize-centric agrifood systems are limited, and perhaps even antithetical to a goal of food security; and,

[2] In its most recent special report, the IPCC predicts reductions in yield and overall food availability in Africa, and the steps that need to be taken to reduce the severity. http://www.ipcc.ch/report/sr15/

(3) Conceptual frameworks that compel attention to a wider set of indicators that recognize the multi-dimensionality of food security and well-being are critical for strategic decisionmaking that aims for sustainable and equitable food security in a context of climate change, environmental degradation, urbanization, and growing inequality.

1.1 TEEBAgriFood: An analytical frame to repair and regenerate agrifood systems

This desktop study uses the TEEBAgriFood Evaluation Framework to organize and guide the analysis. The framework has been applied to a number of studies as part of the process to develop appropriate and place-based methodologies that better account for and consider the positive and negative effects of agrifood systems.[3] Like those early studies, the analysis in this paper, while making every effort to be as rigorous as possible, should be considered a test case in the application of the framework, to be shared, critiqued, and refined as we work towards better "measuring what matters in agriculture and food systems."[4]

The remainder of this section provides some background that explains the history and values behind prevailing metrics, why they are insufficient, and how the TEEBAgriFood framework means to remedy those deficiencies.

1.1.1 Changing Food Environments, Insufficient Responses

Efforts to transform the farm sector in low-income countries (LICs) have persisted in one form or another since the inception of the 'Green Revolution' in the 1950's, an approach to farming, food security, and economic progress that rested on the assumption that the basic problem in agrifood systems development was low agricultural productivity. At the farm level, the planned transformation of agriculture in LICs was carried out through increased use of modern inputs, which includes hybrid 'improved' seeds, chemical pesticides, fertilizers, and insecticides; irrigation and mechanization; land consolidation; and integration of farmers into global markets, which has implications for what crops should be grown. Seventy years after its inception, this basic approach to agricultural development and food security remains intact and continues to dominate policy interventions and recommendations (Thompson & Scoones, 2009).

The technologies, policies, and other investments associated with the Green Revolution dramatically boosted aggregate output per person, while income and population growth, policy liberalization, foreign direct investment, and other globalization processes drove exponential growth and consolidation of the retail food sector (Hawkes, 2006, 2018; Reardon, Barrett, Berdegué & Swinnen, 2009; Reardon et al., 2018; Thompson & Scoones, 2009). Particularly over the last three decades, financial and trade liberalization encouraged transnational food and beverage corporations to colonize local value chains in many low- and medium-income countries (LMICs), replacing them with food exchange processes that are spatially long and vertically integrated, i.e. supermarkets (Anand et al., 2015; Hawkes, 2006; Reardon et al., 2018; Stuckler, McKee, Ebrahim & Basu, 2012). This structural transformation is indicative of

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[3] See, for example, the exploratory studies on the TEEBAgriFood website: http://teebweb.org/agrifood/home/exploratory-studies/

[4] For a more detailed and most recent discussion of TEEBAgriFood, refer to Alexander Müller and Pavan Sukhdev (2018) "Measuring What Matters in Agriculture and Food Systems: A synthesis of the results and recommendations of TEEB for Agriculture and Food's Scientific and Economic Foundations Report." http://teebweb.org/agrifood/wp-content/uploads/2018/Synthesis_report_lowres.pdf

economic globalization and therefore reads as economic development and progress towards an "advanced" food system (Reardon et al., 2018).[5]

However, the agrifood development community has not fully reckoned with the negative outcomes wrought by such approaches, though a growing body of research is demonstrating the impact with increasing precision:

- The increased access to animal-sourced foods, refined grains, and cheap high-fat and high-sugar ultraprocessed foods is dramatically driving up rates of diet-related non-communicable diseases, such as heart disease, diabetes, hypertension, and obesity (Baker & Friel, 2016; Hawkes, 2018).
- Modern agrifood systems are characterized by reliance on petrochemicals, long value chains, highly processed foods, meat-centered diets, and large amounts of waste, all of which exact high energy inputs and are characterized as having high water and carbon 'footprints' (Chaudhary, Gustafson & Mathys, 2018).[6]
- The benefits of such transformation, both in relation to capital accumulation and improved nutrition, accrue disproportionately to wealthier populations, while lower income groups are more likely to experience impeded access to nutritious foods and will likely, as in Western countries, "experience convergence to obesogenic diets" (Baker & Friel, 2016; Hawkes, 2018, p. 113).

Assumptions of universal trajectories implies that the 'necessary evils' of 'modern' food systems can only be redressed rather than avoided. Moreover, the assumption that development trajectories are universal removes the impetus to examine local food exchange and provisioning practices, rendering them invisible and unworthy of research. Consequently, outside of the farming sector, there is little investment into or understanding of local food systems, which are commonly pigeonholed as a source of labor for the corporate sector.

Moreover, as the 2017 International Panel of Experts on Sustainable Food Systems (IPES)-Food report on food-health nexus points out, people working in the food system, many of whom experience multiple kinds of social and economic vulnerabilities, are commonly exposed to working conditions and contaminants that make them sick.

Why do the policies and practices that reproduce such negative outcomes continue to have such wide support? Certainly, it has much to do with entrenched interests in the food system, but it also has to do with the frames that guide our metrics, which in turn guide our decision-making.

The conventional economic wisdom is that negative outcomes, or "externalities," are unavoidable and should

[5] Development economists commonly frame food system development as proceeding along a linear path from traditional to advanced/modern. Such a narrow framing constrains research agendas and conveys the notion that there is little value to studying food systems that do not meet the criteria of "advanced" except to articulate *how* they do not meet those criteria. Moving away from that framing is important to understanding the qualities of different kinds of food systems in relation to contemporary challenges.

[6] Studies that attempt to quantify water and carbon footprints in relation to diets and other aspects of the food system typically caution that there is no one-size-fits-all approach to reducing negative impacts, and that it is very important to take into account the particularity and intersections of infrastructure capacity, cropping practices, diet, geography, transportation methods, consumer expectations, etc. Sometimes 'local' will prove to be more sustainable, while other times it will not. Three studies that grapple with this complexity are Chaudhary, Gustafson & Mathys, 2018; MacRae, Cuddeford, Young & Matsubuchi-Shaw, 2013 and Pelletier et al, 2011. In general, however, diets high in meat and sugar are clearly more damaging to environmental and human health.

be addressed retrospectively through individual initiative or once a certain level of economic growth has occurred. Development economists promote this framing using at least two different constructs. One is the Environmental Kuznets Curve, which posits that economic growth must occur before human capital and technology can be mobilized to address environmental degradation. [7] This assumption underlies policies in Malawi as evidenced by statements such as the following, which appears in Malawi's National Environmental Policy: "Priority will be given to establishing an enabling economic environment in which market prices provide appropriate incentives for sustainable natural resource use and environmental protection" (National Environmental Policy, 1999).

The other is the food systems transformation narrative, which, like the modernization narrative to which it is related, assumes relatively universal food system development trajectories regardless of historical or material conditions.[8] Assumptions of universal trajectories implies that the 'necessary evils' of 'modern' food systems can only be redressed rather than avoided. Moreover, the assumption that development trajectories are universal removes the impetus to examine local food exchange and provisioning practices, rendering them invisible and unworthy of research. Consequently, outside of the farming sector, there is little investment into or understanding of local food systems, which are commonly pigeonholed as a source of labor for the corporate sector (Meagher, 2018).

Such framings are emblematic of mainstream economics theory, which fixates on GDP as the primary measure of progress and regards the value of the environment primarily in relation to what can be extracted from it. Similar values underlie modern agrifood systems, which are fixated on productive output as the driving force. Given the challenges we face, such a theoretical orientation, which is widely taken as conventional wisdom, clearly needs to be questioned and alternatives proposed. As Kate Raworth (2017) notes, "Rethinking economics…[is] about choosing or creating [the model] that best serves our purposes—reflecting the context we face, the values we hold, the aims we have. As humanity's context, values and aims continually evolve, so should the way that we envision the economy" (p. 20)….or, in the case of what we eat and grow, the way we envision food economies.

1.1.2 TEEBAgriFood, Metrics for a 21st Century Food System

Denning et al. (2009) explain that "agricultural productivity improvements have long been viewed as the foundation for economic prosperity and social development" (p. 002). In general, the link between agricultural productivity and improvements in wellbeing are widely assumed, though common development indicators tell a mixed story. They also tell an incomplete story since many outcomes, such as soil degradation, pest build-up or price volatility, or other constitutive contextual factors, such as climate change, are left out of the analysis.

The TEEBAgriFood framework was developed based on the recognition that metrics that primarily focus on productivity miss many other indicators that encourage sustainable practices that serve both planet and people. The values that inform the TEEBAgriFood framework reflect the recognition that putting sustainability into practice means moving beyond 'productivity only' thinking and fostering an ability to

[7] One paper that discusses the faulty reasoning underlying the EKC is Mao et al., 2013. A related and recent discussion on how neoclassical economic reasoning and models provide the rationale for policies that promote economic growth at the expense of the climate is entitled "The Nobel Prize for Climate Catastrophe" https://foreignpolicy.com/2018/12/06/the-nobel-prize-for-climate-catastrophe/

[8] Three publications that do a good job explaining food systems transformations not as destiny but as outcomes of particular interests are Guthman, 2011; IPES, 2016b; and, Thompson & Scoones, 2009.

grapple with complex systems in order to deliberately link food systems to human and environment wellbeing. In a TEEBAgriFood analysis, externalities, or the *true costs,* become integral to understanding the system rather than incidental.

Figure 1 shows the basic elements of a TEEBAgriFood analysis. *Stocks* comprise the various capitals, or assets, that are used to implement an agrifood system. Stocks can be depleted or built through various *flows. Outcomes* refers to changes in stocks, either positive or negative, which have *impacts* on wellbeing. In this way, the TEEBAgriFood framework compels analyses that more accurately reflect food system interactions and impacts in multiple domains, and which "cut across silos of expertise and

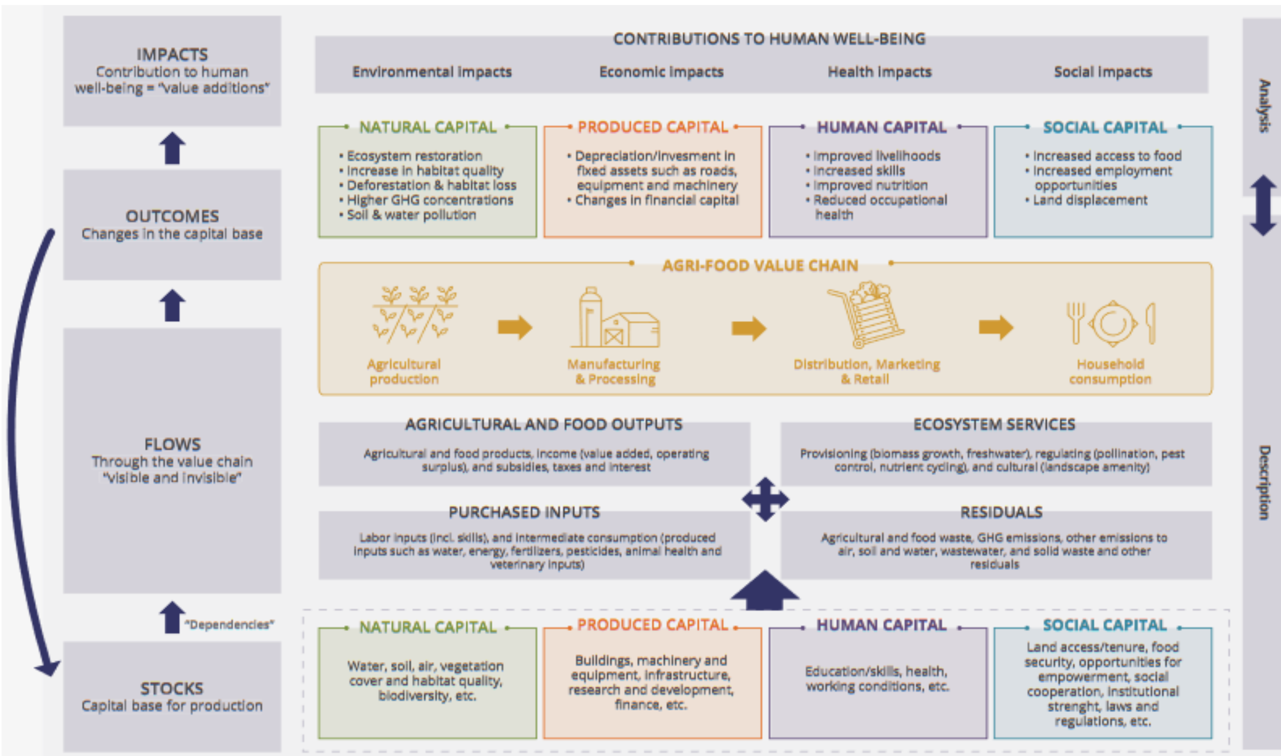


Figure 1 Elements of the TEEBAgriFood Framework. Source TEEB, 2018

selected interests" (TEEB, 2018, p. 23). *Dependencies* refers to how food exchange and provisioning is carried out, and can provide a valuable lens for understanding who benefits and who suffers as a result of those relationships.

Architects of the framework recognize "five families of applications" (TEEB, 2018): typology comparison of agricultural management systems, business analysis, dietary comparison, policy evaluation, and national accounts for the agricultural sector. The analysis in this paper falls primarily within the analytical space of 'policy evaluation.'

1.2 Organization of Paper

The remainder of this paper is organized as follows:

- The next section provides historical, political, environmental context of the maize agrifood system. Maize is generally regarded as entrenched in the region because of deep cultural preferences. Though it is true that maize in the contemporary food system *is* culturally preferred, the story underlying the entrenchment is more complicated and entwined with colonial and neocolonial history.

- Sections 4 and 5 provide an analysis of maize in relation to several parameters: input stocks and flows and associated dependencies; outcomes on human and environment health, including costs associated with those outcomes. In addition, this section discusses why maize-centricity persists.
- Based on the analysis, the next section discusses what some qualities of a more adaptive, regenerative system might look like.
- The paper concludes with a discussion of the implications for policy and research.

2 Historical, Political, and Environmental Context of the Maize Agrifood System

In Malawi, like in many African countries, maize occupies a central position in contemporary agrifood systems. Introduced to West Africa by slave traders around 500 years ago, maize appears to have become common in southern Africa by the mid 1800's. The appeal of maize is clear. For farmers, maize's husk provides it with natural protection against birds in the field and the hard grain of the locally preferred flint varieties protect it against weevils in storage (Carr, 2004; Kampanje-Phiri, 2016). Compared to other grains, maize yields more food per unit of land and labor and it is more easily processed than the sorghum it replaced (Kampanje-Phiri, 2016). In addition to its agronomic features, maize in Malawi is imbued with cultural meanings that celebrate, enact, and reinforce local identity (Kampanje-Phiri, 2016).[9]

According to historical accounts, maize was initially cultivated in mixed cropping systems that farmers managed according to locally variable, and often challenging, agroecological conditions (McCann, 2001). Given that maize is relatively finicky – with its high nutrient demands and its sensitivity to light and water deprivation – it was too risky a crop to depend on in subsistence production systems, especially in combination with the site variability that characterizes Malawian agroecosystems. During the latter half of the twentieth century, however, it came to dominate the agrifood system, its proliferation accelerating in association with political dynamics and the Green Revolution.

2.1 A Brief History of Maize: From Colonialism to the Malawi Miracle

The association of maize with food security has its roots in colonialism (McCann, 2001; Kampanje-Phiri, 2016). Kampanje-Phiri (2016) explains how, from about 1912 onwards, the British promoted maize as a foundation for food security and used it as a vehicle to exert control over agricultural production and distribution. Practices and institutions that remain important today, such as the Agricultural Development and Marketing Corporation (ADMARC), were established during the colonial administration.

[9] Cultural and historical accounts of maize in Africa include: Miracle, M. P. (1966). Maize in tropical Africa*;* McCann, J. (2001). Maize and grace: history, corn, and Africa's new landscapes, 1500–1999. *Comparative Studies in Society and History*, *43*(2), 246-272.; Kampanje-Phiri, J.J., (2016). The Ways of Maize: Food, Poverty, Policy and the Politics of Meaning among the Chewa of Malawi.

Following independence in 1964, Kamuzu Banda, who presided over Malawi from 1964-1994, continued to use maize-based food security as a means of exerting control, but in ways linked more tightly to Malawian culture. Kampanje-Phiri (2016) explains:

> *…Banda assumed responsibility for ensuring that all his people had houses that did not leak, that they did not lack clothing and, most important of all, that they did not go hungry…[H]e promoted maize production through his calendared crop inspection trips, which sought to encourage smallholder farmers to compete in producing the best maize. As a Chewa chief was obligated in pre-colonial times, Banda guaranteed the Malawian people…that, being their* nkhoswe *(guardian/patron), the availability of food (specifically maize) was one of his primary concerns. In return, he expected loyalty, obedience, unity and discipline [which] he enforced…through political violence.*

Thus, monocropping maize, which Banda conflated with 'modern' farming and advancing the interests of the nation, demonstrated loyalty, and not growing it could be construed as a betrayal (Bezner Kerr, 2013; Kampanje-Phiri, 2016).[10]

For the first two decades of Banda's rule, maize research that could benefit smallholders was virtually non-existent. Rather, Banda invested in the estate sector, which benefitted from access to lucrative markets and higher yielding maize hybrids (Bezner Kerr, 2013). Smallholders, meanwhile, could sell only to national marketing boards at low prices and were actively discouraged from growing indigenous crops.

Beginning in the 1980s, enabled by a developing research capacity that focused on the locally preferred flint-type and advantageous fertilizer prices, Banda's government began to promote hybrid maize and fertilizer use among smallholders. The parastatal marketing board ADMARC turned its attention to the smallholder sector, distributing subsidized fertilizers, marketing farmers' grain, and transporting grain to food-deficit areas during the hungry season (Smale & Jayne, 2003). It was this combination of practices that marked the onset of continuous maize monocropping and land tilling (Vargas & Omuto, 2016). As the marketing board's activities became increasingly focused on smallholders, and activities increasingly complex in an attempt to prop up the maize system, costs escalated (Smale & Jayne, 2003).

[10] The U.S. Government recognized Banda's authoritarianism, but generally gave him good marks for his "firm and consistent pro-Western course in foreign affairs" and his "moderate position on African issues" noting that he has "followed sound economic stabilization and development policies."
https://www.cia.gov/library/readingroom/docs/CIA-RDP84S00552R000300120004-1.pdf

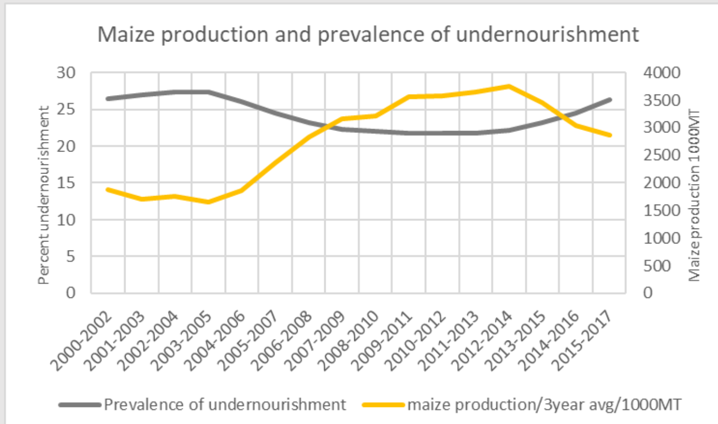
The implementation of structural adjustment policies in the 1980s forced the government of Malawi to remove funding to the public sector, which included many of the practices that caused the proliferation of maize. As funding to the national maize research program declined, the government became increasingly reliant on donors, their program prescriptions, and outside seed companies (Bezner Kerr, 2013).

Throughout this period, the Malawian government remained focused on promoting maize for food security, while donors were more measured in their enthusiasm for a particular crop, advocating instead for market liberalization and various other crops with commercial potential (Bezner Kerr, 2013).

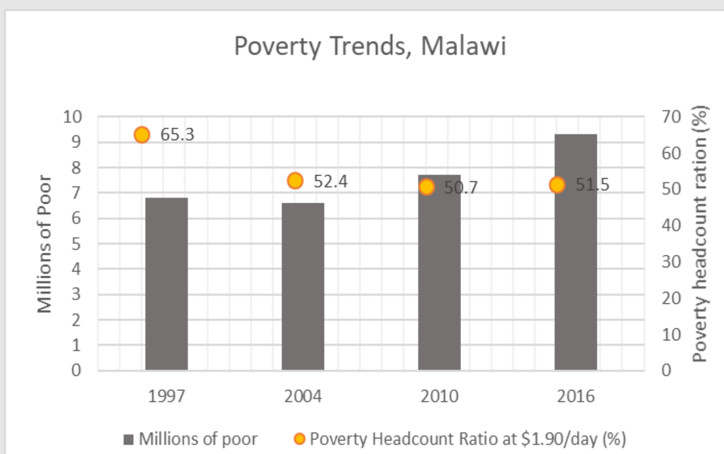
When Bingu wa Mutharika came into power in 2004, he implemented the Agricultural Input Subsidy Program, or AISP, which focused on maize production and was later changed to FISP. Donors had mixed reactions to the program, but it was eventually widely touted as a success, and came to be known as the Malawi Miracle.

Between 2007-2012, 52 percent of Malawi's agricultural budget went to subsidies, but only seven percent to technology and one percent to extension services (Ragasa & Mazunda, 2018). Though the new agriculture strategy, published in 2016, emphasizes the need to transition

In recent years, maize productivity gains have been minimal and undernourishment has begun to climb. The drop in maize production in 2015-16, largely attributed to drought, along with the corresponding rise in undernourishment highlight the vulnerability of people dependent on a single crop for food security. It should be noted that a number of researchers are skeptical of the government-reported production numbers, suggesting that actual yields were significantly lower (Messina, Peter, & Snapp, 2017; Pauw & Thurlow, 2016).



Moreover, the number of people in poverty continues to climb, while the number of people who experience severe poverty (measured by the poverty headcount ratio) has scarcely moved for over a decade, even ticking upwards in the most recent estimate. Half the population lives below the poverty line (World Bank, 2018).



Source: FAO

away from maize-centrism, the government increased the allocation to FISP in 2018. One local paper reported that the Minister of Finance, Economic Planning, and Development admitted that the increase was to "win votes in the 2019 Tripartite Elections" ("Malawi's Finance Minister…", 2018).

To date, 'maize-led development' has produced disappointing outcomes. Despite being one of the few countries to meet the goals of the Comprehensive Africa Agriculture Development Programme (CAADP),[11] and despite notable (reported) increases in average national maize yields, human development indicators have scarcely budged and, in some cases, are deteriorating. High volatility continues to characterize maize markets, diets are poorly diversified, malnutrition among children remains high, and poverty levels have increased in recent years (IMF, 2017; Mazunda, 2013; Schiesarie, Mockshell, & Zeller 2016). In addition, environmental resource stocks such as agrobiodiversity and soil fertility, which are particularly critical to smallholder farmers, are deteriorating due to the continuous cropping of hybrid maize on small tracts of land (Bezner Kerr & Patel, 2014).

2.2 The Contemporary Agrifood System

Around 80% of the population of about 18.1 million people consists of smallholder farmers and many more work as food retailers, transporters, and small-scale processors. Ninety percent of crops are rainfed, and most farmers cultivate .5 to 1.5 hectares of land. Lea & Hanmer (2009) note that many farmers leave portions of their plots fallow, which is partially due to labor constraints (Bezner-Kerr & Patel, 2014). Eleven percent of farmers are landless and only 13% of households cultivate on more than 2ha (Mangelsdorf, Hoppe, Kirk, & Dihel, 2014). Farms tend to be larger in the north than further south due to lower population density.

Malawi is an export-led economy and agriculture comprises 80% of exports. The major export crop is tobacco, but sugar, tea, and coffee are also traded internationally. Smallholder rainfed maize production comprises about 25% of the agricultural GDP, while agriculture makes up around 30% of the overall GDP (Pauw, Beck, & Mussa, 2016). At the farm level, net revenue varies widely and may be influenced by existing soil conditions, farm size, infrastructure, distance to market, composition of the household, education levels, agro-climatic variability, and a range of other variables.

Maize occupies at least 60% of cultivated land and is farmed by 97% of farming households. It makes up 60-70% of total food intake and 48% of protein consumption (Aberman, Meerman, & Benson, 2015; Bezner-Kerr & Patel, 2014; Ellis & Manda, 2012; Kampanje-Phiri, 2016). Average maize yields in Malawi are around 1.2 MT/ha, which is lower than the average for Africa, 1.8 MT/ha, also considered far below the average potential (Abate et al., 2017; Mango et al., 2018). Though most maize is consumed on-farm,

[11] CAADP proposed that African countries allocate at least 10 percent of their annual budgets to agriculture.

farmers also sell maize to earn cash. In this endeavor, traveling grain traders provide an important service, facilitating access to urban and peri-urban markets that might otherwise be out of reach for farmers (Sitko & Jayne, 2013).

The agrifood system in Malawi is characterized by a high degree of uncertainty and volatility. Because the livelihoods of most Malawians rely on rainfed annual agriculture production, food and income security are highly vulnerable to the vagaries of the weather and other agroecological pressures, such as fall armyworm (*Spodoptera frugiperda)*, which arrived in the region at the end of 2016. Many people, both urban and rural, are vulnerable to an annual hungry season when the previous year's stored maize has been consumed and the new maize is not yet ready for harvest. Malnutrition was steadily declining from a high of 26.3% in 1998, down to 12.1% in 2009, back up to 16.7% in 2014. Undernourishment in 2015 stood at 20.7% and declines have been slow in recent years. Poor infrastructure, uneven and deteriorating power access, expensive fuel, and poverty combine to exacerbate the volatility and precarity of the system.

Across the region, climate change is expected to have widely variable impacts that generally exacerbate uncertainty and extremes (Challinor et al., 2014). According to Adhikari et al. (2015), who developed projections from 15 Global Circulation Models under three different scenarios, Malawi is situated in one of the most dramatically affected regions. By the end of the 21st century, temperatures are expected to increase by anywhere from 2°C to greater than 4°C while precipitation is expected to decrease by 0-26% by 2050 and 3-29% by 2090 (Adhikari et al., 2015; Msowoya et al., 2016). Changes to rainfall distribution are uncertain, but no models project increased precipitation. In the short term, climate change may benefit maize production but increased maize production may worsen soil degradation and deforestation (Stevens & Madani, 2016). Msowoya et al. (2016) show that maize production may drop by 14% in central Malawi by 2050, and by 33% by the end of the century. Over the long term, climate change will drive down yields, as well as nutritional content of plants (Challinor et al., 2014; Smith & Myers, 2018).

2.2.1 Farm Input Subsidy Programme

The basic idea behind FISP is simple. Each year, eligible farmers receive vouchers that they trade for fixed quantities of fertilizer and seed. Over the years, farmers have sometimes been required to contribute towards the cost of fertilizer. At the outset of the program in 2004, farmers did not contribute anything to acquire inputs; while in 2005, they contributed 36% (Ricker-Gilbert & Jayne, 2017). In the most recent year farmers contributed somewhere around 25% of the cost of fertilizer.

The exact features of the program vary from year to year, but in 2016/17, the aim was to distribute 50kg NKP, 50kg urea, 5ks hybrid maize or 6kg open-pollinated varieties (OPV), and 2kg legumes or 3kg soya to 900,000 beneficiaries (Logistics Unit, 2017). The Malawian Government reimbursed input suppliers 15,000 Malawian kwacha (MK) for each 50kg of fertilizer, 5000 MK for each maize seed pack and 2500 for each legume pack. [12] The farmer made up any difference between the subsidized amount and the market rate, which amounted to more than in past years. The 2016/17 season marked the first time the private sector distributed both seed and fertilizer, an activity that is traditionally carried out by parastatals ADMARC and SFFRFM (Smallholder Farmers Fertiliser Revolving Fund of Malawi). The program is extremely logistically intensive and delays are common. In the 2016/17 year, for example,

[12] 1USD= ~730 MK (26 October 2018)

input distribution could not commence until the end of December, which is around two months into the growing season. Consequently, there was a “loss of opportunity to put the inputs in the hands of the beneficiaries at a time when maximum returns could be achieved” (Logistics Unit, 2017, p. 9).

FISPs main costs are seeds, fertilizers, transportation and logistics **(Figure 2).** The 2018 agriculture budget allocated MK41.5 billion to subsidies and aims to reach one million beneficiaries. This is a 20% increase over the 2017 allocation of MK33.2 billion.[13] (Malawi Budget statement).

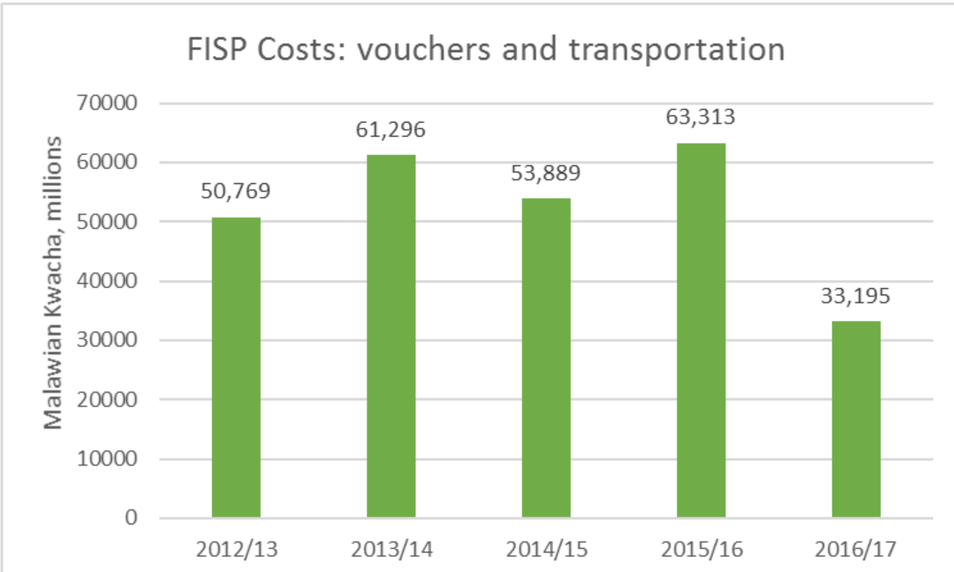


Figure 2: Costs of FISP in Malawian Kwacha. 2016-17 does not include transportation costs. The cost of the program in 2012 in USD translates to 144 million USD. In 2012, the kwacha was devalued. Using an exchange rate of 730 kwacha to the USD from 2013-16, this translates to $83,967,123; $73,820,548; $86,730,137; $45,472,60. Source: Logistics Unit, calculations by author.

3 Parameters of Study

The vast majority of studies on maize in Malawi are agronomic in nature and focus on productivity. A smaller but still significant body of studies consider maize-centered diets in relation to nutrition or food security. Many researchers have discussed the problems of maize-centricity in Malawi and the southern Africa region, but fewer have looked at the conditions that foster maize-centricity. Our contribution here is to look at several of the stocks and flows that shape the maize agrifood system in relation to actors in the system, and to draw attention to the multiple reinforcing ways that maize stays entrenched. That is, this research builds on the existing body of knowledge by ‘locating responsibility in the system’ and ‘looking for ways that the system creates its own behavior’ (Meadows, 2008). The TEEBAgriFood framework provides the organizational framework for the inquiry and an extensive review of the literature informs the analysis.

In some cases, analyses were conducted by the author based on methods established elsewhere, e.g. externalities associated with urea production, transportation and application. In other cases, analyses were drawn from reports conducted by other organizations, e.g. the cost of poor nutrition. All graphs

[13] This number is sourced from the Malawi budget statement. It was not included in Figure 2 because the numbers in the figure represent an accounting of what was actually spent rather than what is allocated in the budget.

were generated by the author based on publicly available data, typically from the UN Food and Agriculture Organization and World Bank. Data sources are noted by graph.

4 FISP: Considering Inputs and Associated Dependencies

This section discusses some of the major, but hidden, costs of the maize-based food system in Malawi. One overriding theme stands out: the focus on maize-led development in relation to inputs, many of which are imported from outside Malawi, has interfered with developing the capacity of the agrifood system to drive change from within Malawi.

The increase in maize output is an overly simplistic indicator for a much more complex story. This section begins to unpack that complexity by looking more deeply at the hidden costs of increased maize production. The section is divided into three major subsections: fertilizer, seeds, and factors of entrenchment. Following Donella Meadows (2008), this section also locates responsibility in the system, a component of the TEEBAgriFood framing that falls under the heading of 'dependencies.' In this way, it becomes possible to perceive a concentration of power, one of the major reasons that systems remain locked in or entrenched (IPES, 2016a).

4.1 Fertilizer

Figure 3 demonstrates the upward climb of maize yields in association with increasing nitrogen use since the inception of FISP. The dips in maize production are associated with adverse environmental conditions, such as widespread drought or flooding, but overall research has found that supply has exceeded demand since FISP was implemented (Dorward et al., 2013).

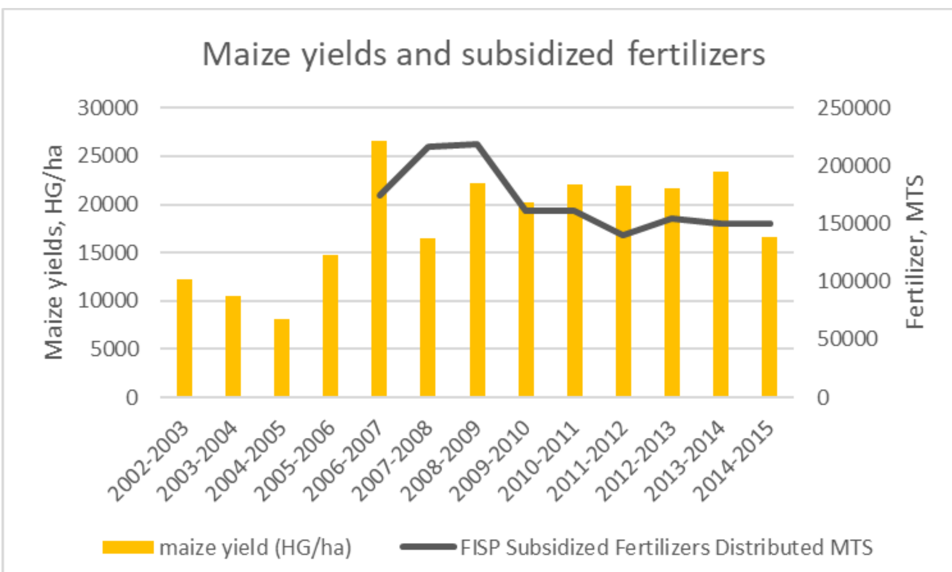


Figure 3: Recorded national maize yields, 2002-2015, Source: FAO and FISP Logistics Unit

Raising maize productivity, regarded as a central tenet of food security in Malawi, is largely construed as an outcome of improved access to modern inputs (Bezner Kerr & Patel, 2014). This section looks more closely at capital flows and associated hidden costs of modern inputs, i.e. fertilizers and improved seeds.

Fertilizer costs are typically accounted for in relation to financial capital used purchase, transport, and distribute it, which are considerable and are discussed below. However, there are also costs to society that relate to greenhouse gas emissions during its fabrication, transport, and field applications.[14] Quantifying emissions during production is highly dependent on the technology used to produce the

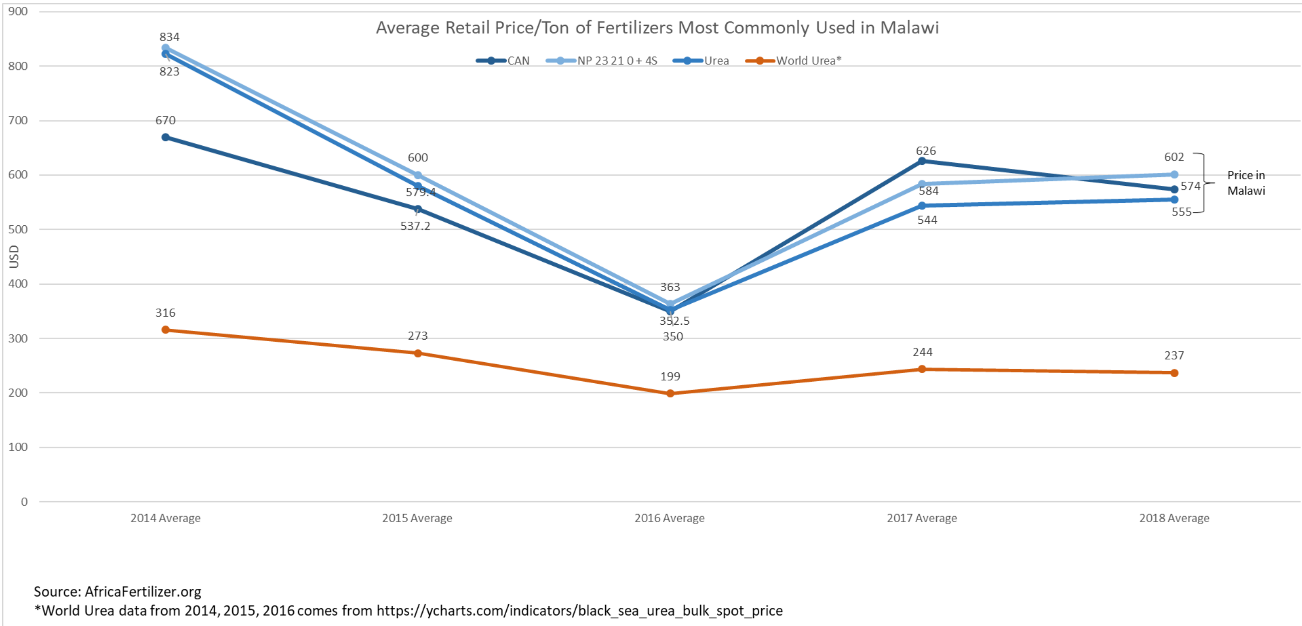


Figure 4: Recent Average Fertilizer Prices in Malawi, compared to Urea world price

fertilizer, while quantifying it in the field is highly dependent on local agroecological conditions, farmer management, and various other factors.

In terms of financial capital, the costs of acquiring fertilizer are among the highest in eastern and southern Africa. **Figure 4** shows the average retail price for fertilizer in Malawi compared to the average world urea price from 2014-2018.

In part, this is because Malawi is a landlocked country and must import from coastal ports. Fertilizer is shipped to Africa most frequently from the Black Sea, the United States (via the Gulf of Mexico), and the Middle East. Most often, it comes to Malawi through Durban even though Dar es Salaam in Tanzania is much closer (1506.2 miles vs. 933.8 miles, see the insert "Fertilizer, Freight Transport, and Air Pollution") (Roberts & Vilakazi, 2015). Distribution of inputs are reliant on geographically extensive transportation networks, with plenty of opportunities for delay along the way that are not related to poor infrastructure, but to, for example, delays and backups in ports and at borders due to regulations in countries that neighbor Malawi. However, transportation costs are considerably higher than in

Fertilizer, Freight Transport, and Air Pollution

Road transportation is the most frequent method for moving freight in southern Africa. Vehicular freight transport is responsible for significant air pollution and greenhouse gas emissions. A study from 2011 found that improving the efficiency of road freight transport offered high potential for reducing emissions (Thambiran & Diab, 2011). Only Kenya, Uganda, Tanzania, Burundi, and Rwanda have implemented standards on low sulfur fuels, which perhaps explains why transporters moving fertilizer to Malawi most often travel from Durban, despite the longer route.

[14] It is important to note here that Malawi is responsible for less than 1% of GHG emissions.

neighboring Zambia, also a landlocked country, which suggests other factors are at play. Roberts & Vilakazi (2016) suggest that powerful trucking lobbies and minimal competition are two reasons costs are so high.

Malawian government contracting practices around fertilizer transport result in payments that are considerably higher than what other organizations pay for transport. For example, according to Mangelsdorf et al. (2014), the World Food Programme contracted transport costs were 30% lower than the Malawian government's fertilizer transport costs. In addition, delays are common and extreme. For example, a study by Mangelsdorf et al. (2014) shows that passenger travel time from Durban to Lilongwe is 30 hours, whereas freight transit time is five days. From Dar-es-salaam, a passenger traveling to Lilongwe can expect to make the trip in 21 hours, where as a freight truck takes anywhere from four days to three months.

From a purely monetary standpoint, some studies point to a low cost/benefit ratio compared to the very high cost of the program. Ricker-Gilbert & Jayne (2017), for example, say, "Relatively low rates of return from subsidised fertiliser on maize production indicate that there is very little possibility that the benefits of these programmes in terms of maize output can cover their full implementation costs. Low benefit/cost ratios limit programme sustainability, and raise the need for interventions that complement subsidies for inorganic fertilizer." Because soil management strategies that increase soil organic matter would improve the efficacy of fertilizers, the authors go on to suggest that farmers' participation in FISP should be contingent on their willingness to implement soil management strategies that would increase returns.

Though conditioning farmers, rather than collaborating with or incentivizing them, is probably counterproductive, Ricker-Gilbert & Jayne's observation is important and dovetails with efforts to create measurement systems that are more attentive to quantifying externalities. A recent 'true cost accounting' study in neighboring Zambia, for example, found that the economic efficiency of fertilizer can be improved over time with investments into cover crops and applications of compost (Bandel & Nerger, 2018). Importantly, implementing sustainable soil management strategies is a knowledge-intensive human capital development process that would require large investments.

Nitrogen is the single most limiting factor in Malawi's maize-intensive system and considerable resources are devoted to acquiring it. Urea is commonly used in Malawi and is part of the FISP allocations. Among nitrogen fertilizers, urea has lower GHG emissions associated with its production, but higher emissions in the field (HESQ & Fossum, 2014).

The following calculation of the hidden costs of urea use is based on a paper from Munawar, Ubaura, Goto & Fujie (2003) focusing on urea production emissions in Indonesia. The figure of 114 USD/tonne CO_2 is from a 2014 FAO figure.

- For FISP 2016/17, 44,735 MTS of urea were distributed at a cost of 13,434,675,000MK (half of cost of all fertilizer because urea and NPK are distributed in relatively equal portions).
- Munawar et al. (2003) estimate that urea production generates 275 MTS of direct and indirect CO_2 and other GHG emissions per thousand tons of urea produced.
- 44,735 MTS of urea would produce 12,292.5 MTS of direct and indirect CO_2 emissions (44.7 x 275 MTS)

- Based on the figure of 114 USD/tonne CO_2, this represents an additional cost of **1,401,345 USD hidden costs.**

ANNUAL CO_2 EMISSIONS FROM UREA APPLICATION

CO_2–C Emission = M • EF

Multiply by 44/12 to convert CO_2–C emissions into CO_2

CO_2–C Emission = annual C emissions from urea application, tonnes C yr-1

M = annual amount of urea fertilisation, tonnes urea yr-1

EF = emission factor, tonne of C (tonne of urea)-1. For urea, this is .2

Other emissions accrue with transport to Malawi but would require some approximation of emissions associated with ship and vehicle transport, as well as approximations of emissions per unit of space occupied (by the fertilizer on a ship or a truck), which are unavailable. Though shipping is comparatively efficient among methods of transportation, the kind of fuel that cargo ships use is more carbon-intensive than other fuels. The shipping industry generates around three percent of total global greenhouse gases (Green, 2018).[15]

Once applied to the field, urea quickly hydrolyses and releases CO_2 in the process. Estimates for CO_2 lost after application are based on guidance from 2006 IPCC Guidelines, p. 11.32 (De Klein et al., 2006).

As with the production figures, this estimate applies only to urea applications as part of the FISP.

- 44,735 MTS Urea x .2=8947
- 8947 x 44/12 (or 3.67)=32,835 tons of CO_2
- 32,835 x 114USD=**3,743,246 USD hidden costs**

4.2 Seeds

Maize is a notoriously finicky plant. Its extreme sensitivity to water and light deprivation make it a poor staple to rely on in the context of climate change. Many in the development community, however, assert that its importance to food security warrants investing in research to create modern hybrids that are 'climate-smart,' which means breeding it to be more drought resistant or capable of growing in shortened rainy seasons. A key message of the corporate seed sector and of Malawi's National Agricultural Investment Plan is that modern technology is required to create 'broad-based and resilient agricultural growth.'

Bezner Kerr (2013), however, argues that investing in a modern seed sector undermines (1) food sovereignty by outsourcing seed breeding to the corporate seed sector, and (2) food security by shifting seed selection away from flint varieties towards dent varieties that have a less desirable flour-to-grain ratio, poorer storage capacity, higher external input requirements, and are more prone to pest infestation. Moreover, because local agricultural knowledge is tied to seed selection, Bezner Kerr argues that outsourcing seed development and distributing those seeds through FISP and other charitable organizations has a hidden cost of degrading local agricultural knowledge and seed exchange networks (which likely serve as a platform for other kinds of important social interaction and ties, and, potentially,

[15] Worth noting here is that the some important shipping industry actors have recently shown an impressive commitment to go carbon-neutral by 2050: https://www.reuters.com/article/us-maersk-emissions/worlds-largest-container-shipper-maerskaims-to-be-co2-neutral-by-2050-idUSKBN1O40QW.

a critical forum to leverage towards building agrifood system resilience). FISP promotes hybrids, and knowledge about those seeds comes to farmers through agrodealers who are trained by major companies on how to use the seed (Audet-Bélanger, Gildemacher & Hoogendoorn, 2016). Similarly, while FISP has stimulated local maize seed marketing and entrepreneurship, it has stagnated development of other seed enterprises, resulting in a vulnerable seed sector rather than a vibrant and responsive one (Zidana et al., 2012).[16]

Hybrid maize, smallholders, and a commercial seed sector

…for African smallholder farmers…to sustain the yield increases they seek, they are reliant on a seed industry in a way that neither the rice nor wheat farmers of Asia's green revolution ever have been. On the other hand, a hybrid-based maize sector also requires large-scale commercial seed enterprises whose profits can be sustained only by strong seasonal demand by farmers for renewing their seed. (Haggblade & Hazell, 2010).

Leading Seed Companies in Malawi

Multinational seed companies carry out seed breeding, production, multiplication, processing and distribution of mainly hybrid maize. Local seed companies are involved **only** in seed multiplication and distribution. Malawi's main seed companies are Seed Co, Monsanto (Bayer), DowDuPont (Pannar), Demeter, and MUSECO. (Mujaju, 2018)

Moreover, though some researchers frame the increased use of hybrid seed by farmers as a function of farmer preference (Denning et al., 2009), others are more circumspect, and question the sustained demand for, and thus viability of, a hybrid seed sector once subsidies are discontinued (Bezner Kerr, 2013; Hoogendoorn et al., 2018). Because the private sector has become the "main driving force behind the maize seed value chain" the seed landscape is more heavily characterized by hybrids due to "clear financial benefits," but increasingly less agrobiodiverse, a recognized key quality of resilient and adaptive agroecosystems (Audet-Bélanger et al., p. 17).

Lastly, in an environment of scarce research funding, it is important to highlight how available research funds are distributed. Though climate change is likely to reduce the viability of growing maize throughout Africa, public investment into maize breeding outpaces investment into any other crop or research program in the CGIAR system. Allocation of resources, of course, defines the supply-side of research and has an impact on the direction and substance of innovation and adaptation to climate change.[17] The following charts contain data drawn from CGIAR financial reports.

The International Maize and Wheat Improvement Center (CIMMYT) receives more funding than any other CGIAR institution (**Figure 5**). The International Crops Research Institute for the Semi-Arid Tropics

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[16] Research by McGuire & Sperling (2016) highlights the continuing importance of local seed markets, especially for women. This research highlights the degree to which local seed systems are already market oriented, as reflected by the majority number of farmers who pay for seed. However, these market transactions do not 'read' as commercialization, a key objective of the new agricultural strategy, because they occur in what are commonly referred to as 'informal markets.' They observe that "the array of crops needed for production, nutrition and resilience goals will not likely be promoted via a commercialized formal sector approach alone" (p. 190). They go onto suggest that there is a "need to address the imbalance in seed channel focus so as to give attention to the main seed systems smallholders use, including several informal channels" (p. 190).

[17] Later in this report, the discussion turns towards the implications of a supply driven extension system. In short, a supply driven extension system is less responsive to the stated needs of agrifood system actors.

(ICRISAT) is the institution that is responsible for investing into some of the lesser known, but more adaptable, dryland grains, such as millet and sorghum. It has consistently received tens of millions of dollars less than CIMMYT. Likewise, there is a huge funding differential between programs that support maize breeding and those that support crops better suited to unpredictable production environments (**Figure 6**).

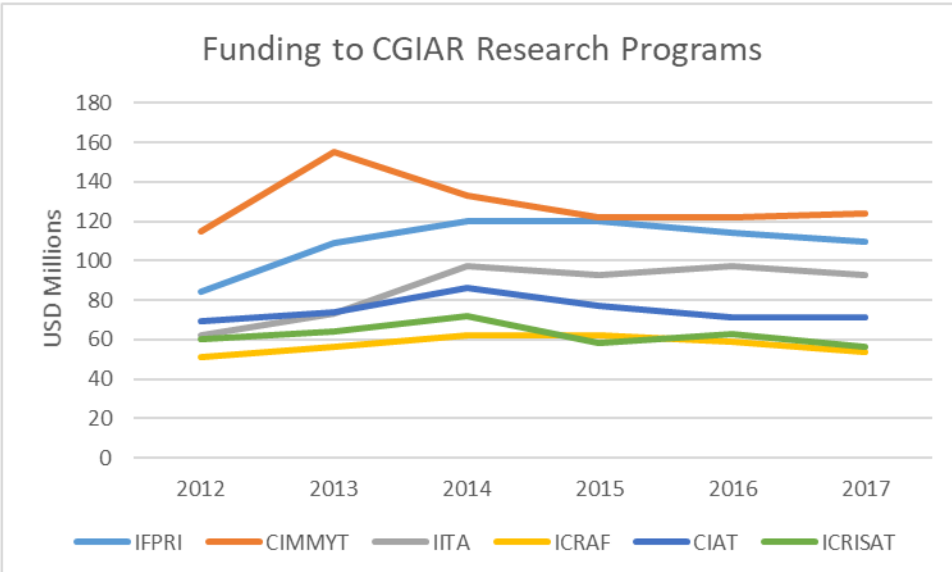


Figure 5: Funding to select CGIAR research programs. Source: CGIAR annual financial reports

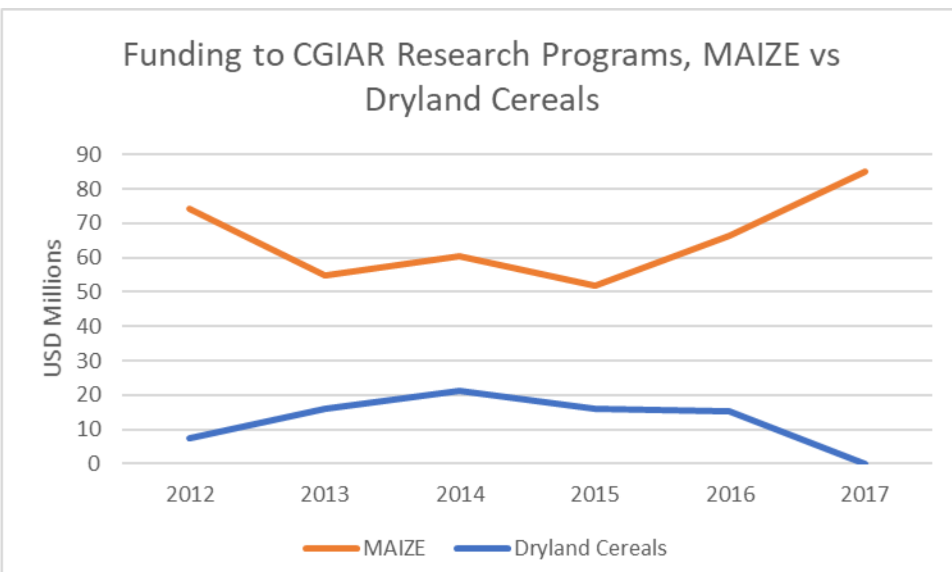


*Figure 6: Differential Funding to MAIZE and Dryland Cereals. Note: *The program on Grain Legumes and Dryland Cereals was restructured and approved for implementation starting in 2018 and thus has no revenue or expenditure in 2017*

Within CIMMYT (**Figure 7**), the research program MAIZE focuses on "increasing maize production for 900 million poor consumers in Africa, South Asia, and Latin America for whom maize is a staple food." The collaboration involved "more than 300 partners from public and private sectors to mobilize global

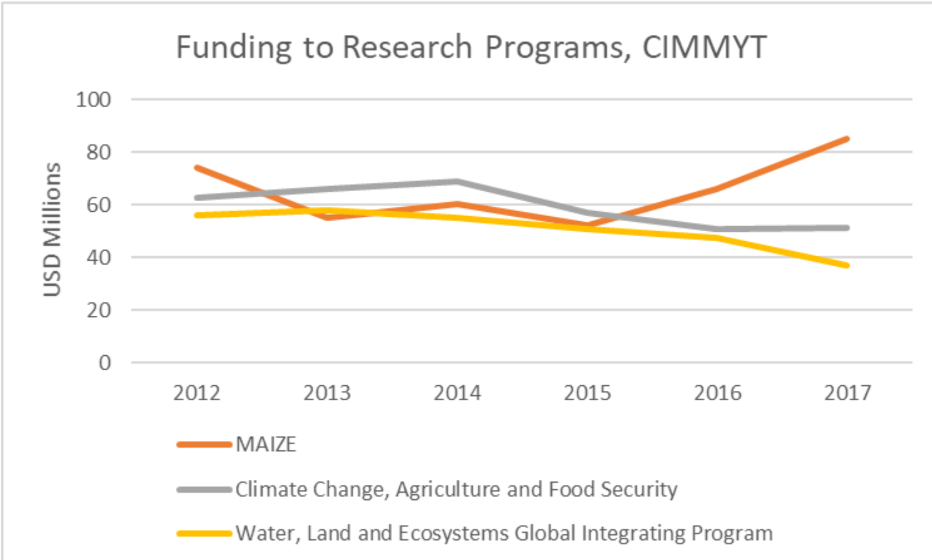


Figure 7: Funding to CIMMYT programs

resources in maize research and development to achieve greater strategic impact on maize-based farming systems."[18] Representative MAIZE themes include sustainable intensification of maize; genetic improvements; stress resilient and nutritious maize; and, aligning with strengthening maize seed systems for effective product delivery. In contrast, representative Climate Change, Agriculture, and Food Security themes include adaptation to progressive climate change, managing climate risk, pro-poor mitigation, integration for decision-making, and gender strategies.

4.3 FISP-related Maize Lock-In

Financial capital flows suggest the factors that keep the maize system locked in. The maize-intensive system in Malawi is heavily reliant on flows from external sources. From 2004-2014, distribution of inputs were carried out by parastatals ADMARC and SFFRFM. Since the 2014/15 season, FISP reforms that were ostensibly put in place to spur development of private sector input markets have served large-scale retailers and multinational companies but have marginalized, or 'crowded out' small scale retailers due to the rules conditioning eligibility (Kaiyatsa, Ricker-Gilbert & Jumbe 2018). Notably, none of the large-scale retailers or seed companies are locally owned (see the inset, "Who controls stocks and flows in Malawi's input markets? (Fertilizer edition)").

[18] https://www.cimmyt.org/maize-crp/

In addition, aid inflows are substantial, but largely finance consumption and recurrent expenditures that do not support development of the local agrifood system, including purchase of inputs. They also tend to finance emergency aid interventions, rather than strategies and projects to manage agricultural risk (Giertz, Caballero, Dileva, Galperin & Johnson, 2015). In contrast, a strategy focused on export agriculture or yield increases would ostensibly support the development of local input and output markets and networks (Jayne, Chapoto, & Govereh, 2010). This would mean supporting and working with independent fertilizer dealers throughout Malawi who "play a critical role in meeting the input needs of rural communities in various ways" that large-scale retailers do not (Kaiyatsa et al., 2018). Local independent retailers, for example, shorten the distance farmers must travel to acquire inputs; they sell fertilizer in smaller quantities than do large-scale retailers; and, they are open year-round, unlike ADMARC and SFFRFM, which are functional for only a short time during the growing season (Kaiyatsa et al., 2018).

Who controls stocks and flows in Malawi's input markets? (Fertilizer Edition)

According to Kaiyatsa et al. (2018), private fertilizer dealers in Malawi can be categorized into two groups: large-scale corporate organizations and local, small-scale independent dealers. Large-scale dealers import around 93% of fertilizers into Malawi and include Farmers' World, Export Trading Group (ETG), Nyiombo Investment, Transglobe, Agora, and Kulima Gold.

- Transglobe is a Dubai-based company specializing in fertilizers
- Kulima Gold is a RAB Processors company, which is Indian owned.
- ETG, established in Kenya, is also Indian-owned. The company produces and sells fertilizers, seeds, and other chemical inputs.
- Nyiombo Investments is a Zambian based company, small by comparison with Farmers' World, Transglobe, and Agora
- Farmers' World and Agora are both Meridian subsidiaries. Meridian is based in Mauritius.

Meridian was bought out by Phatisa in 2014. Phatisa is a private equity firm that manages the African Agriculture Fund (AAF) (http://www.phatisa.com/funds/aaf/), a private equity fund "investing in the agriculture and food processing sector across the continent." AAF manages the Technical Assistance Facility, a grant-based facility that supports capacity building for small and medium sized enterprises (SMEs) invested in by the AAF and its SME sub-fund the AAF SME Fund, aiming to improve linkages between outgrowers, smallholders and the AAF portfolio companies."

5 Outcomes and Impacts

Ideally, a food system produces a well-nourished population while sustainably using natural resources. It should also offer equitable opportunity for sustainable, remunerative, and fulfilling livelihoods. This section discusses the outcomes, or changes in the capital base, produced by FISP and a maize-centric food system, and the impacts those outcomes have on human well-being. Four areas are discussed: nutrition, prices and access to food, extension and access to information/skills, and soil fertility and forests.

5.1 Nutrition

Though the maize boom may have increased the overall number of calories consumed, it has done very little to improve nutrition outcomes (Aberman et al., 2015). As of 2016, 37% of children under five suffer from chronic malnutrition and 30-43% are stunted depending on education levels of their mothers

(USAID, 2018). Children living in urban areas experience less undernutrition and stunting; about a quarter of children in Malawi's cities and towns are stunted (USAID, 2018).

5.1.1 The costs of poor nutrition in Malawi

Maize comprises the dominant share of calorie intake in Malawian diets. The World Food Programme recommends that starchy staples make up just 38% of daily calorie intake; in Malawi, however, starchy staples comprise 73-85% of diets, a share that increases when the price of maize drops (Mazunda & Droppelmann, 2012). A nutritious and diverse diet, which is required for proper physical and mental development, contains sufficient levels of essential proteins, vitamins, and minerals. A diet comprised primarily of maize has deleterious effects on individuals and, by extension, the whole community.

Poor nutrition in childhood has cascading effects throughout life: people are more predisposed to recurring illness and impaired cognitive and physical development leads to poor outcomes in school, work, and overall self-actualization. The costs of undernutrition are borne by both the public sector and families. A 2015 report by the World Food Programme looks at the costs of malnourishment in Malawi in relation to three broad categories:

- Health: undernutrition leads to low birthweight children and increased morbidity. Families and the public sector bear costs related to recurring illness, diarrhea, increased respiratory infection, and increased risk of malaria. Treating undernutrition and related illnesses is a recurrent cost for both families and the health system, and can be very expensive, especially if the malnutrition is extreme. Levels of anemia are particularly high and are an outcome of diets comprised primarily of maize but low in fruits, fats, and other nutritionally rich food. Chronic undernutrition leads to stunting, which has cascading effects later in life. The total costs of poor nutrition to health are estimated to be .8% of Malawi's 2012 GDP.
- Education & Self-Actualization: Undernutrition and stunting early in life reduces an individual's capability to perform in school. The public sector and families pay for underperformance in school directly when a student has to repeat grades or drops out of school early. The report estimates that only 43% of children who were stunted complete primary school versus 60% of children who were not stunted. The total costs of poor nutrition on education are estimated to be .24% of Malawi's 2012 GDP.
- Productivity: Less education reduces lifetime earning potential by relegating people to lower paying jobs. As it relates to manual labor, poor nutrition early in life have less lean body mass later in life, and reduced capacity to perform strenuous work. The economic costs of lost productivity due to poor nutrition for 2012 are estimated at 9.3% of Malawi's GDP.
- The overall costs of poor nutrition in 2012 were estimated at 10.3% of Malawi's GDP, or 603,000,000 USD. This represents financial losses to both families and governments that could have been invested elsewhere to build human, social, and other forms of capital. In the absence of concerted effort to improve outcomes and because of projected population growth, the overall numbers of people experiencing undernutrition will grow, which will increase the overall costs to society.

5.1.2 FISP and nutrition

Clearly, the lack of nutritional diversity is detrimental to individual and community development. Nevertheless, food security in Malawi has long been associated with maize security. Thus, the increased yields brought about by FISP have been seen by some as a program that enables Malawi to 'feed its own people' and "pointed a way for Africa to overcome its chronic hunger, food insecurity, and periodic extreme famines" (Sachs, 2012).

Obviously, a diet overly comprised of maize is not conducive to good nutrition, but one rationale underlying FISP is that increased maize production leads to increased incomes, which, in turn, leads to gains in purchasing power. That is, infusions of produced capital should lead to increased agricultural outputs, which, in turn, should lead to gains in financial capital that could be used to purchase a more diverse diet. This widespread improvement at the household level would then lead to improvements at a national level.

A second rationale is that intensified production at the farm level results in farmers being able to produce more maize on a smaller parcel of land, thus freeing up space to diversify production, which, in turn, provides another source of income or an increasingly diversified diet (Snapp & Fisher, 2015).

Recent research shows that both rationales are faulty, and, on their own, do not lead to improved dietary diversity. Snapp & Fisher (2015) found that FISP (i.e. the use of fertilizer and modern hybrid varieties) did result in improved dietary diversity in the 2009/10 season, but did not attribute the improvement to any one pathway, i.e. increased income vs. increased crop diversity. Kankwamba, Mapila, & Pauw (2012) found the same, but that national and regional crop diversity had deteriorated. Similarly, Chibwana, Fisher, & Shively (2012) found that farmers allocated land to maize at the expense of other crops. Findings suggest that a FISP targeted solely at maize production encourages farmers to produce maize preferentially so that they can receive the subsidy, but to reduce the amount of land allocated to other crops, thus reducing the surplus available for market. While it is not possible to categorically link reduced national crop diversity to national nutritional security, the displacement of other crops could have repercussions in

Re-building Nutritious Diets through Existing Food System Diversity

To move away from maize-centricity, a stated goal of the Malawian government, it is important to note that Malawians diversify their diets in a number of ways. Those practices, as well as the kinds of foods that are preferred, can potentially form a foundation for programs that simultaneously support nutritious diets, regenerative farming practices, and improved livelihood opportunities.

Livelihood and Local Markets

Existing small-scale food provisioning and exchange systems offer many opportunities to support trade in nutritious food. Such food exchange practices are widespread and comprise what is commonly referred to as the 'informal sector.' Though most people acquire their food through this sector, few resources have been devoted to supporting it. Consequently, the system and the people working in it suffer under the weight of failing/minimal infrastructure, costly expenses, and various inefficiencies that negatively influence food exchange. Research conducted by White et al (2017, 2018) shed light on this sector in Malawi.

Nutrition and Farming Practices

Malawians work to diversify their diets in multiple ways, but these practices and preferences typically go unexamined and do not figure into efforts to further diversify diets. Research by Mauricio Bellon (2017) to identify crop and food biodiversity in Malawi found that most households grew, on average, 4.8 crops. In a sample of 340 households, researchers identified more than 30 annual crops (Bellon, personal communication). Transitioning away from maize will entail, in part, better articulating the nutrition and income possibilities that exist with these crops, and building extension programs that serve farmers' efforts to diversify.

urban areas or among landless farmers vis-à-vis increased prices or reduced food availability. Moreover, because the post-farm value chain is a source of income for many Malawians, continuing crop reduction could also threaten the livelihood of many small-scale retailers and transporters.

A recent comprehensive survey of research carried out during 2014-2017 on whether production diversity increases nutrition diversity finds that production diversity is only one, albeit robust, factor in improved dietary diversity. Also crucially important is market participation, which authors say has a greater effect on dietary diversity than crop diversity (Ruel, Quisumbing, & Balagamwala, 2018). Market participation is conditioned by a range of social, economic, and geographic factors: distance to market, gender, wealth, control of household decisions, and the specific nature of farm diversity are all important criteria (Jones, Shrinivas, & Bezner Kerr, 2014).

5.2 Maize price volatility

Figure 8 illustrates the extreme price volatility of maize in three locations over a twelve-year period.

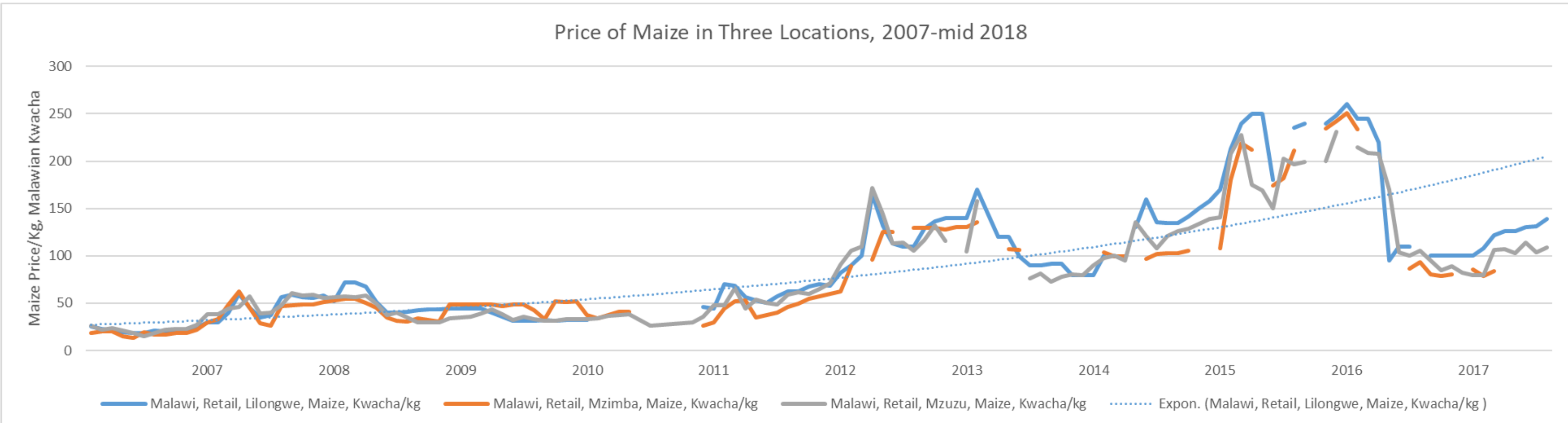


Figure 8: Maize price volatility, nominal values. Source: http://www.fao.org/giews/food-prices/tool/public/#/dataset/domestic

Maize price volatility is a key factor in social and market instability. Rapid and unpredictable change in food prices means that producers and consumers never know what to expect or to prepare for, which causes widespread social anxiety. In addition, if households are unable to plan for food expenses, they may be less likely to allocate financial resources to important non-food items, such as health care, education or investments into economic activities (Cornia, Deotti, & Sassi, 2012). Food price volatility heightens seasonal food insecurity as households reduce food portions and frequency of meals. Households commonly sell other forms of capital, such as livestock, or members of the family may migrate to other areas to seek work (Sassi, 2014).

There are multiple causes of volatility, including,

- Heavy reliance on seasonal production cycle, which is exacerbated by reliance on a single crop (Ellis & Manda, 2012; Bezner Kerr & Patel, 2014). In Malawi, the lowest prices occur at harvest time from April to June, while the highest prices occur in February, just before harvest. The effects of climate change increase production variation and unpredictability (Sassi, 2014).
- Lack of on-farm infrastructure that would permit long-term storage. Farmers who lack good storage facilities or need to repay debts commonly sell much of what they produce soon after harvest and then need to buy food once they have exhausted their stocks. As farmers increasingly enter markets to purchase food, national food supplies decrease and prices increase (Cornia et al., 2012; Jayne et al., 2010).
- Government interventions ostensibly stabilize markets but often have the opposite effect of destabilizing them and hindering the flow of food. Research indicates that government practices and institutional responses in Malawi compound the effects of seasonality more than other countries in the region (Ellis & Manda, 2012; Gilbert, Christiaensen & Kaminski, 2017; Jayne & Tschirley, 2009; Sassi, 2014). Government sets fixed buying/selling prices of maize and imposes export bans, which reduces options for farmers. Though this practice may benefit the urban poor, it also tends to reinforce subsistence agriculture (Aragie, Pauw & Pernechele, 2018).

Surprisingly, neither the price of oil nor volatility of the oil market typically influences discussions of maize price volatility or the ways in which a reliance on external fossil fuel inputs puts the system at risk. Fossil fuels are a key dependency of the FISP system vis-à-vis chemical inputs and transportation of nutrients to Malawi. The current conventional wisdom is that such ‘modern’ inputs are necessary and should play an even greater part in developing the sector.[19]

Though most contemporary maize price volatility results from internal and regional political dynamics and government practice (Sassi, 2014), long-term food security strategies must grapple with the implications of food systems tightly bound to fossil fuels and the nature of future supply and demand shocks. Rising energy prices will make manufacturing and transporting fossil-fuel based inputs prohibitively expensive, thus reducing food production outputs and increasing exposure to volatile world food markets where food prices are strongly tied to crude oil prices (Baffes & Dennis, 2013). As

[19] See for example, AGRA, “Africa must raise fertilizer rate to boost food security” (https://agra.org/news/africa-must-raise-fertilizer-rate-to-boost-food-security/) or the African Fertilizer and Agribusiness Partnership at http://www.afap-partnership.org/

fossil fuel prices increase, demand for biofuels will increase, thus producing demand-side shocks as productive capital is invested away from food and into biofuels. Furthermore, as produced and human capital is increasingly leveraged towards accessing 'modern' inputs, less capital is available for addressing the local and regional factors of food price volatility.

Resilience is a system property that refers to the quality of being able to "absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker, Holling, Carpenter, & Kinzig, 2004, p. 4). As it relates to human managed socioecological systems, such as agrifood systems, the ability to 'absorb' and 'reorganize' to remain viable implies the ability to learn and innovate in order to "adapt to a range of climate risks" (Marshall, Park, Adger, Brown, & Howden, 2012). With an overall emphasis on commercializing smallholder farmers through productivity and income gains, however, the 2016 National Agricultural Policy is likely committing Malawi to the continuation of an approach that prioritizes production through modern inputs and prescriptive agricultural practice, rather than engaging communities to grapple with environmental change, learn about potential options and alternatives, and forge new paths forward.

5.3 Agro-environmental Change and Access to Knowledge

The focus on subsidies has meant that there is minimal support to other areas of the agrifood system. Most of the available agriculture budget is used to maintain and acquire stocks of 'produced capital' (e.g. fertilizers, seeds, trucks, distribution points) and 'human capital' (truck drivers, FISP managers, agrodealers, scientists) that hold FISP in place. Consequently, there are few resources to strengthen other forms of social, human, and natural capitals that could, for example, support innovation and adaptation towards resilient agrifood systems (see inset box, "Resilience is a system property…").

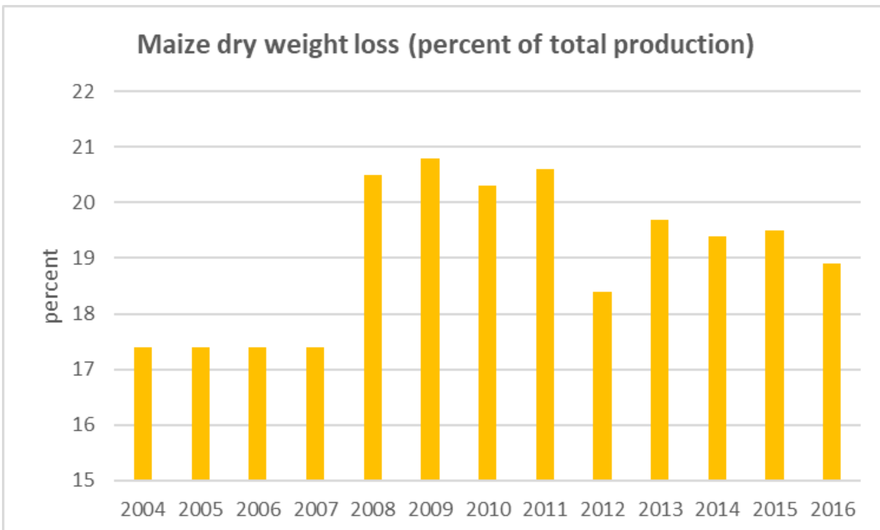
Marshall et al. (2012) argue that climate change will require the ability to mobilize resources to adapt to change. In practical terms, this means, for example, being able to effectively assess and test available options; having the means, creativity and organizational capacity to enact novel approaches; having the ability and opportunity to be flexible; managing risk; and, being able reorganize. A key and established institution for building this kind of capacity is, theoretically, Malawi's agricultural extension system. However, funding to extension services makes up just a tiny fraction of the agricultural budget (e.g. 1.6 percent in 2012), and has shrunk dramatically over the last two decades, declining from 19% of the budget in 2000 to less than 2% in 2013 (Ragasa & Mazunda, 2018; Ragasa, Mazunda & Kadzamira, 2015). Though *access* by farmers to extension services is reported to be quite high, frequency of contact is quite low and advice is heavily supply-driven and oriented towards discrete agricultural production technologies or donor-driven

Post-Harvest Loss in Malawi

The average yearly production of maize between 2004 and 2016 was 2,953,054 tonnes. ***Over that same period, 7,396,505 tonnes of maize was lost from the post-harvest value chain, about 2.5 times the average maize harvest.*** Research has shown that post-harvest loss could be addressed through better technical extension, access to material resources, and a public sector that can share some of the burden in preserving and protecting harvests.

goals (Niu & Ragasa, 2018; Ragasa & Niu, 2017). Consequently, there is "an insignificant effect of access to extension services on adoption of a selected set of improved technologies, on crop productivity, or on food security" (Ragasa & Mazunda, 2018, p. 41). Moreover, Ragasa & Mazunda found that FISP does not automatically contribute to productivity and food security, though it is more likely to do so when complemented by extension services that the farmer deems relevant.

Access to technical advice and resources to minimize post-harvest grain loss (PHL), for example, could make a major difference to food security. Abass et al. (2013) found that most grain losses attributed by farmers to changes in weather, field damage, and storage pests could have been mitigated with improved management knowledge and skills. Zorya et al. (2011) estimate that PHL ranges between 20-40%, and occurs during storage, processing, and other areas of the value chain. **Figure 9** demonstrates the percent loss of maize in Malawi from 2004-2016. The average yearly production of maize over that same period is 2,953,054 tonnes. Over the 13-year period, this works out to a cumulative loss of 7,396,505 tonnes, about 2.5 times the average yearly maize production. **Figure 11** shows where those losses occur in the value chain (the percentage loss in each part of the value chain has remained constant since 2004, the first year of data available).



Year	Tonnes Maize produced,	Tonnes Maize, PHL
2004	1,608,349	279,853
2005	1,225,234	213,191
2006	2,611,486	454,399
2007	3,226,418	561,397
2008	2,634,701	540,114
2009	3,582,502	745,160
2010	3,419,409	694,140
2011	3,699,147	762,024
2012	3,618,699	665,841
2013	3,639,866	717,054
2014	3,978,123	771,756
2015	2,776,277	541,374
2016 (est)	2,369,493	450,204

Figure 9: Maize dry weight loss, percent of total production; Maize production, loss from 2004-2016. Source: aphlis.net, knoema.com

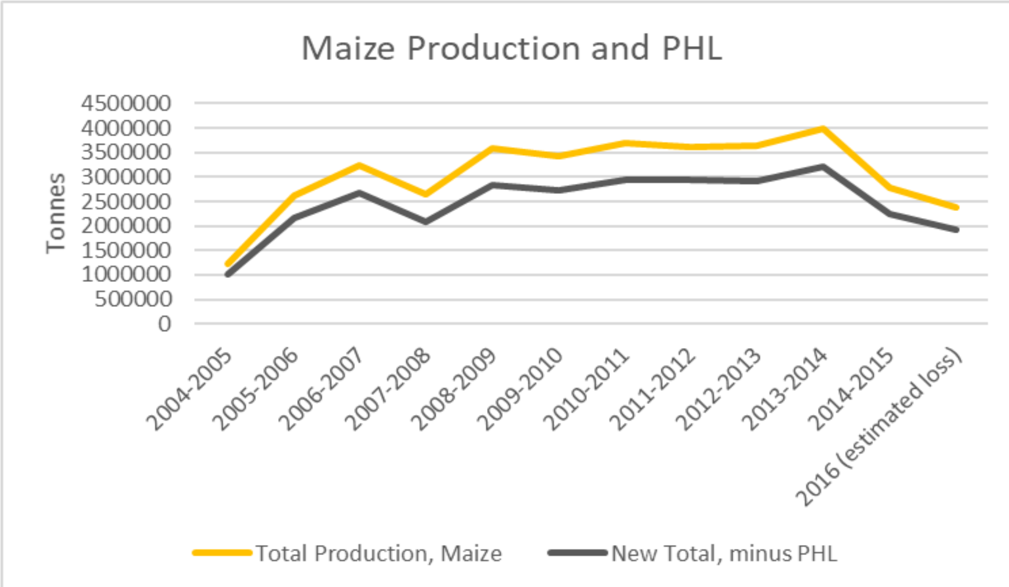


Figure 10: Total Maize Production vs Production minus PHL. Source: aphlis.net, FAO

Figure 12 depicts the producer price per tonne of maize from 2004-2016 in order to show how PHL

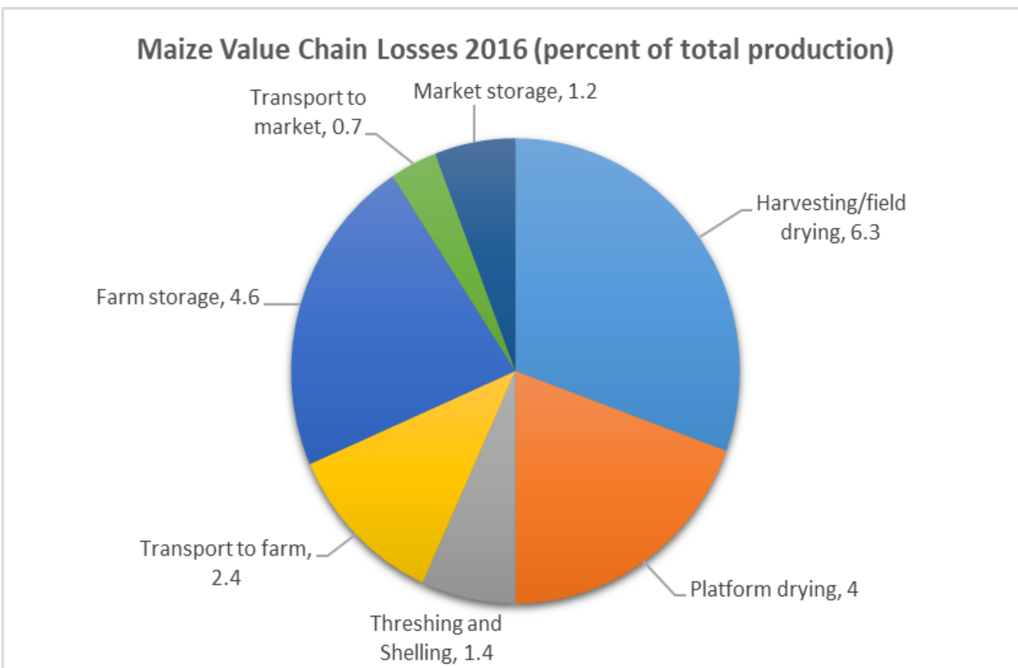


Figure 11: Where is maize lost in the value chain? (Percent of total production). Source: aphlis.net

translates to loss of value over the same period of time (**Figures 13 and 14**). Over the period from 2004-2016, **1,773,700,000 USD** was lost from the system due to PHL.

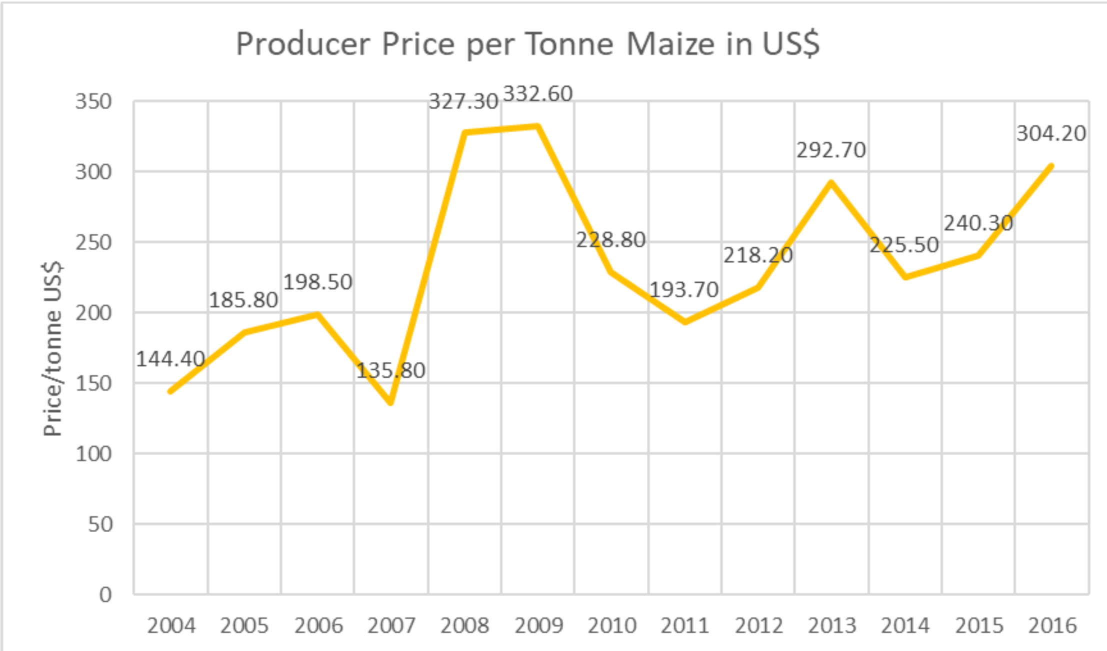


Figure 12: Producer Price per tonne of Maize, 2004-2016. Source: FAO

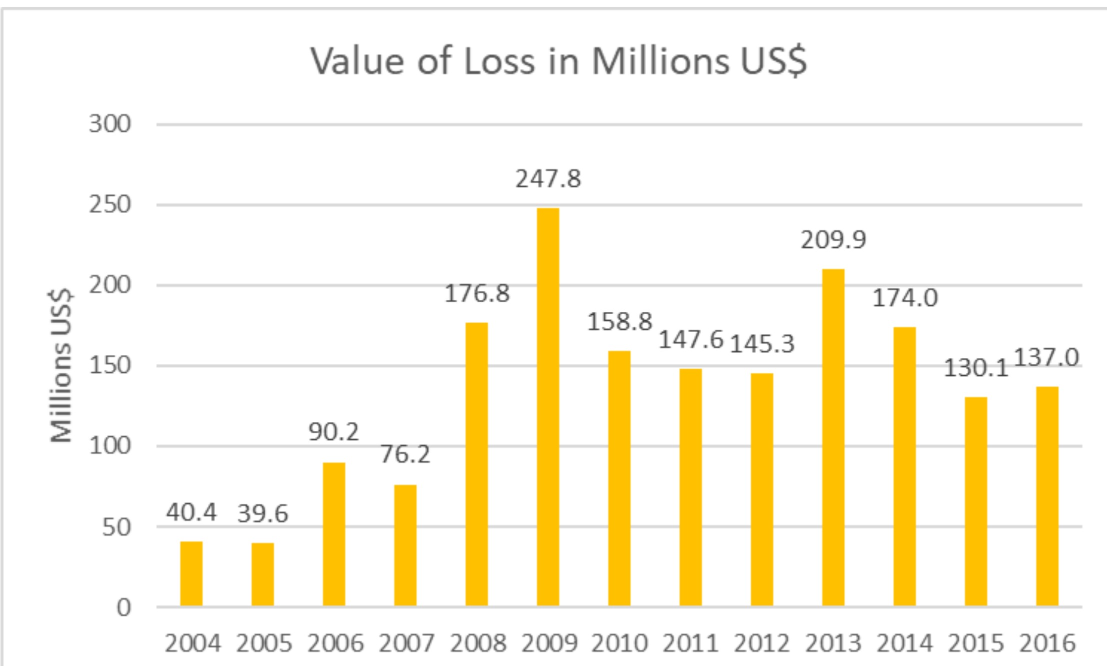


Figure 13: Monetary Value of PHL in Millions US$, 2004-2016. Source: FAO

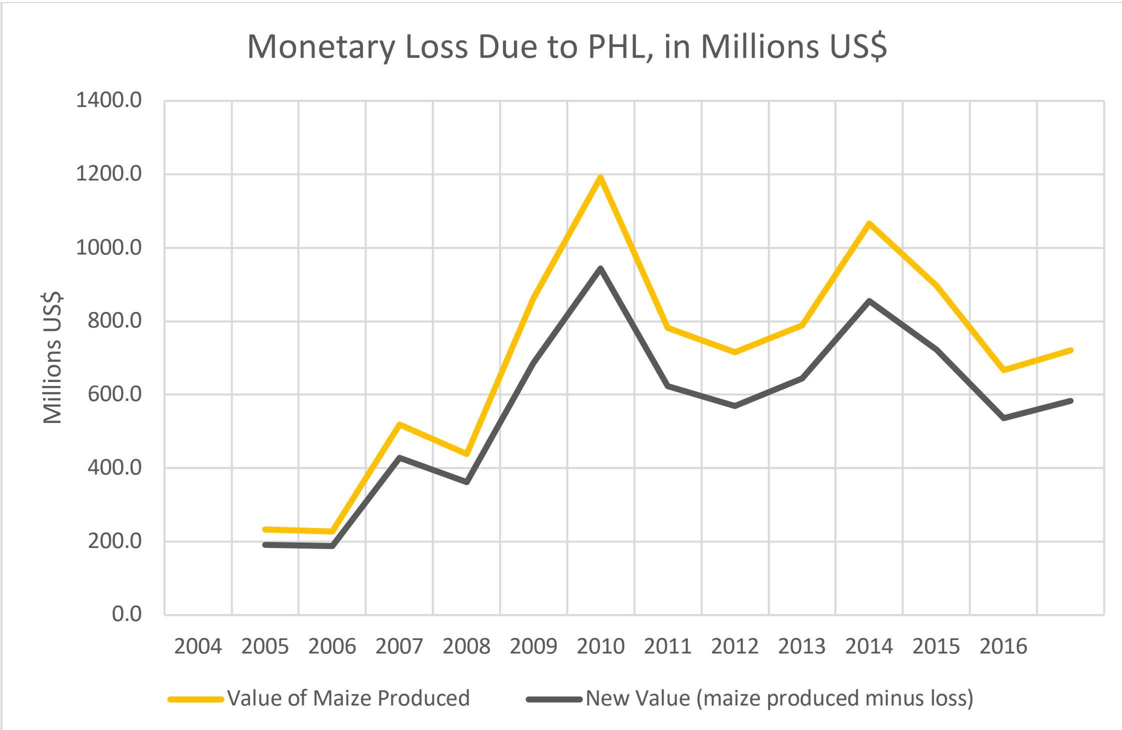


Figure 14: Monetary Loss Attributed to PHL, 2004-2016. Source: FAO

5.4 Soil Fertility and Forests

Two of the three major soil types in Malawi are conducive to agriculture but are generally highly susceptible to erosion. Due to lack of other livelihood options, high population density, and declining natural fertility, people are extensifying their cropping activities, removing forests and wetlands, cultivating on steep slopes, and using highly degradable, shallow soils (Vargas & Omuto, 2016). Sustainable land management practices are not widely used and crop rotations are practiced on only 1% of farms (Kiptoo & Mirzabaev, 2015). Though soil degradation rates vary throughout the country, soils generally suffer due to continuous cropping of maize on small tracts of land and are low in available N and soil organic matter (Mungai et al., 2018; Snapp, 1998). In 2014, an average of 29 ton/ha/year of soil was eroding from Malawi's agroecosystems. Soil loss was particularly high in the southern and northern regions and in areas with steep slopes, shallow soil, and sparse vegetative cover (Vargas & Omuto, 2016). Consequently, soil fertility is declining, especially available nitrogen, which must primarily be added with chemical inputs (Bezner-Kerr & Patel, 2014).

According to Vargas and Omuto (2016), between the years of 1991-2010, natural forest cover declined by 9%, while land allocated to agriculture grew by 9%. Soil loss translates into agricultural yield losses of

Economic Valuation of Sustainable Natural Resource Use in Malawi

Two detailed reports provide economic valuation of Malawi's natural resource base and offer policy options and possible interventions for mitigating poverty through improved natural resource management.

Economic Valuation of Sustainable Natural Resource Use in Malawi, 2011: "The primary aim of the study is to provide evidence on the costs and benefits of sustainable and unsustainable natural resource management (NRM) in Malawi for four selected natural resources: forestry resources, fisheries resources, wildlife resources and soils. The analysis establishes linkages between natural resource management on the one hand, and poverty reduction, economic well-being and development on the other. Further, we draw on case studies and other evidence to assess the net benefits of key interventions to encourage more sustainable natural resource use in each selected NR sector." Depending on sector, various valuation methods were used.

Overcoming Poverty in Malawi through Sustainable Environment and Natural Resource Management: Identifying Policy Options to Accelerate Poverty Reduction, 2016: "The objectives include quantifying identified environment and natural resource (ENR)-poverty linkages in Malawi in terms of the impact on various aspects of poverty and identifying policy options to accelerate poverty reduction through the more sustainable use of ENR. In so doing, the study demonstrates how unsustainable ENR use and environmental degradation impact on poverty levels." As it relates to supporting the agriculture sector, the study recommends, "there is need to review the resource allocation patterns within a given sector (intra-sectoral resource allocation review) to prioritize investments in agricultural research and development, agricultural extension services and training to improve smallholder productivity and sustainability."

4-25%, while forest loss translates into losses of animal habitat, biodiversity, medicinal plants, timber and non-timber forest products, and food (Vargas & Omuto, 2016; Yaron et al., 2010). Malawi has a comparatively high deforestation rate of 2.5% per annum (Maseko, Shackleton, Nagoli, & Pullanikkatil, 2017), which, according to a recent report by the UNDP-UNEP Poverty-Environment Initiative, translates to a loss of income to 18% of households in the amount of $60 million (UNDP & UNEP, 2016).[20] The loss of forests and wild food sources is particularly detrimental for children and poor households who depend on them for dietary diversity (Johnson, Jacob & Brown, 2013; Maseko et al., 2017; Rasolofoson, Hanauer, Pappinen, Fisher, & Ricketts, 2018). Kiptoo & Mirzabaev (2015) estimate that between 9.5-11% of Malawi's annual GDP is lost to land degradation.

[20] That report estimates that a one percent reduction in forest cover translates to a loss of income of nearly US$24 million/year.

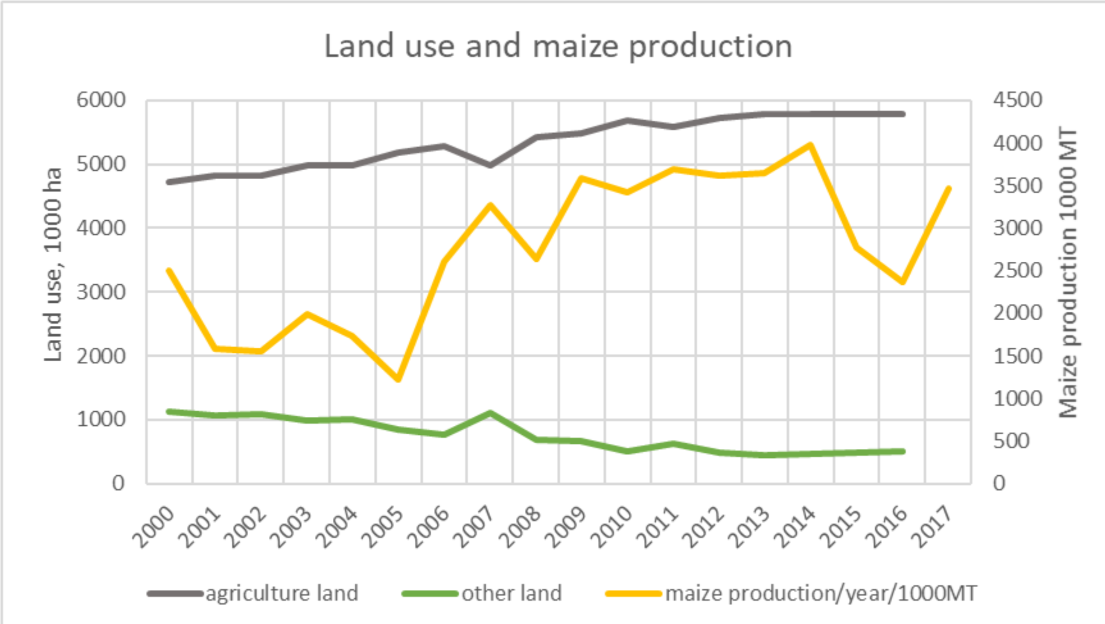


Figure 12: Maize production and changing land use. Source: FAO

There are multiple causes of land degradation in addition to unsustainable agricultural practices, including charcoal production and wood fuel harvesting. Like unsustainable agricultural practices, unsustainable charcoal production and wood fuel harvesting are caused by underlying factors of poverty, population pressures, a lack of livelihood options, and national policies that undermine sustainable land management (Kiptoo & Mirzabaev, 2015). Though FISP has not been subject to an environmental impact assessment, a number of researchers have identified the ways in which it drives extensification and unsustainable land management practices, including maize monocropping (Chibwana et al., 2012; Kankwamba et al., 2012). Chibwana et al. (2012), for example, found that farmers who received the subsidy allocated 45% more land to improved maize, while Kankwamba found that FISP was a key driver of a decline in diversification between 2004/5-2010/11 cropping seasons. Though this resulted in higher maize yields, it also resulted in overall crop simplification which contradicts the stated policy goal of crop diversification and likely has detrimental impacts on soil fertility. Recent research by Mungai et al. (2018) suggests there is ample opportunity to make better use of chemical fertilizer in conjunction with sustainable intensification practices that use organic soil amendments, which, over time, can simultaneously improve stocks of soil carbon while maintaining yields. As with efforts to reduce PHL, building the capacity of farmers to implement appropriate and diverse soil-building practices will require renewed support to Malawi's extension networks.

6 Alternatives: Building Adaptive and Resilient Agrifood Systems

The driving metric for agricultural policy and practice in Malawi has been maize productivity. Raising maize productivity and improving maize input and output markets has long been considered a requisite condition for economic and social improvement. Though maize yields have gone up since the inception of FISP, however, there have been no great gains in either area. The overwhelming response from donors and policy experts is to diversify production in order to become more competitive on global markets. Given the challenges that Malawi faces, that goal puts the cart before the horse. As noted earlier in this report, most Malawians are faced by annual hungry seasons, poverty, labor constraints, minimal and declining access to productive inputs, and environmental degradation. The recommended strategy sets aside these immediate concerns in favor of an approach that promises improvement somewhere down the line. Moreover, the recommended approach is not an outcome of democratic deliberation; rather, it is based on economic rationales that are narrowly focused on economic growth, disconnected from resource use, and grounded in a fossil fuel economy.

In contrast, the TEEBAgriFood framework provides a metric system that better reflects the multidimensional outcomes of agrifood system and seeks to better quantify and qualify them. It is a framework that aligns with systems research principals and insights, such as those exemplified by resilience studies. Researchers are increasingly recognizing and documenting how communities can foster resilient social-ecological practices and processes that will enable an improved capacity to withstand or bounce back from the uncertainty and environmental change that is caused by a warming climate. Identifying, measuring, and attending to how capital stocks in various places among various communities helps to foster wellbeing and adaptive/transformative capacity will be important to informing policies. For example, Jones et al. (2014) found that gender and distance to market are critically important to food security in Malawi. For the smallholder trader, it may be more important to improve conditions in markets or access to credit, while for the smallholder farmer, "tiny outlays in livestock, soil fertility, curing barns, fruit trees" would be more appropriate (Lea & Hammer, 2009, p. 17; White et al., 2017). Identifying and building stocks based on those determinants could help communities to nurture adaptive and transformative capacity.

In Malawi, a number of ongoing interventions already apply these sorts of insights to improving social and ecological wellbeing. Though not necessarily framed in relation to 'capital stocks and flows' these interventions and research provide evidence for how attention to factors beyond productivity shapes outcomes.

- Since 2000, the Soils, Food, and Healthy Communities (SFHC)[21] project has taken an integrated, gender-based approach to improving food security and reducing poverty. Based on research that found food insecurity to be an outcome of interrelated social and ecological factors (Bezner Kerr, 2005), the SFHC project taught sustainable agriculture techniques to community-elected Farmer Research Teams, who then went on to teach these techniques to interested community members. These techniques spread to other farmers in the area, which had the effect of improving soil health vis-à-vis legume inter- and relay cropping, and household nutrition. As the project progressed, however, women began to complain that, in some cases, the new agricultural techniques resulted in more work for them and not necessarily improved nutrition due to husbands selling the crops away from the household and spending the money on alcohol. That women felt safe and empowered enough to articulate their concerns was due to the deliberative processes built in from the inception of the project to "create spaces and processes in which women and men might consider one another equal in skill, entitlement to speak and as bearers of knowledge" (Patel et al., 2015, p. 34). In more recent research, Bezner Kerr et al. (2018) highlight how important it is to foster increasingly resilient agrifood systems. While communities consistently observe reductions in annual rainfall amounts, they do not know how

[21] http://soilandfood.org/

to prepare to deal with the changing climate, nor how to adapt their agrifood practices to create more resiliency. Moreover, prevailing knowledge flows "point to potential relations of exclusion from key adaptation strategies" (p. 245). Clearly, a productivity-centered metric system could not capture such dynamics; conceivably, however, a TEEBAgriFood Framework could measure the various forms of capital and how they relate to each other to document outcomes, change, and improvements in wellbeing.

- Snapp et al. (2018) show how a multidimensional analysis of sustainable intensification reveals complexity in how people judge those technologies and their ability to use them. For example, poor households receiving the FISP subsidy are heavily reliant on the increased yields they get with fertilizer, which prevents them from being able to adopt more sustainable technologies. Researchers posit that state-supported infusions of multiple kinds of capital, such as food safety nets and agronomic education, would be required to enable those farmers to transition away from maize.
- Efforts to diversify the cropping system must also focus on increasing the capacity of, and conditions in, the rest of the food system on which people rely. A constant refrain among development professionals is that farmers must be supported in their efforts to connect to markets. Likewise, people working in markets must be supported in their efforts to connect to farmers. Research by White et al. (2017, 2018) illustrates the far-reaching food exchange networks in Malawi, but found that exchange is burdened by high transportation costs and conditions in markets. There is enormous opportunity to improve conditions in ways that would remove those burdens, thus enabling small-scale food actors all along value chains to benefit.

7 Conclusions and Recommendations

In general, most studies that recommend investing in sustainability in southern African cropping systems do not recommend abandoning maize as the primary staple. Rather, they recommend improving soil management practices in maize-based systems. This is likely due to sensitivity to cultural preference. However, given the nitrogen requirements of maize, and its sensitivity to light and water deprivation, maize is not a good bet for the increasing climatic volatility that climate change will bring. The transition away from maize as a primary staple will require vigorous community engagement and conversation, and a commensurate investment in so-called 'lost' or indigenous crops that are more suited to local environments and can withstand a greater range of agroecological conditions.[22]

7.1 The Way Out: Transitioning to a More Sustainable Food System

Develop a notion of food security that is governed more by climate change trajectories, nutrition, and socioeconomic justice. At the heart of maize-centricity is the persistent narrative that maize security and food security are the same thing. In addition to technical interventions and programmatic investments, there is a basic and fundamental need for a national conversation to challenge that narrative and to engage the population to identify alternatives. They exist! Moreover, those alternatives build on the existing food system *and* the knowledge and cultural preferences of Malawians, qualities that could be leveraged to ease the transition.

[22] There is historical precedent for GoM investments in staples other than maize. In the 1980s, for example, the government started promoting cassava in response to drought and the consequent maize crop failure http://afsafrica.org/wp-content/uploads/2015/11/Cassava_Malawi_Zambia.pdf

In Malawi, a number of ongoing interventions already apply these sorts of insights to improving social and ecological wellbeing. Though not necessarily framed in relation to 'capital stocks and flows' these interventions and research provide evidence for how attention to place and to local environmental, social, and economic factors can improve food security *and* social cohesion. Research and community interventions by Bezner-Kerr and Snapp shed light on how systems approaches open up the solution space in relation to rural livelihoods, while the work of White et al. engages with conditions in urban markets and regional food exchange networks.

Diversification should be governed by local context and resilience rather than global markets. The 2016 National Agriculture Policy highlights the need for diversification, but does so within a narrative that prioritizes growing the agriculture sector through the commercialization of smallholder farmers through productivity and income gains. The overall policy orientation towards global markets is not likely to result in a resilient and flexible agriculture attuned to the economic and environmental uncertainty that climate change will bring to Malawi. A recent paper by Martin et al. (2019) discusses the difference between diversification-oriented-towards commercialization vs diversification-oriented-towards-nutrition-and-food-sovereignty; crop diversification at a regional level may indicate a greater number of commercialized commodities being grown in intensive monocultures, which actually displaces diverse agroecosystems and represents an overall global trend of increasing crop homogenization.

Subsidies should be redirected to support and ease sustainable food system transitions. Most contemporary policy regarding food production in Malawi assumes the need for 'modern inputs.' However, 'modern inputs' are heavily reliant on fossil fuels. Malawi pays some of the highest prices for importing agricultural inputs, and those prices are likely to climb as the world focuses more on limiting carbon emissions. Expenditures on these inputs will therefore have to become much more judicious, and production systems much more oriented towards regenerative practices that tightly recycle nutrients.

Systems-oriented, community-engaged research will result in a plurality of innovative approaches to resilient food systems. Finally, as a follow-up to this desktop study research, the application of this framework to a research protocol could help develop alternative strategies in collaboration with farmers and others food system actors in Malawi. Among the various geographies and ecologies in Malawi, what alternative food crops could help to transition away from maize? What is their cost of production? How do food security calculations change? What existing food practices could be supported to improve income-earning opportunities to diversify not only the maize production system, but also other areas of food exchange, processing, and retailing? What are the hidden costs of *other* potential staples *in relation to the daily realties of average Malawians?*

7.2 Recommendations for Applications of the TEEB evaluation framework

This section reflects on the implications of using a TEEB evaluation framework and offers some cautionary considerations.

7.2.1 Systems analyses result in more holistic explanations, which opens up the solution space.

Presumably, agrifood systems development in particular places would focus on growing the infrastructural and institutional capacity of food economies in broadly inclusive ways. For example, the spectacular growth in local food economies in the US is attributed not to yield increases at the farm level, but concerted, collaborative, multiscalar, and diverse investment strategies and innovations (Federal Reserve Bank of St Louis, 2017). In contrast, as it concerns Malawi, the focus on a narrow construction of productivity has fostered a system in which available financial capital is overwhelmingly deployed to purchase hybrid seeds and fertilizers, which leaves little for strengthening other aspects of the system. Moreover, the overall effect of FISP has been to increase maize monocropping, thus reducing the adaptive capacity of the agrifood system.

Most studies on food systems in Malawi are disciplinary in nature and do not necessarily shed light on the relationships between a maize-centric agricultural system and outcomes related to human or environmental wellbeing. In addition, few studies attempt to unpack the various dependencies in systems and how they work to entrench practices and stagnate system evolution. The TEEB Evaluation Framework provides an alternative that can improve understanding of food-society-environment relationships and the outcomes they produce. To create better outcomes for both people and planet, it is crucial that more studies use whole-system practices and processes to *construct* research protocols rather than applying such frames retrospectively.

7.2.2 Any metric system can be used in coercive ways. TEEB evaluation practitioners should take care to employ democratic approaches

Knowledge creation is a political process. Any metric system comes with embedded values about what matters, and like any metric system, TEEB true cost analysis will be used to further particular interests. Moreover, the TEEB evaluation framework is not immune from being used in overly technocentric ways and excluding non-experts from decision-making. To bring about more sustainable and *just* agrifood systems, engagement of marginalized and poor communities should be integral and profound.

Likewise, it is the tendency of some in the Global North to blame global problems on those in the Global South, and to dictate the terms of solution implementation. Historically, many 'bright ideas' have come from the Global North and have been imposed on the Global South, to the eventual detriment of those who were supposed to have been helped by that bright idea. When applying the TEEB framework, it is important to understand the historical dynamics of, for example, environmental degradation or poor soil management. The power relationships that have brought the prevailing maize agrifood system into being in Malawi have not been seriously challenged, and it would be exceedingly easy, and perhaps instinctive for some, to blame poor farmers for the negative outcomes that they produce.

7.2.3 Cost and value are socially situated concepts.

The TEEB framework seeks to better measure the *true costs* of agrifood systems. *True* cost implies that cost is a universal, objective metric. However, cost and value are relative aspects of relationships between humans and inform our transactions with each other. Neither costs nor values are universal. Consequently, it is critical to ask whose values predominate or drive the system? Who bears the costs? What are relevant costs and values from a community perspective? How would they like to see those community-based costs and values reflected in policy? In environments of inequality, do marginalized populations bear costs because of value creation elsewhere in the system?

The common evaluation framework needs to be powerful enough to capture and make transparent multiple realities. Moreover, finding ways to involve poor people in creating the metric scale is vital to enabling findings that can foster inclusive policies and practices and transparent governance processes.

7.2.4 There is a need to capture not just capital stocks and flows, but capital transformations

Even though TEEBAgrifood aims at holistic evaluations, the distinct categories for stocks and flows present challenges. In agrifood systems, capitals are transformed from one kind of capital to another through both managed and natural flows. For example, one practice for improving natural fertility is to initially use chemical fertilizers and to manage them to improve natural fertility stocks. Or, natural fertility stocks that would ostensibly benefit the farmer might be turned into produced capital stocks that would benefit other actors in the system. To develop a workable 'theory of change' it may be important to develop guidance for how to better capture these transformations. Like some of the previous recommendations, better tracking transformations and whom they benefit could enable a more politically aware agrifood system analysis.

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