1. The three pillars of food security – availability, adequate income and increasing productivity

INTRODUCTION TO THE THREE PILLARS OF FOOD SECURITY

If one is lucky enough to be food secure, then it is unlikely to be top of mind. Other needs, desires and preoccupations fill the days: Can I afford to buy a new car? Should I go to university? Who will win the cricket? When should I cut the lawn? Does God exist? That the next meal will be there is often taken for granted. The next meal may be simple and involve no choices or an individual may be faced with a vast array of choices. For the food secure, deciding on what food will be eaten usually involves little thought regarding where the food came from or the effort that went into providing it. Providing a secure supply of food, however, takes a tremendous amount of effort. This is as true for subsistence farms as it is in major urban centres in modern market economies. For subsistence farms, back-breaking labour goes into preparing the soil, planting the crop, hand weeding through the growing season, harvesting the crop, and storing enough to tide one over until the next harvest. In modern cities, food supply chains can be long, with many hands involved in providing inputs to on-farm production, growing and harvesting the crop, processing and preserving the food, moving it over sometimes vast distances and putting it into the hands of the consumer. In both cases, for the food secure, food is simply there, with little thought towards the how and why it got there. The majority of the world’s population may live their entire lives without ever giving food security a thought.

It is also true that food security is a fragile thing. It can quickly disappear. All one has to do is observe the reactions of individuals when they perceive that their food security is threatened. It is instructive to watch the news every time a major hurricane comes ashore in the southern United States. A hurricane normally disrupts life in major ways for four to five days at most. The population of the area where the storm is forecast to make land likely receives one or two days notice. In many cases, this sets off a run in grocery stores (and
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Gas stations and sources of bottled water). Store shelves empty instantly. The scenes in grocery stores depict general mayhem with people grabbing anything they can. In the worst cases, looting breaks out. Clearly, the people engaging in such activities no longer feel they are food secure – and remember, the likely disruption is only for a few days. Prior to the hurricane, nary a thought would have been given to food security by the average joe – but food security is fragile, and individuals are quickly moved to feeling food insecure by relatively minor shocks.

In a similar but less dramatic fashion, circumstances can change and individuals or families can no longer be food secure. The loss of a job or a debilitating medical condition can disrupt the flow of income. Once any savings and other reserves are exhausted, one may be on the outside of a supermarket full of food without the means to enter the store and purchase food. Such an individual and their family are no longer food secure. Societies tend to deal with this form of food insecurity through a variety of methods – soup kitchens, food banks, food stamps, welfare payments, tolerance of begging – to forestall outright starvation. The very existence of such institutional arrangements, however, points to the real danger of starvation being the outcome of a loss of food security. Where such mechanisms fail, as is the case in some cities in developing countries, the toll it takes is evident on the streets. Food security is fragile, and its absence can lead to tragic outcomes. It suggests that one should not be so arrogant as to assume it will never happen to you. For example, in 2022 the (largely unexpected) war between Russia and Ukraine led to food insecurity among previously secure Ukrainians – both those who chose to remain and those who fled. It also led to declining food security in poor countries that, in normal times, purchased grain and sunflower oil from Ukraine.

Given its importance, it is worthwhile examining what providing food security entails and whether achieving food security for all is possible. While being better informed cannot ensure that more people remain food secure, it may, however, improve the odds of achieving that goal.

Being food secure entails three central elements: (1) availability; (2) adequate income; (3) increasing productivity. Although it may sound trite, to be food secure, food must be available. It must be reliably available on a daily basis. While it may be possible to skip a few meals, there must be an assurance that food will be there when needed to sustain life and health. There are many sources from which food can become available. It may be from well-stocked supermarket shelves. It may come from on-farm storage. It may come from reliable deliveries of food aid. If one is not confident that the food will be there, then one is not food secure.

If food is available, one must have the wherewithal to acquire it. It does not matter if the supermarket is full of food, if one lacks the money to purchase it, they are not food secure. This is why in countries where food is abundant there
still may be segments of the population that are not food secure. Circumstances can change quickly, with large price rises reducing the purchasing power of one’s income to the point that sufficient food cannot be acquired. Large global increases in food prices in recent years have moved millions of people from being classified as being food secure to being food insecure. Normally self-sufficient peasant farmers who experience a crop failure may not have the resources to purchase food from the market. In a policy sense, simply ensuring that food is generally available is not sufficient to make the population as a whole food secure. A plethora of policies (including relying on charity) have been put in place to handle the problem of insufficient income – soup kitchens, food banks, food stamps, welfare payments, distribution centres in refugee camps and school lunch programmes to name just a few.

The third pillar of food security – increasing productivity – is a longer-term challenge. As the global population continues to increase, there are more mouths to feed. There must be increases in agricultural productivity that at least offset the increase in population. While there are methods that can stretch existing food supplies, such as reducing wastage and spoilage as well as bringing more land into production, their effectiveness is limited in the long run. In developed countries, much food is wasted both in the typically long supply chains, in supermarkets and in peoples’ kitchens. Supermarkets work hard at attempting to match supplies with demand, but they do not always get it right and in their striving to have consistent product availability, they are risk averse in the probabilities they assign to stock-outs, meaning there are surpluses in perishables – food that is wasted. There is certainly room for improvement but even if such waste could be removed, it is only a short-run stop gap in the face of the ever-increasing population.

In developing countries, spoilage is a massive problem. As storage is often rudimentary and voracious pests are typically endemic, much of the food produced is lost. Rats, insects, vermin, mould and bacteria extract an enormous toll from food once it is harvested, slaughtered or otherwise moved to post-production. Again, improved storage, never mind refrigeration and modern food preservation methods, can lead to significant reductions in spoilage but, again, improvements are finite in their ability to increase food security over the long run.

Most land with agricultural potential is already in use. While there are small pockets of land that could be brought into agricultural production, they are likely to exhibit low productivity and are not available in sufficient quantities to offset projected increases in population. Further, existing farmland is under constant threat of urbanization, with many thousands of hectares lost each year. While there are policies to retain land in agriculture in some countries, they vary greatly in their efficacy. The pressure from urbanization will continue to grow.
In contrast, increasing agricultural productivity appears to be unbounded. Increasing productivity is a function of scientific progress and its application to increasing production. It has had three main thrusts. The first has been mechanization. This is the movement away from human exertion and harnessed animal power to the use of machinery. While the replacement of draught animals with tractors and trucks is probably what first comes to mind, mechanization has been wide-ranging, from refrigeration replacing stockpiles of winter ice, to milking machines replacing the tedium and physical rigours of hand milking, to aerial spraying replacing the back-breaking chore of weeding with a hoe, to electric pumps for irrigation where animals had walked in interminable circles lifting water. While the mechanization of agricultural production is widespread in developed countries, in many places in the developing world it is, as yet, in its infancy. Some may think that mechanization has run its course in modern market economies but, in fact, the combination of new data collection and analytical capacity along with computer and communications technology – called big data – seems set to provide a new avenue for increasing the productivity of machines. That may be in the form of GPS-based steering of tractors and combines to deliveries of parts to farms by drones to self-driving grain trucks delivering crops to storage or shipment points. Sensors can read soil and moisture conditions to provide exact mixtures of seeds, fertilizers and chemicals through a seeder. Dairy cow rations can be customized through electronic monitoring of individual animals. Drones can be used to monitor crop development down to the individual plant. Thus, the improvements in productivity from increasingly sophisticated mechanization and technology continue apace.

The second major source of productivity increases has come from applied chemistry. This includes chemical fertilizers, pesticides, herbicides, fungicides, chemical water purification, cleaning of machinery such as bulk milk tanks and micronutrients in animal feeds. The combined use of chemicals has led to major increases in crop outputs through increased yields and reduced losses from pests and diseases. While there has been considerable adoption of chemical fertilizers and pest control in developing countries, far more adoption can take place before the potential benefits of applied chemistry are exhausted. Further, new innovations in this space continue.

The third major source of productivity increases in agriculture comes from applied genetics through genetic selection. From simple crossbreeding to advanced genomics, the productivity of plants and animals is being continually improved. Long before the formal understanding of genetics, farmers had been selecting animals on superior visual traits and domesticating plants to develop landraces. As the science of genetics developed, genetic selection became more precise with the formal establishment of private and public breeding programmes replacing farmer intuition. The green revolution of the 1960s, which...
saw a major increase in productivity, was based on this level of genetic knowledge. In the 1980s, genetics came to be understood at a more fundamental level leading to genetic engineering and the application of transgenic techniques in improving productivity. Latterly, genomics – based on the significant decrease in the cost of gene sequencing – and enabling technologies such as CRISPR/Cas9, have the potential to increase the precision of genetic selection and extend the application of genetics to a wider range of crops and plant species.

The application of scientific genetics has not been without controversy. There has been fierce resistance to the use of genetically modified organisms (GMOs) in food production in some parts of the world. The risks associated with the use of GMOs are considered unacceptable by some members of civil society and some governments. These risks need to be carefully assessed, given the contribution to long-term food security that further applications of applied genetics can make.

Increasing agricultural productivity is a long-run process. From the development of a new technology to trials in production, to licensing for commercial production, to widespread adoption, productivity gains can take decades. Thus, it is important to keep a sustained flow of investment in the development of new technology. Both the private and public sectors have historically had important roles in enhancing agricultural productivity. In recent years, governments, in particular, seem to be underinvesting in research and development targeted towards improving agricultural productivity. As a result, the rate of increase in agricultural productivity appears to be slowing. Given that the rate of increase in global population is not expected to peak until later in the twenty-first century, the ramifications for food security could be severe. Any falling off in the rate of increase in agricultural productivity will lead to additional hungry stomachs chasing less and less food. This can only mean that the food security status for some in the world will deteriorate – likely those who comprise the world’s poorest. The effects of climate change will likely mean a decline in the ability of some places in the world to produce food. Other areas, of course, may well be able to produce additional food. Adaptation will be necessary to compensate for the pressures of climate change, which will require additional investment in agricultural research and development.

Food security is multifaceted. Securing it is complex. For most of those who will read this book it will be an abstract and remote concept. That is because they enjoy food security – even if they don’t understand why, and for that matter, never think about it. Having picked up this volume, hopefully it can give you some things to think about.
AVAILABILITY

When discussing food security, availability must be seen in a specific context. Availability is about here and now. While, for example, sufficient food may be available on a country-wide basis, that national availability becomes irrelevant if it is distributed in such a way that food is not available in all parts of the country. Populations in those parts of the country where food is unavailable today are not food secure. Similarly, sufficient food may be available over some span of time, say a year, but if it is unavailable at a particular point in time then at that moment, people will be food insecure. Thus, one cannot be complacent and lulled by aggregate statistics in various forms. The combined distributional and immediate nature of food security is often poorly understood by policy makers, who are far removed from a problem and likely enjoying food security (Nakuja and Kerr, 2019).

Of course, the broader questions pertaining to quantities and prices cannot be ignored by those charged with ensuring food security – and food security is an idea that lies in policy space. Those involved in ensuring the functioning of food supply chains in the private sector are not thinking of food security, they are interested in making a profit out of whatever portion of the supply chain they hold sway over. As with the Friedman’s famous explanation of how pencils are made, ‘There’s not a single person in the world who could make this pencil’ (Friedman and Friedman, 1990, p. 22), no single person in a supply chain is driven by food security concerns. Decision-makers in supply chains react to incentives and constraints. The wheat farmer in Saskatchewan on the Canadian prairies is not concerned with, or even aware of, the cook in Kolkata in India who is buying flour to make bread for the day’s meal. The same is the case for the shipper in the grain elevator in Kindersley, Saskatchewan organizing hopper cars to carry the wheat to port. The captain of the ship carrying a cargo of wheat to India is equally unaware and unconcerned with their contribution to food security. And so it is with all of the actors in the supply chain.

Only in the case of self-sufficient subsistence farmers is food security likely to be near top of mind when they are carrying out their daily activities. That is because they are both producer and consumer. Consumers may worry about food security if they have experience with food insecurity, but it is not a concern of those in the supply chain. Only when private sector supply chains do not provide a sufficient degree of food security for most of the population does food security become an issue where policy makers may want to intervene in the market in attempts to correct the system’s failure. They must examine the food supply chain from the broader point of view of food security. They have a large array of policy instruments at their disposal from intervening in prices, providing incentives such as subsidies, direct state...
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intervention through marketing boards and stockpiling, emergency purchases by governments, removing trade barriers, putting in place barriers to exports, moving people to where food is available, turning responsibility for food security over to non-governmental organizations (NGOs) and a plethora of others. These efforts are not always successful (Perez-Escamilla et al., 2017). The supply chains that solve the availability part of the food security challenge are complex and, despite the best efforts of policy makers, failing to understand that complexity can lead to unforeseen and unintended consequences. For one example, lowering food prices by fiat leads inevitably to farmers reducing output in the next period, exacerbating shortfalls in food availability. It is astounding how often this policy scenario continues to play out and is repeated despite the accumulated evidence (Cardwell and Kerr, 2009; Swinnen and Squicciarini, 2012).

Part of solving the availability piece of the puzzle is recognizing that food security, and when it is not being achieved, is open to a considerable degree of interpretation. This is particularly the case for determining when governments should intervene to solve an availability problem. The Food and Agricultural Organization (FAO) of the United Nations (UN) cites the definition developed by the 1996 World Food Summit:

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. (FAO, 2006, p. 1)

While this definition encompasses the wide-ranging issues underlying food security, it also sets a very high bar, particularly for policy makers. For example, do potential competitive athletes fall within … all people … have … access to sufficient … food that meets their … food preferences for an active … life? Of course they do. If they are to meet their athletic challenges, they will have preferences for food with protein and caloric content that far exceed what normal individuals would desire, or need. It is unlikely that policy makers would be willing to intervene to ensure that the definition is met for those individuals. While it is an extreme case, it belies the fact that food availability is an opaque concept open to different policy interpretations – despite the lofty, and laudable, criteria set out in definitions such as the one above.

By the Prevalence of Undernourishment measure reported by the FAO in 2019, 820 million people suffer from hunger, approximately one person in nine globally (FAO, 2019). If individuals experiencing moderate and severe levels of food insecurity are combined, the total number of people experiencing food insecurity rises to two billion or over one-quarter of the world’s population (FAO, 2019). People in neither of these categories are food secure under the definition presented above. Since 2015, the number of people suffering from
hunger has begun to increase after a long gradual decline (FAO, 2019). The very existence of 820 million food insecure people, much less two billion, indicates either that there has been no serious effort to garner food security on a global level, or that such an effort has failed. That food security is declining suggests that the political will to deal decisively with food insecurity is simply not there. This does not mean that efforts to ensure the availability of food do not exist, only that their ambition or effectiveness falls short of what is needed to meet the criteria set out in the food security definition presented above.

**ADEQUATE INCOME**

The term *adequate income* is shorthand for the recognition that, as a normal course of events, it takes resources to acquire sufficient food for one’s well-being. It emphasizes that simply making food available may be a necessary condition to achieve food security in the short run, but that it is far from a sufficient condition to achieve food security. In modern market economies, the image one has of this type of food insecurity is that of a family standing outside a supermarket brimming with food looking through the window but unable to enter with the intent of purchasing food because they have no money. They are not food secure. If they are not hungry now, they will be very soon – unless there is some form of intervention. This might take the form of an observant stranger pointing them towards a food bank or a charity providing meals to the unfortunate. It does not solve their income problem, but it can solve the *here and now* reality of food security.

*Adequate income* is also a proxy for the many ways individuals can acquire the resources necessary to remove food insecurity. For example, saving can provide sufficient resources to acquire food long after the ability to earn income passes. A self-sufficient farm family does not, strictly speaking, have an income. It simply has access to sufficient land and farming implements and other inputs (e.g. saved seed, manure, water) to produce enough food for the family unit. In the short run, money to acquire food can be borrowed.

Most societies, but not all, are not content to let their members die of starvation. This does not mean that starvation does not take place, but in most cases when it does, it is due to incompetency and underestimation of the resources required, rather than a *let them starve* attitude. Wars and other forms of strife disrupt societal norms and can lead to impotency in the realm of food security. This is for two reasons: (1) many more people will have their ability to generate income removed; and (2) the ability of public and private (i.e. NGOs, charities) sector actors will be constrained. An example is food aid NGOs forced to remove their distribution personnel from a war zone.

At a simplistic level, for policy makers, the way to overcome the problem of inadequate income would be the direct provision of income to those needing
it to purchase sufficient food. While this has been tried many times, it suffers from a spate of problems. The money given to purchase food may be spent on something else – internet access, other needs or desires such as housing, heat or shoes, or, in the worst cases, drugs and alcohol. It is difficult to match the intent of those providing the income with the priorities of the recipients. The result is, in the eyes of the income providers, a waste of resources and a goal not achieved – food insecurity continues. If incomes are further raised to compensate for these leakages, there is still no assurance that the food security goal will be reached. Other complications may be that direct provision of income may lead to a decline in willingness to work – meaning the income provided is offset by a decline in employment income and the goal of achieving food security is effectively thwarted. With direct income supplements unable to achieve their intended goals, a wide range of alternatives have been attempted.

If leakages are a major concern and direct provision of income fails to solve the food insecurity caused by inadequate income, restricting the potential for leakages is one alternative strategy. These often require the establishment of institutional arrangements. In the United States, food stamps are part of institutional mechanisms designed to improve food security without resorting to direct income transfers (Wilde, 2007; MacEwan and Okrent, 2018). In short, food stamps can be redeemed for food in food retailers. The intent is clear. The efficacy of the US food stamp programme is, however, a subject of considerable debate (Dinour et al., 2007; Basiotis et al., 1983; DePolt et al., 2009). One of the consequences has been the development of secondary markets whereby food stamps could be exchanged for cash at a discount – again suggesting that some of the recipients of food stamps may have priorities other than their food security. The donor, the US government in this case, again see their good intentions thwarted. Of course, the development of secondary markets led to efforts to stem this form of leakage – with mixed success.

Another institutional arrangement that is an alternative to direct income supplements is food banks. Food banks are often run by NGOs receiving a mixture of support from governments and charitable donations. Food banks are meant to provide food security to those who have insufficient income. Food is provided directly to those who visit the food bank. One of the problems encountered by food banks is determining if those arriving to draw food are actually those in need. There are incidents of those who have sufficient income to be considered food secure utilizing the services of food banks, thereby freeing their income to be spent elsewhere. With their often-limited resources, food banks are therefore concerned that those in real need will not be served. As a result, food banks are forced to spend some of their limited resources on screening to determine those who are in real need – often with indeterminate efficacy.
The above is not meant to be a criticism of food stamps or food banks. They are only presented to show that solving the problem of food security for those with inadequate incomes is not simple, even in developed economies where there should be sufficient resources. One of the other problems that may arise is that policy makers may mis-identify the source of food insecurity and, for example, intervene in food supply chains, when the problem lies in inadequate incomes. The results may be a considerable expenditure of resources without an improvement of food security.

INCREASING PRODUCTIVITY

Ever since Thomas Malthus postulated what has been termed the Malthusian trap in 1798 there has been concern that the world’s growing population will outstrip its ability to produce sufficient food (Malthus, 1798). Malthus wrote his essay prior to the application of science to agricultural production, and the development of modern science in general. Thus, he did not take into account the efficacy of science in increasing agricultural productivity that began in the nineteenth century, nor of its impact in reducing human reproduction. Malthus’ prediction of mass starvation and disease outbreaks among the lower classes did not come to pass. Increases in agricultural productivity were able to offset Malthus’ predictions regarding population growth as well as the demographic changes brought about by modern medicine such as declining infant mortality rates and improved longevity.

While Malthus was proven wrong because he could not foresee the means by which agricultural productivity increases would be accomplished, escaping the Malthusian trap is not a foregone conclusion. It depends on sustained future increases in agricultural productivity until, at least, the point where global population might decrease. From a global population of 7.7 billion in 2019, projections put the population at 10.9 billion by 2100, a 42 per cent increase (UN, 2019). The assumption is that the rate of increase in population is slowing. Of course, estimates may prove to be wrong, and the future total may be lower, but it may well be higher. The message is, one cannot be complacent (Pardey et al., 2006). Agricultural productivity must continue to increase, and increase substantially. In the past much of the increase in agricultural productivity came from entrepreneurs in the private sector and corporate investments in research and development. There is no reason to believe that this activity will not continue. There are facets of productivity enhancement, however, that have relied on government initiatives. These have included the funding of basic research in universities and applied research in government research stations. In addition, some aspect of research did not have a property rights architecture that provided the incentives for private sector investment. This was particularly true for aspects of genetic research where farmers could
retain a portion of harvests as seeds for the next year’s crop – meaning only one season’s sale of seeds would have to recoup investments. While property rights have been altered in some countries to provide incentives to the private sector for this type of research, this is not the case everywhere (Boyd et al., 2003; Gaisford et al., 2002) as property rights protection is inadequate in other countries (Cardwell and Kerr, 2008). In short, there is still an important role for government in fostering increases in agricultural productivity. Governments, however, have been cutting back on their support for research designed to enhance agricultural productivity (Alston et al., 2009).

Over almost 200 years, increases in agricultural productivity have generally been viewed positively with willing uptake by farmers and relatively uncontroversial acceptance by consumers. In the last few years, however, objections to some productivity-enhancing technologies have become more common among some members of civil society (Gaisford et al., 2001). These activities can have serious repercussions for food security and, hence, require careful scrutiny (Pavleska and Kerr, 2019).

Ensuring food security is a multifaceted challenge. Despite considerable efforts on all three fronts – availability, adequate income and increasing productivity – securing the goal of food security for all has remained elusive. This book is intended to enhance understanding of this complex topic. That has to be the first step forward.

REFERENCES


