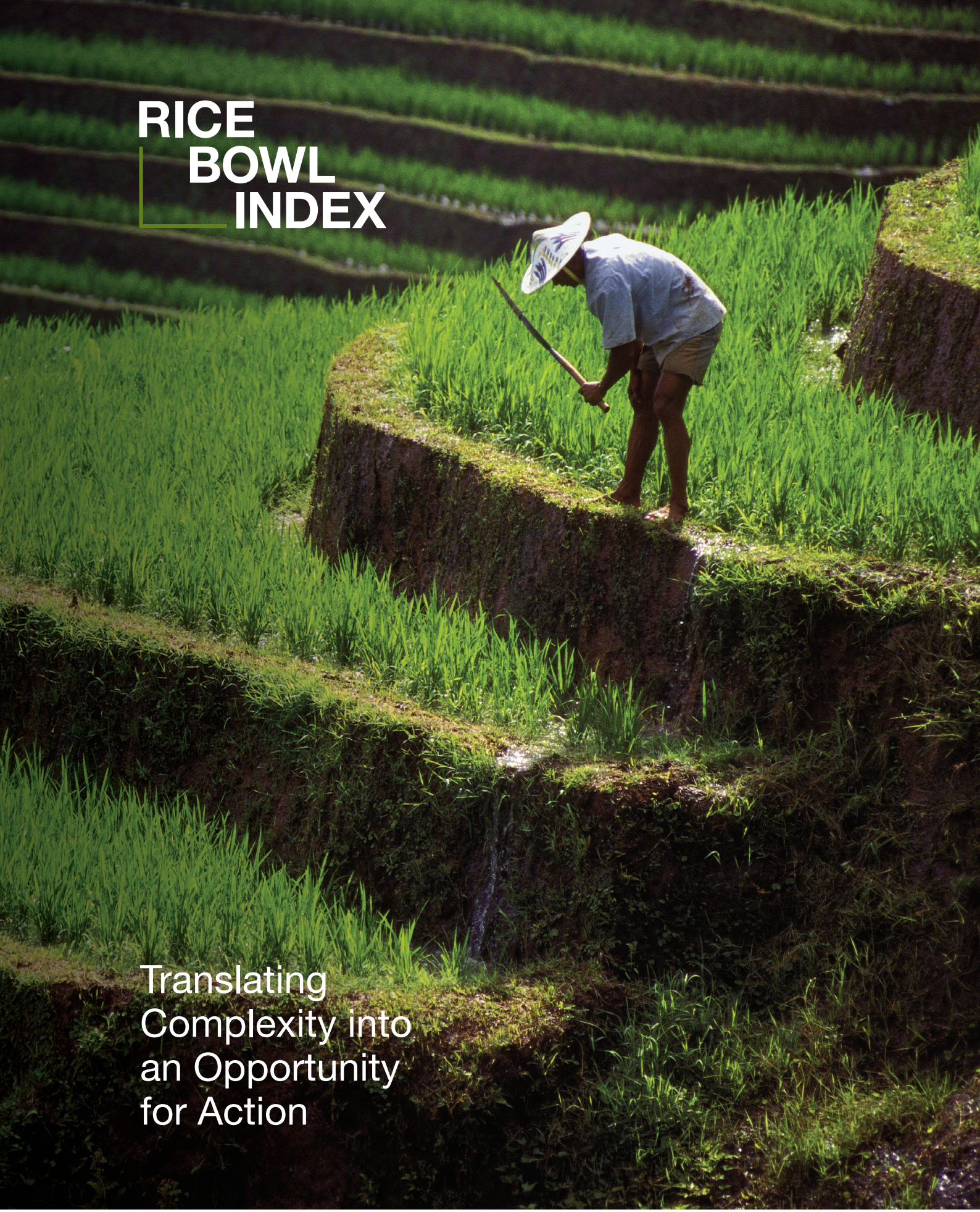

RICE BOWL INDEX

Translating Complexity into an Opportunity for Action

FRONTIER STRATEGY GROUP

syngenta

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ABOUT THE RICE BOWL INDEX

The Rice Bowl Index© is an initiative designed to facilitate positive productive dialogue, collaboration and action between governments, the private sector and other key stakeholders in the area of food security. It assesses *how robust* a country's capacity is to address the challenges of food security. It is not a measure of a country's *actual level* of food security.

The Rice Bowl Index consists of:

- a quantitative component which is a modular diagnostic platform examining the key enablers and disablers of food security built on Frontier Strategy Group's MarketView© Platform
- a qualitative component being this paper, authored by Professor Paul Teng, one of Asia's leading food security experts.

The concept of the Rice Bowl Index, its creation and the initial funding to support this project was provided by Syngenta Asia Pacific Pte Ltd.

Copyright for the overall concept, how the Rice Bowl Index is aggregated and this paper rests with Syngenta Asia Pacific Pte Ltd. Ownership and copyright of the MarketView Platform rests with Frontier Strategy Group. The ultimate outcomes are the results of a collaborative effort between Syngenta, Frontier Strategy Group and Professor Teng.

About Professor Paul Teng

Professor Paul Teng is a Senior Fellow (Food Security) at the Centre for Non-Traditional Security Studies, Rajaratnam School of International Studies, Nanyang Technological University, Singapore. With over 20 years of experience on food security issues, Prof. Teng is one of the leading academic experts in the area of food security. He has held positions at the WorldFish Center, Malaysia; the International Rice Research Institute; and Monsanto Company. He is also currently Vice-Chairman, International Service for the Acquisition of Agri-biotech Applications (ISAAA) and Chair, Asia Biobusiness Pte Ltd. His most recent book is BioScience Entrepreneurship in Asia and his other publications include over 250 technical papers and eight books.

About Syngenta

Syngenta is one of the world's leading companies with more than 26,000 employees in over 90 countries dedicated to one purpose: Bringing plant potential to life. Through world-class science, global reach and commitment to our customers, Syngenta helps to increase crop productivity, protect the environment and improve health and quality of life.

About Frontier Strategy Group

Frontier Strategy Group (FSG) partners with business leaders at over 200 multinational corporations by providing market-validated expertise to drive their success in emerging markets. Since 2007, FSG has developed a range of solutions to support executives in emerging markets based on the expertise of its extensive community of executives, market experts and validated data. FSG is headquartered in Washington DC and has regional offices in Singapore, London and Miami.

EXECUTIVE SUMMARY

Translating the complexity of food security into an opportunity for action

- Food security is multidimensional and complex. Considering how robust a country's capacity is to withstand and address the challenges of food security can be transformational to a country's economic, social and technological development.
- The Rice Bowl Index considers the enablers and disablers of food security in a simple form to help assess how robust a country's capacity is to withstand and address the challenges of food security. It is clear from this analysis that collaboration is essential in order to affect change that is sustainable in the long term.
- Across Asia, Farm-level Factors are the major contributor to the robustness of a country's food security system while Demand and Price often reflect the volatility inherent within the system. Policy and Trade and Environmental Factors have longer term impacts and must be managed with a view of the robustness and sustainability of the overall food security system.
- A focus on all components that contribute to how robust a country's capacity is to withstand and address the challenges of food security is necessary for stability. Reflecting the importance of a system-wide integrated approach, improvements that need to be made must be done so in a sustainable manner for long-term advancements in food security.

Asia's food security challenges are formidable. The region is home to over 60 per cent of the world's population, some of the world's fastest growing economies and yet has only 34 per cent of the world's arable land and 36 per cent of the world's water resources. Asia is also home to six of the world's top ten most populous countries and to half of the world's urban population.

At the same time, the agriculture and food production landscape in Asia is changing rapidly and the question of how food security can be increased in an environmentally sustainable way must guide food security strategies. To maximize the potential of Asia's agricultural sector and improve food security in the region and beyond, governments must embark on a multi-faceted, integrated and collaborative strategy that is broad in scope and fully adapted to these dynamic challenges.

To facilitate positive and productive dialogue, collaboration and action between governments, the private sector and other key stakeholders in the area of food security, tools are required that can help the multitude of players assess how robust a country's food security system might be to meet the challenges ahead. This is an important first step for establishing what action needs to be taken.

This paper provides insights into exactly what we mean when talking about food security and the multitude of dimensions that may impact on its achievement. These dimensions are the availability of food, physical access to food, economic access to food and being able to effectively utilize the nutritional value of the food available. The threats to these dimensions of food security are likely to include:

- Population growth and urbanization
- Declining agricultural performance
- Limited natural resources
- Increasing food prices
- Changing climatic conditions and natural disasters

The challenge is to move from a mere assessment of the problem to a more solutions-focused understanding; to do this we must capture in a simple form those drivers (enablers or disablers) which will affect a country's capacity to achieve or improve food security. Considering these challenges, the Rice Bowl Index takes the key factors and places them into the following four rubrics:

- Farm-level Factors
- Environmental Factors
- Policy and Trade
- Demand and Price

Each rubric, in turn, is a composite of different metrics and proxies representing factors which have an enabling or disabling influence on food security.

The Rice Bowl Index is a tool which assesses how robust a country's capacity is to withstand and address the challenges of food security. Its unique feature is that it captures the complexity of food security through a multi-dimensional approach and reduces this complexity into user-friendly charts and tables. These provide a platform for discussing potential action to address the challenges. The tool serves as a common language for different stakeholders to engage in purposeful dialogue leading to solutions-oriented action.

Analyzing the outputs of the Rice Bowl Index establishes that:

- In countries where agriculture contributes substantially to GDP, Farm-level Factors have the greatest impact when considering how robust the food security system might be. This reflects a larger segment of the population being directly dependent on the production off the farm or the income generated from it.
- Farm-level Factors fluctuate more than other factors irrespective of the overall stability and robustness of the food security system. This could point to a need to improve the overall contribution of Farm-level Factors to food security robustness while recognizing that year to year fluctuation is inevitable.
- It is difficult to discern a direct causal relationship between Farm-level Factors and Demand and Price. It is important to recognise the complex interplay of access to markets, price transparency, the level of trade, government intervention in markets on overall system robustness.
- Periods of greater price volatility result in Demand and Price having more impact on the robustness of a country's food security system. Stability of price and production is very important in considering food security and the capacity of a country to achieve it.

EXECUTIVE SUMMARY
CONTINUED

- The Policy and Trade environment within a country has a longer-term impact on the overall stability of a country's food security system. A more stable and predictable policy environment, supported by free and open markets improves the overall robustness of the food security system.

- Environmental Factors impact system robustness over an extended period and although change is generally gradual, extreme weather shocks can have immediate impact. It is important to avoid policy myopia on Environmental Factors because the opportunity for improving performance is substantial, while any intervention is likely to require significant time to manifest in positive change. It is essential that available resources are used in a sustainable manner.

- A country's capacity to address food security challenges is likely to be more robust where there is more balance between the four rubrics. This suggests that a focus on all of the contributing components is necessary to achieve a stable, robust food system.

- Population growth and urbanization present direct and indirect challenges to a country's capacity to address food security challenges as it also impacts the demand for and price of food.

To conclude, the Rice Bowl Index is a tool built on accepted concepts of food security, the key threats to food security and the opportunities to be better prepared for food security. The trends established from the analysis of the Rice Bowl Index results can form important discussion points for multi-stakeholder dialogue on food security. It turns challenges into opportunities for collaborative action

1. PURPOSE OF THE RICE BOWL INDEX

An initiative to facilitate dialogue, collaboration and action on food security

Asia's food security challenges are formidable[1]. The region is home to over 60 per cent of the world's population, some of the world's fastest growing economies and yet has only 34 per cent of the world's arable land and 36 per cent of the world's water resources. Asia is also home to six of the world's top ten most populous countries and to half of the world's urban population[2]. It is therefore not surprising that Asia plays a dominant role when considering food – both demand and production.

In the past few decades, Asia has been a remarkable success story - reducing poverty and generating strong economic growth. The result of this success is that several previously less-developed economies, have now achieved middle-income status. But, as a region Asia still suffers from high levels of food insecurity. According to the Food and Agriculture Organization (FAO)[3], over 60 per cent of the world's undernourished people – around 578 million of them - live in Asia.

The agriculture and food production landscape in Asia is also changing rapidly and without collaborative action, these changes will threaten the capacity and ability of Asia to feed itself and undermine the region's food security. To maximize the potential of Asia's agricultural sector to improve food security in the region and beyond, governments, the private sector and other stakeholders must embark on a multi-faceted, integrated and collaborative strategy, that is broad in scope and which is fully adapted to these dynamic challenges.

Tools are required that can help the multitude of players determine how *robust* a country's systems might be to support the achievement of food security. The identification and assessment of the key enabling and disabling factors of food security is an important first step for establishing what action needs to be taken. At the same time stakeholders must commit to come together to take concerted action.

Recent collaborative efforts by Syngenta and Frontier Strategy Group have resulted in the creation of the Rice Bowl Index which is a quantitative tool that provides a measure of how robust a country's food security system actually is. The Rice Bowl Index does not describe a country's actual state of food security but is intended to provide a means of assessing how *robust* a country's *capacity* is to meet the challenges of assuring food security by considering the host of factors (enablers or disablers) which will affect a country's capacity to achieve or improve food security. It is intended to point to areas of possible focus and collaboration for intervention to help improve food security and characterize the opportunity that is available. It should also help support collaboration not just within countries, but across countries as achieving food security is a shared responsibility.

In Asia, the term "Rice Bowl" is synonymous with food security as rice is the main staple for most of Asia's population. Around 90 per cent of the world's rice is grown and consumed in Asia and so it would be impossible to talk about food security in Asia without considering rice. The Rice Bowl also has a substantive place in the culture of Asia – it is synonymous with security and plenty - of the household, employment, and food.

[1] Teng & Escaler, 2010
[2] United Nations, 2009
[3] FAO 2010

1. PURPOSE OF THE RICE BOWL INDEX
CONTINUED

It is therefore entirely appropriate to relate to the Rice Bowl as a tool designed to help understand the robustness of a country's food security system. In the context of the quantitative tool - the Rice Bowl Index - "Rice Bowl" is used to mean not just the cereal, but also all of the accompanying factors which may help assure food security, livelihood and a country's state of development.

This paper firstly provides insights into exactly what we mean when talking about food security and the multitude of dimensions that may impact on its achievement. Having established a framework for considering food security, the paper outlines the development of the Rice Bowl Index including the concepts, rationale and methodology for its development. It then provides analysis of the Rice Bowl Index results revealing the myriad complexities inherent in addressing food security. From these complexities emerge opportunities for focus and collaboration between the multitudes of players who may have a role in helping a country achieve food security.

The Rice Bowl Index has been developed in an attempt to translate complexity into an opportunity for action.

2. THE COMPLEXITY OF FOOD SECURITY

A complex concept with many dimensions and multiple threats

The magnitude of the world's food security challenge is well documented. By 2050 the global population will exceed 9 billion people. In order to feed this population, it is estimated that global food production will have to increase by 70 per cent. This is a tremendous challenge which is further exacerbated by existing constraints such as erratic climatic conditions, limited farmland availability, scarcity of natural resources as well as lack of infrastructure and finance.

Also inherent in this challenge are the differences between large scale agriculture and smallholder agriculture, the latter of which dominates the Asian and African rural landscape. The International Food Policy Research Institute (IFPRI) has noted that smallholder farming technology is inadequate to meet the large productivity gains required to meet the increased food needs. The productivity gains required to meet the overall target have been estimated at 200% for smallholders in comparison to 20% for large farms.

Food security has many different meanings. The concept of food security originated in the mid-1970s – at a time when the world faced a global food crisis. The initial focus was primarily on food supply problems – in other words, assuring the availability of food supply and to a lesser degree the price stability of basic foodstuffs at the international and national level. The 1974 World Food Summit described food security as: "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices."

In 1983, the Food and Agriculture Organization (FAO) expanded the concept to consider not just the supply of food, but also demand for food, to reflect the importance of vulnerable people being able to secure access to food. This development reflected the importance of achieving balance between the demand and supply equation for food: "ensuring that all people at all times have both physical and economic access to the basic food that they need."

In 1986, the highly influential World Bank report *Poverty and Hunger* introduced the (widely accepted) distinction between *chronic food insecurity*, associated with problems of ongoing or structural poverty and low incomes, and *transitory food insecurity*, associated with periods of intensified pressure caused by natural disasters, economic collapse or conflict. This concept of food security is further elaborated in terms of: "access of all people at all times to enough food for an active, healthy life".

The 1996 World Food Summit adopted a still more complex definition: "Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life".

In 2001 this definition was again refined in an FAO report titled *The State of Food Insecurity in The World 2001:*

"Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."

2. THE COMPLEXITY OF FOOD SECURITY CONTINUED

It is this definition ("the FAO definition") that has won wide acceptance among governments, non-government organizations and civil society. The FAO definition forms the basis for considering food security in the context of the Rice Bowl Index and its associated analysis.

2.1. Food Insecurity – Transitory or Chronic

Given the widely accepted definition of food security discussed above (the FAO definition), food insecurity therefore exists when people do not have adequate physical, social or economic access to food. There are two types of food insecurity: transitory food insecurity and chronic food insecurity.

Transitory food insecurity

Transitory food insecurity is short-term and temporary. It occurs when there is a sudden drop in the ability to produce or access enough food to maintain adequate nutrition. It results from short-term shocks and fluctuations in food availability and food access, including year-to-year variations in domestic food production, food prices and household incomes. Transitory food insecurity is relatively unpredictable and can emerge suddenly and it makes planning and programming more difficult. Food insecurity of this type requires different capacities and types of intervention, including early warning systems and safety net programmes.

Chronic food insecurity

Chronic food insecurity is long-term or persistent. It occurs when people are unable to meet their minimum food requirements over a sustained period of time. It results from extended periods of poverty, lack of assets and inadequate access to productive or financial resources. It can only be overcome with long-term development measures to address poverty and productivity.

Recognizing that food insecurity may be caused by any of a number of transitory (short-term, temporary) or chronic (long-term, persistent) factors, identifying these factors allows selection and prioritization in establishing how prepared a country is to deal with threats to food security.

2.2. Food security has many dimensions

It is clear from the FAO definition that food security is complex, consists of many components and interactions and that increasing agricultural productivity is not the only consideration for improving food security. There is general acceptance that there are four main dimensions of food security: availability, physical access, economic access and utilization. These dimensions are shown in Figure 1[4]. While each dimension is necessary for overall household food security, they may have different weightings in a rural setting as compared with an urban setting as well as across countries with different incomes and net food trade balances.

Availability of Food

The first dimension of food security is the availability of food. This dimension addresses the 'supply side' of food security and is determined by the level of food production, stock levels, food aid and net trade[5]. Here, raising farm productivity is the core issue; whether by accessing or increasing inputs, improving seed varieties or chemistry, or employing better farm management practices. It can, however, be seen in Figure 1 that agro-climatic conditions and an entire range of socioeconomic and cultural factors also have a significant influence on food availability, as they determine where and how farmers perform in response to market conditions.

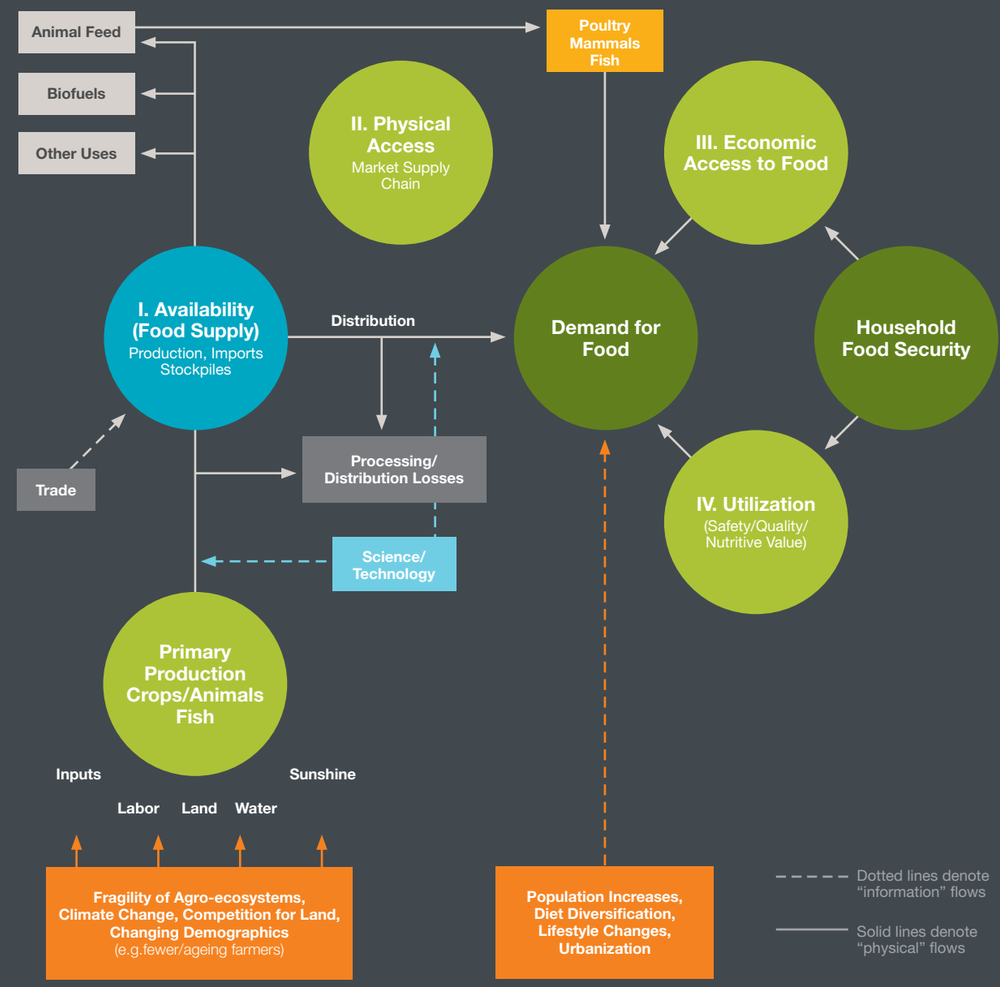


Figure 1: Conceptual Model for Food Security
(Source: Teng and Escaler 2010)

[4] Teng & Escaler, 2010
[5] Riely et al. 1999

2. THE COMPLEXITY OF FOOD SECURITY CONTINUED

Food availability is often the focus of much of the debate on food security but as Figure 1 illustrates, raising farm productivity, although necessary, is not sufficient to ensure household food security. Figure 1 further illustrates the importance of environmental factors in making more food available – these include not just physical factors like soil, water and sunshine, but infrastructure support for modern agriculture. Sustainability has to be considered to ensure there is growth in production over time.

In urban environments and countries which are net food importers, food availability is more dependent on imports and grain supply, both made possible by trade policies, rather than physical production.

Physical Access to Food

The second dimension of food security is physical access to food. This means that an adequate amount of food must be within the physical reach of vulnerable households, whether through their own production or through the marketplace.

Common threats to physical access to food are war, civil strife, poor infrastructure, inadequate logistics for food distribution and market imperfections. Such problems are more likely to exist in rural areas characterised by difficult terrain and remoteness. In urban areas improving the efficiency of supply chains to deliver food to consumers is the primary concern. This is particularly relevant given 50 to 70 per cent of the consumers' cost of food is formed in post-farmgate segments of supply chains, e.g., wholesale, logistics, processing and retail[6]. Appropriate policies, investment and trade are important for ensuring food supply chains remain open and operate efficiently.

Economic Access to Food

The third dimension of food security is economic access to food. This dimension considers the ability of a household to purchase the food it requires and is particularly important for households that are net food buyers. When considering economic access, key dimensions are the purchasing power of consumers, the evolution of real incomes and food prices. We often see that as Consumer Price Indices rise, so too does the level of food insecurity in the poorer sectors of society. In general, urban dwellers may face more threats to their economic access to food compared to people living in rural areas[7], while physical access to food and food utilization (discussed below) may heavily impact rural communities.

Additional factors that will influence economic access to food include macroeconomic policies, employment policies, social security programmes and the actual availability of food because this impacts food supply in the market, and therefore the prices that consumers pay for their food. Physical access also influences economic access because without adequate infrastructure the food cannot be moved to market in adequate quantities and acceptable quality.

Food Utilization

The fourth dimension of food security is food utilization, which is typically reflected in the nutritional status of an individual. Having food to eat, whether the food was purchased at the store or grown on the family farm, is not the only determining factor. Adequate nutrition is a basic human need. Individuals must consume sufficient amounts of not only calories, but also protein, fats, vitamins, and minerals to support growth and development throughout their life. Although tremendous progress has been made in the area of food availability, many parts of Asia continue to suffer from under nutrition — that is, deficiencies in energy, protein, and essential vitamins and minerals.

[6] Reardon 2010
[7] Teng and Escaler 2010

These deficiencies are a consequence of inadequate dietary diversity or a poor physical condition affecting capacity to properly 'utilize' the food. Food utilization is, therefore, determined by diet quality, general child care and feeding practices, food preparation, food storage, along with general health status and its determinants[8]. It is not enough that an individual is getting what appears to be an adequate quantity of food if that person is unable to consume the food because he or she is always falling sick.

As part of overall economic growth, agricultural growth has an important role to play in reducing and preventing under nutrition through a number of channels. Its impact extends from increasing household ability to purchase and produce more nutritious food to economy-wide effects such as increasing government revenues to fund education, health, infrastructure, and nutrition-intervention programs. Furthermore, factors such as infrastructure, the status of women (including their educational level) and land distribution also contribute to how well agricultural growth translates into nutritional improvements[9].

Malnutrition is often associated with rural poverty. Poor farming households may largely rely in their daily dietary consumption on one single crop (e.g. rice) and may not have access to sources of proteins, essential vitamins and minerals. At the same time, poor health may further impact on their food utilization. But this nexus between poverty and malnutrition may also be translated to the cities. Urban poor live in slums and consequently living conditions may affect nutritional status in the form of malnutrition and poor health.

2.3. What is threatening food security?

As illustrated above, there are many factors affecting the overall level of food security in Asia including (but not limited to): population growth and urbanization, declining agriculture performance, constraints on the availability of natural resources, erratic climatic conditions, high and volatile food and oil prices.

Population Growth and Urbanization

In 1950 the world's population was just 2.5 billion people. In October 2011, the population reached 7 billion and by 2050 it will surpass 9 billion people. But while the population is increasing, the resources available to feed them are not. In 1950, a single hectare of land had to feed just 2 people, but by 2005 this requirement had doubled to 4 people needing to be fed from each hectare of available agricultural land. By 2030, that same hectare of land will need to feed more than 5 people[10].

A substantial portion of the growth in population will occur in Asia and while fifty per cent of the world's population now lives in cities, this proportion will reach 70 per cent by 2050. Asia, in particular, is projected to see its urban population increase by 1.7 billion with China and India alone accounting for about a third of the total increase. Underpinning this rapid urbanization in many parts of Asia is strong economic growth meaning that population growth is just one factor. Urbanization in combination with rising incomes will increase food demand, accelerate the diversification of diets and see demand for better quality food increase. As incomes rise, diets will come to include more resource-intensive food products, such as meat, dairy, eggs, fruits and vegetables, further increasing the demand for the agricultural commodities that supply these foods.

[8] Riely et al. 1999
[9] IFPRI, 2011
[10] FAO, World Bank 2008

2. THE COMPLEXITY OF FOOD SECURITY CONTINUED

Declining Agricultural Performance

The contribution of agriculture to the economy has declined steadily over recent decades as a result of economic growth in other segments, alternative employment opportunities, shifting investment, an aging farm population, outdated systems of land tenure and declines in overall levels of agricultural productivity.

For example, agriculture's share of gross domestic product (GDP) in South Asia fell from 43 to 18 per cent between 1961 and 2009[11] while the number of people working in agriculture steadily declined from 70 to 55 per cent between 1980 and 2010, and is projected to further fall to 49 per cent in 2020[12].

In terms of farm size, smallholder agriculture continues to dominate Asian farming systems with 87 per cent of the world's 450 million small farms (less than 2 hectares) in the region. Farm size is continuing to decline as a result of population growth and inheritance-based fragmentation[13].

Annual growth in productivity, measured in terms of average aggregate yield has also been slowing[14] - for example, the global aggregate yield growth of grains and oilseeds averaged 2.0 per cent per year between 1970 and 1990, but declined to 1.1 per cent between 1990 and 2007. While it is likely that many factors have contributed to this outcome, declining input efficiency, increasing resistance and the introduction of exotic species (weeds etc), variety performance and under investment in key factors like extension and knowledge transfer are likely to have had an impact. Without intervention, yield growth is projected to continue declining over the next ten years to less than 1.0 per cent per year.

Asia's farmers are also getting older - according to the Japanese Agriculture Ministry, 70 per cent of Japan's three million farmers are 60 or older[15] and many countries are seeing shifts in the gender base of farming. A recent study conducted in three South-western China provinces showed the average age of active farmers was around 50 years old and women composed 78 per cent of the total agricultural labor force[16]. These demographic changes and their impact on farm labor availability will continue to affect farm productivity.

Limited Natural Resources

Many of the world's agricultural ecosystems being used as food production systems are under pressure. With competition for both land and water from alternative uses, it is essential that available resources are used in a sustainable manner and yet according to the Millennium Ecosystem Assessment, 60 per cent or 15 out of 24 "components" of the agricultural ecosystem examined are already being degraded or used unsustainably. Erratic climatic conditions are likely to place further pressure on available natural resources and food security through more variable temperatures, changes in precipitation patterns, and increased occurrences of extreme weather events[17]. According to recent projections by the International Food and Policy Research Institute (IFPRI), Asia's production of irrigated wheat and rice will be 14 and 11 percent lower, respectively in 2050 than in 2000 due to changes in climate.

Increasing Food Prices

International prices of major food commodities rose sharply in the early part of 2012, just a few years on from the food price crisis of 2007-2008. Since June 2010, international maize prices have more than doubled and wheat prices have almost doubled. Domestic food prices in many countries in Asia have also increased rapidly[18]. For example, between June 2010 and May 2011, domestic rice prices in Bangladesh, China, Indonesia and Vietnam rose between 13 and 46 per cent. There are also links between the price of food and the price of fuel and oil. For example, the price of nitrogen fertilizers of which natural gas is a key component, have remained high in recent years, while higher oil prices directly translate into higher fuel costs which affects the cost of transportation and shipping with flow through impacts to the cost for countries that need to import food.

Changing Climatic Conditions and Natural Disasters

Erratic climatic conditions express themselves in transitory, short-term events such as severe weather phenomena. According to the International Disaster Database (EM-DAT), the number of natural disasters has increased dramatically since the 1970s, mainly from storms, floods, drought and extreme temperatures. The impact of these natural disasters has been particularly acute in Asia. That said, there is very little reliable data on the overall impact of erratic climatic conditions and natural disasters on agricultural production and this is an area of obvious policy intervention because in general, a better capacity for disaster preparedness also means a better capacity to deal with the downstream effects on food availability. In the absence of adequate data, infrastructure like road and bridges can therefore become surrogate measures when considering food availability. The International Food Policy Research Institute (IFPRI) has projected that erratic climatic conditions are likely to further depress crop yields in the coming decades.

2.4. Key Drivers of Food Security

From the discussion above we conclude a framework for considering overall levels of food security can be based on four dimensions:

- Food availability (production, stocks, imports)
- Physical Access (food distribution and marketing)
- Economic Access (food affordability and pricing)
- Food Utilization (food safety, nutrition).

To advance the debate to focus on outcomes it is important to look beneath these dimensions and consider what might impact each of them. Adopting this approach then allows us to assess how prepared a country might be in addressing the challenges of food security as opposed to just understanding the extent of the challenge. A more solutions focused analysis will provide a platform from which the various players can take action. It also shifts the discussion from viewing food security as a current state (i.e. is a country food secure), to viewing food security from a perspective of how robust a country's capacity is to withstand and address the challenges of food security by addressing any factor or set of factors which may disrupt food security. It is therefore appropriate to consider each of the dimensions through a "robustness lens".

[11] Fan, 2011; World Bank 2011
[12] FAO, 2011
[13] Thapa and Gaiha 2011
[14] Trostle, 2008
[15] Fackler, 2009
[16] Song et al., 2009
[17] Nelson et al. 2010
[18] FAO/GIEWS, 2011

2. THE COMPLEXITY OF FOOD SECURITY
CONTINUED

Food Availability has three components: production, imports and reserves. The dimension is influenced by production factors such as crop yield (especially cereal yields which may be considered a surrogate for the technological state of crop agriculture), area of arable land, availability of labor and credit and infrastructural support such as irrigation, roads and bridges. Additionally, rural literacy and communication capabilities (as measured by ICT or mobile phone usage) will determine the capacity to innovate and adopt new technologies. For food imports to supplement national production and to meet growing demand for diversified diets, food availability is strongly influenced by trade, political stability and the standard of infrastructure like ports, storage facilities and distribution channels which take the form of harbours, waterways, railways and roads.

These same factors concurrently drive the capacity to ensure **Physical Access** to markets by farmers and the ability to distribute food to consumers. The levels of reserves is difficult to incorporate into any consideration as little public information is available but it is recognized as an important component because of the critical role it plays to address short-term, transitory food insecurity. The premise in this paper is that reserves will remain a relatively minor component to safeguard a country's capacity to be food secure, and that preparatory action should be focussed on other components (production, import) to assure longer-term food security.

Economic Access points to demand for food as an important driver in overall food security. In translating the conceptual frame into a pragmatic platform, metrics with public information may be characterised in terms of per capita consumption, the percentage of urban population (reflecting net consumption of non-producers), the change in demand for protein food like chicken, pork, beef and veal as well as overall population growth.

Food Utilization and economic access are also strongly influenced by price (best represented by the consumer price index) and personal disposable income, albeit in different ways. As noted above, food utilization is typically reflected in the nutritional status of an individual and is therefore determined by the diet quality, general child care and feeding practices, food preparation, food storage, along with general health status and its determinants

In addition to these dimensions, several macro-level factors are important for long-term sustainable food security, notably the availability of water and change in forested area (reduction of which indicates disruption of the hydrologic cycle which governs rainfall and overall water replenishment).

The challenge is to move from a mere assessment of the problem to a more solutions-focused understanding; to do this we must capture in a simple form those drivers (enablers or disablers) which will affect a country's capacity to achieve or improve food security. The credibility and sustainability of this assessment, however, depends on the availability of adequate data. Considering these challenges, the Rice Bowl Index – the design of which is described in the next section – takes the key factors represented through metrics and places them into the following four rubrics[19]:

- Farm-level Factors
- Environmental Factors
- Policy and Trade
- Demand and Price

[19] In this context a "rubric" means a standard of performance for a given population

3. EXPLAINING THE RICE BOWL INDEX

Translating the complexity of food security into an opportunity for action

Food security is a multi-dimensional phenomenon. The challenge is how to identify the key driving factors in each of its dimensions, characterize them individually and then in an integrated form to guide further action in view of improving a country's overall capacity to achieve or enhance food security.

At the outset it was stressed we must distinguish between (a) indices which describe the *state of food security in a country*, and (b) indices which describe *how robust a country's system of food security might be*. The type (a) indices will provide a quantitative estimation of how food secure a country is at a *point in time* from the perspective of supply and demand, while type (b) indices focus on identifying the factors which enable a country to be food secure *over time*. Type (b) indices can help inform type (a) indices and have as their starting point more of a solutions focus.

A central hypothesis of the Rice Bowl Index is that while there are many tools and indices that may purport to assess the state of food security at any point in time (type (a) indices), there are few, if any, tools available of the form described here as type (b) indices. Type (b) indices may become important planning tools and platforms for further discussion by the many government agencies, NGOs and private sector players with roles to play or contributions to make in the achievement of food security.

Recognizing the complex mix of factors which influence the four dimensions of food security, the question to be asked is whether it is possible to design a system based on "complexity theory" to capture the key factors and synthesize them into a single simple index which points to the way to possible intervention strategies.

The Rice Bowl Index has been designed in an attempt to answer this question by:

- Taking a holistic view on the enabling and disabling factors of food security
- Integrating relevant, (publicly) available datasets
- Providing analysis with a solutions-focused mindset
- Creating a means for catalyzing collaborations

Design criteria for the Rice Bowl Index

The Rice Bowl Index has been designed first and foremost as a tool to support deeper and more informed engagement between stakeholders who may influence outcomes on food security. From engagement it is mooted that opportunities for greater collaboration will emerge with a solutions mindset, supported by the insight the Rice Bowl Index brings to the debate by using quantitative data, metrics and proxies to examine the key enablers and disablers of food security using credible and publicly available data.

The enablers or disablers of food security are described here as factors – each of which may influence the state of food security. These factors are quantified on the basis of publicly available data and grouped into four rubrics:

- Farm-level Factors,
- Environmental Factors
- Policy and Trade
- Demand and Price

3. EXPLAINING THE RICE BOWL INDEX CONTINUED

In designing the Rice Bowl Index it was considered imperative to be able to answer the following related questions:

- **How robust is a country's food and agricultural system to address the food security challenge?**
- **Which are the areas that need to be a focus for intervention?**

The underlying assumption is food security can be achieved if demand and supply can be brought into balance (production, trade), people have access to food (price, income), farmers have the means to be productive (farm-level factors), innovation and private sector initiative is encouraged (policy and investment) and the environmental prerequisites exist for providing long-term sustainability.

Design framework for the Rice Bowl Index

In addition to the two broad questions which the Rice Bowl Index seeks to answer at a disaggregated level, each rubric is also aimed at helping address some additional key questions which it is considered must be asked by a country when seeking improve the robustness of its food security system.

The component rubric **Farm-level Factors** seeks to answer the question:

- *Do farmers have the capability and means to be productive over the longer term?*

The component rubric **Policy and Trade** seeks to answer the question:

- *Does the trade and policy environment encourage open markets, investment and innovation on an ongoing basis?*

The component rubric **Environmental Factors** seeks to answer the question:

- *Does the environmental capacity in the country provide for long-term agricultural productivity and sustainability?*

The component rubric **Demand and Price**[20] seeks to answer the question:

- *How are food security needs in the country likely to evolve in terms of quantity, affordability, access?*

Schematically, the framework on which the Rice Bowl Index is constructed is shown opposite. The four rubrics are then synthesized to help understand how robust a country's food security system is likely to be given the various enablers and disablers that may impact within the country. The technical details that underpin the design of the Rice Bowl Index are provided in Annex 2.

[20] This indicator is inversed. The higher the value the lower the score

4. WHAT DOES THE RICE BOWL INDEX TELL US?

Achieving food security requires participation from multiple stakeholders

An important theme that has been stressed throughout this paper is that achieving food security (a complex phenomenon) requires participation from multiple stakeholders representing key sectors and industries together addressing the four dimensions of food security.

Analyzing the Rice Bowl Index allows the user to identify common trends and gaps (e. g. yield gap, access to suitable credit facilities, access to market etc.), which in turn may serve as the starting point for a solutions-focused dialogue. Some countries may already have experiential or analytical knowledge on what has to be addressed in order to achieve food security. The added value of the Rice Bowl Index is that it addresses the issue in an unbiased, data-driven manner, with results that may either confirm or challenge preconceived notions. Moreover, it points to some 'low hanging fruit' where targeted action could yield significant improvement of the broader system.

In countries where agriculture contributes substantially to GDP, Farm-level Factors have the greatest impact when considering how robust the food security system might be.

In countries with large agricultural economies (either in real terms or in terms of contribution to GDP), such as China, India, Vietnam and Indonesia, Farm-level Factors are the major influencer among the four rubrics. In China's case for example over the entire period, Farm-level Factors dominate the dataset.

This insight emphasizes the need to make farming an economically viable activity because a larger percentage of the population is involved in agriculture and so dependent on farm productivity to provide both food (subsistence production) and income (the capacity to buy food). In general the agricultural systems for all countries in Asia are dominated by smallholders. If we estimate each farm supports around 4-5 people, then a large percentage of the population is directly dependent on what happens on the farm. Once the result in the Farm-level Factors rubric moves beyond about 10%, this would seem to provide a stable platform for focusing on other factors, albeit that farm productivity must be maintained sustainably over the long term.

From an intervention point of view it suggests that improving the performance of those elements which contribute to Farm-level Factors will deliver an improvement in the robustness of the food security system, because Farm-level Factors are already dominant in the makeup. This would seem to be the case in Vietnam for example, where a strong commitment from government has seen a steady improvement in the performance of Farm-level Factors and a corresponding increase in the robustness of the country's food security system. However, improving Farm-level Factors does not just mean a focus on yield – which is the end result; because there are a number of elements that influence this end result, including education and knowledge transfer, access to technology, availability of credit, labor costs and infrastructure investment.

Farm-level Factors provide a first development opportunity to deliver improvements before shifting focus to Demand and Price or policy development. We may conclude this because for countries where agriculture provides a much smaller contribution to overall GDP, such as Australia or Japan, the factors Demand and Price and Policy and Trade are more dominant in their impact on the food security system.

Farm-level Factors fluctuate more than other factors irrespective of the overall stability and robustness of the food security system

Over an 11-year time series[21] for fourteen Asian countries, Farm-level Factors show much greater fluctuation irrespective of whether a country has relatively high or low score (percentage) when compared to the other rubrics. This is largely influenced by the annual fluctuations in agricultural production which carries relatively heavy weight in the overall composition of the rubric (see Annex 2).

We believe this indicates a significant opportunity to focus interventions on providing consistent and meaningful support to growers such as assisting with access to technology and knowledge (e.g. communication via mobile phones), credit and markets (facilitated by infrastructure such as roads, bridges, irrigation). The trend analysis has also shown that Farm-level Factors together with Demand and Price have the largest impact on the overall robustness of a country's food system but the fact that they show much fluctuation would also suggest that there is a need to stabilise them to have better assurance of food security.

The Example of Myanmar

The trends analysis suggests that Farm-level Factors like cereal yield, available arable land, short-term household credit per capita and unit labor cost are important in driving overall levels of food security preparedness.

The overall Rice Bowl Index score for Myanmar over the time series 2001-2011 ranged from 33% to 40% in comparison with New Zealand which had the corresponding low and high of 59% and 70% respectively. New Zealand's food security preparedness during this period was therefore roughly double that of Myanmar.

Drilling down into the detailed trends shows that during this period, the New Zealand highest cereal yield was 7.02 t/ha compared to the 3.6 t/ha Myanmar. Increasing cereal yield would therefore be an opportunity for Myanmar to improve its overall capacity to achieve and enhance food security. The multi-stakeholder dialogue should then be encouraged which focuses on how this yield gap can be narrowed.

[21] The Rice Bowl Index actually allows historical analysis back to 2001 and forecast analysis through to 2015

4. WHAT DOES THE RICE BOWL INDEX TELL US? CONTINUED

It is difficult to discern a direct causal relationship between Farm-level Factors and Demand and Price.

Across many of the countries considered in the Rice Bowl Index, it is difficult, at least on the surface, to see a strong correlation between the impact of Farm-level Factors on the food security system and impact of Demand and Price. While both are significant, they do not necessarily seem directly related.

At first glance this might seem counter-intuitive because higher levels of production will, all things being equal, lead to an increase in supply and a subsequent lowering in price. However, this presumption of a simple supply and demand curve fails to recognise the complex interplay of access to markets, price transparency, the level of trade, government intervention in markets etc, in other words, imperfect markets. What can be said is that for a country which might be considered "developing", such as Pakistan, the combination of Farm-level Factors and Demand and Price contributes disproportionately to its overall level of system robustness. It may also suggest that food price is of paramount importance especially in countries where disposable incomes may not provide enough flexibility to adapt to higher prices.

Periods of greater price volatility result in Demand and Price having more impact on the overall robustness of a country's food security system

Historically we know that the 2008-09 period was one of extreme price volatility. During this period, across all but two of the countries (Pakistan and Myanmar) in the Rice Bowl Index, Demand and Price factors were the major determinant of system performance, exerting greater influence than they did during adjacent periods. In 2008-2009 prices for many agricultural commodities reached record levels and high commodity prices flowed through to higher prices for food. Regardless of income, this meant people were spending a larger proportion of their income on food, making them more vulnerable to price changes and undermining the overall stability of the food security system and this is reflected in the results presented by the Rice Bowl Index.

It need not flow from this outcome, however, that a country should immediately seek to control prices which can be a blunt tool and have unintended consequences on supply and trade of food among other things. Rather by understanding the implications of price volatility on the robustness of the food security system, decision makers can with a tool such as the Rice Bowl Index, establish what other levers are available - for example supporting investment in new technology or better access to markets and price information – and shift focus to help manage the underlying factors of food price volatility in both the immediate and longer term.

The Policy and Trade environment has a longer-term impact on the overall stability of a country's food security

The Rice Bowl Index allows comparison across a fifteen year period from the year 2000 out to a forecast for 2015. Observing trends over this extended period shows that higher and more stable scores in the area of Policy and Trade are more likely to have a stabilizing and favourable impact on the overall robustness of a food security system. It is also evident that as a factor, Policy and Trade may have less impact year on year, but can be consequential over the longer term. This finding reinforces the notion that to achieve better outcomes in terms of the robustness of a country's food security system, stakeholders must take a longer-term perspective and consider the broader implications of today's decisions. Policies and interventions must therefore be considered in the context of 10 or more years and not perhaps the immediate political cycles of 3-5 years.

Furthermore stability in Policy and Trade tends to be more apparent in the group of countries in Asia where agriculture provides a smaller overall contribution to GDP. So for example Japan, New Zealand and Australia with relatively strong policy and trade metrics have consistently more robust systems, irrespective of crisis or non-crisis years over the period. These Policy and Trade metrics include a strong short-term political rating, the ease of doing business, per capita government spending and net trade in agricultural products. The implication - an important subject for dialogue among the various stakeholders involved - is that a stable open system for trade with supportive policies seems to make a country better prepared to meet food security challenges.

Environmental Factors impact system robustness over an extended period and although change is generally gradual, extreme weather shocks can have immediate impact. The opportunity for improving performance is substantial while any intervention is likely to require significant time to manifest in positive change.

Relative to other rubrics, for most countries Environmental Factors do not make as substantial a contribution to a country's overall score, although as a set of factors they may exert ad hoc, variable effects on a country's food security robustness.

The Example of Japan

Japan provides an illustrative example of a country that is dependent upon factors other than those at the Farm-level. The contribution of agriculture to the Japanese economy is small at around 1.5%[22] and the overall level of self sufficiency in food is less than 40%[23]. This means that Japan is very dependent upon imports of food to ensure its system of food security remains robust. Consequently the impact of Policy and Trade is significant. The results of the Rice Bowl Index clearly confirms this, with Japan's Policy and Trade factors scoring consistently high over the period 2001-2011. Similarly we see the impact of Demand and Price to be more significant than almost all other countries in the dataset as the country has less scope to expand its own agricultural production (evidenced through Farm-level Factors) to offset price fluctuation driven by international commodity prices.

In considering possible interventions there is scope to increase agricultural production, bringing greater balance to the overall food security system. There is also a case to suggest if it is not possible to further increase productivity then ensuring Demand and Price stability through the development of multiple sources of supply and a stable and predictable policy environment can preserve a robust food security system.

[22] The World Fact Book, Central Intelligence Agency
[23] The Japan Times: "Food self-sufficiency rate fell below 40% in 2010", August 12, 2011

4. WHAT DOES THE RICE BOWL INDEX TELL US? CONTINUED

There are countries, for example New Zealand, where Environmental Factors are a major contributor to system robustness and this may reflect the commitment of government to protect biodiversity and sustainable environment management, both of which require long-term commitment and investment. Across all countries it is clearly evident that Environment Factors are an area that require additional policy focus in order to ensure the long term sustainability of the food security system. This is particularly the case given that resources available for food production are declining while the demand for food continues to increase.

Environmental Factors may also (negatively) impact system robustness more significantly in any given year where there have been extreme weather events. For example, in 2011 for Japan and Australia, the relative contribution of Environmental Factors to overall system robustness declined reflecting the impact of extreme weather and environmental events in these two countries.

Environmental Factors fluctuate less year on year. As with many other outcomes from the Rice Bowl Index, this is intuitive but important as the Rice Bowl Index serves to confirm this intuition. While short-term shocks can have immediate impact, changes to the environment materialize over time. It may therefore be more difficult to discern immediate impacts in the absence of shocks, however, the long-term consequences can manifest in terms of sustainability, available resources and levels of production – where the stability of the resource base is crucial. It is important to avoid policy myopia on Environmental Factors because while it may seem they offer less of a lever for food security related interventions, any intervention is likely to require significant time to manifest and so action should be taken now in order to have greater impact in the longer-term. It is essential that available resources are used in a sustainable manner.

It is worth noting that the data available to establish this rubric is relatively scarce which leads to an important point: there is a need to increase data availability in the area of Environmental Factors to better inform the debate on the environmental nexus of agriculture. Increased environmental monitoring and early warning of impending environmental issues may be important to increase a country's overall level of food security robustness and may be an important tool to achieve food security in a sustainable manner.

A higher level of robustness in the capacity to address food security challenges is directly related to balance between the four rubrics

Countries with consistently higher Rice Bowl Index scores (suggesting greater robustness in the food security system) over the trend period 2001 – 2011 show a much better balance between the four rubrics (Demand and Price, Farm-level Factors, Policy and Trade, Environmental Factors). The data indicates that once a certain overall score is reached (> 50%), countries are much more resilient and achieve greater stability (less fluctuation). Conversely, countries that have one particular factor contributing more dominantly to the overall score, are more vulnerable to shocks and therefore tend to have less robust systems and are subject to much greater fluctuation.

Because all countries have various government agencies in charge of matters related to the four rubrics, the analysis clearly shows the need for much better inter-agency cooperation and coordination to increase the capacity to achieve and enhance food security. As we have established, food security is a complex matter with multiple dimensions and requires an integrated approach. With balance comes stability, underpinning the need for an integrated approach to food security.

Population growth and urbanization present direct and indirect challenges

The link between population growth and the demand for food resources is well known. Our analysis shows that achieving robustness in the food security system is most challenging in countries that also face the most rapid population growth and its accompanying urbanisation. Over the period, countries with more robust food security systems (as determined by aggregating the four rubrics), for example New Zealand, Japan and China, show relatively lower population growth than those with less robust systems (e.g. Pakistan, Philippines, Bangladesh, India). There are exceptions like Australia which has a robust system but also high population growth, most likely due to purposeful immigration policies.

In general, exposure to food insecurity is much higher for countries with a high level of population growth and a comparatively low score on the other factors impacting on food security. This suggests that the real issue might not be population growth and its control per se, but rather ensuring that while the population is growing there is enough food available. This may require changes in the trade policies or measures aiming to increase per-capita income across the population.

5. CONCLUSION

A tool for more informed dialogue, engagement and collaboration

The forgoing discussion has been drawn from an initial high level analysis of the Rice Bowl Index. The purpose of the discussion is to illustrate that through the development of a tool that focuses not on the extent of the problem but rather on its contributing factors and the various "levers" that can be considered, a more focused dialogue can commence and which is informed in a manner likely to support far greater levels of collaboration between all of the parties involved in helping to improve food security.

In other words, the Rice Bowl Index aims at supporting a solutions-focused approach to the food security discussion and in doing so the goal is to identify some factors which lend to collaborative planning for action, i.e. the move from "talk" to "walk". Building on this, it is expected that future versions of the Rice Bowl Index will be supported with a capacity for developing 'if – what' scenarios, which would then underpin the message that if changes are made in the right areas, they will lead to an increased robustness of the food system in a particular country and thereby to an improvement of food security.

It is easy to either fall into the trap of inaction due to the complexities in dealing with food security or to simply apply unilateral, unimodal approaches to deal with the complexities. What is most challenging is how to capture the multifarious aspects of food security and to translate the complexity into an opportunity for action. We believe the Rice Bowl Index is one platform which supports an effort and commitment to doing so. No one tool will ever be the "silver bullet" to solve all problems but it is a tool to engage in a meaningful dialogue, based on trend analysis of the main contributing factors of food security, which allows concerned parties to agree on a plan for action. The importance of dialogue as a precipitator for collaborative action to prepare for food security has been a theme throughout this paper. The Rice Bowl Index provides the tools and data for this dialogue to occur.

The food price crisis of 2007-08 refocused much attention on the issue of how robust a country's capacity is to withstand and address the challenges of food security. Many indices and reports have been prepared which directly or indirectly address food security including:

- Global Hunger Index (IFPRI)
- Food Price Index (FAO)
- State of Food Insecurity in the World (FAO)
- Human Development Index (UNDP)
- Development Indicators (World Bank)
- Ease of Doing Business Index (World Bank)
- Water Scarcity Index (UNEP)
- Environmental Vulnerability Index (UNEP)

Apart from these pieces of work, there are many initiatives focused on food security at global and regional levels (e.g. APEC, ASEAN). Many of these have not progressed beyond the "talking" stage. A number of these efforts derive indices which describe the *state of food security* in some aspect, but not *how robust a country's system is to ensure food security*. The index described in this paper differs from the others in this respect.

It is anticipated that the Rice Bowl Index will contribute by providing a platform to identify aspects of food security which lend themselves to joint action between various governmental and non-governmental stakeholders to address. It will therefore provide focus to the ongoing dialogue and hopefully the right impulse to shift the dialogue from discussing the extent of the problem to forging the solutions needed to address the food security challenge: Translating complexity into an opportunity for action.

ANNEX 1: THE RESULTS OF THE RICE BOWL INDEX

A tool for more informed dialogue, engagement and collaboration

The Rice Bowl Index aggregates a selection of metrics (for details see Annex 2) into the following four rubrics: Farm-level Factors, Environmental Factors, Policy and Trade, and Demand and Price. The score in each of the rubrics represents the combined weighted result of the metrics in this rubric. The results are presented here on a country basis over a period of five years split (the actual platform produces results over a 15 year period but for simplicity results for only five years are presented here) along the four main dimensions of the Rice Bowl Index:

- Policy and Trade

  A high score indicates that the trade and policy environment encourages open markets, investment and innovation in support of food security.

- Environmental Factors

  A high score indicates that the environmental capacity in the country is favourable to provide long-term agricultural productivity and stability.

- Demand and Price

  A high score indicates a comparatively low food security pressure resulting from demand and price drivers.

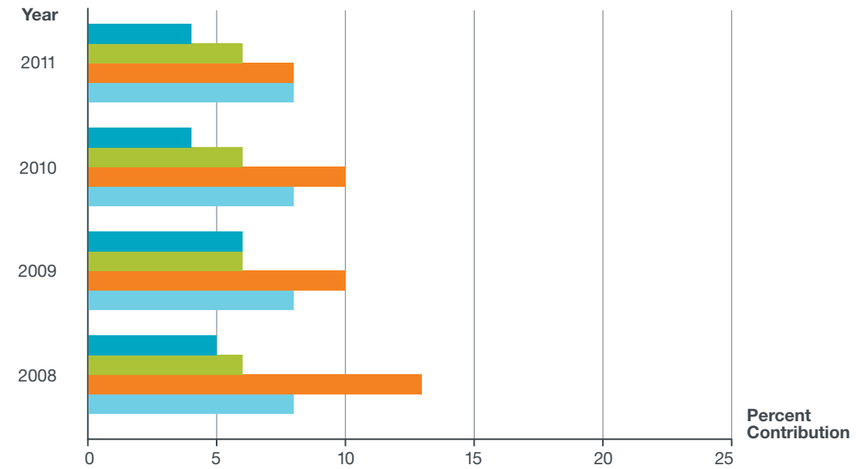
- Farm-level Factors

  A high score is an indication that the farmers have the capability and means to be productive.

A rubric score of approximately 15 (the actual number is a percentage) can be considered as a 'high score'. Adding the scores of all four rubrics will result in a country score, which can be interpreted to reflect the robustness of the country's food security system. An explanation of the technical aspects of the Rice Bowl Index, including a list of the metrics used in each rubric as well as their weightings are contained in Annex 2.

Australia

Bangladesh

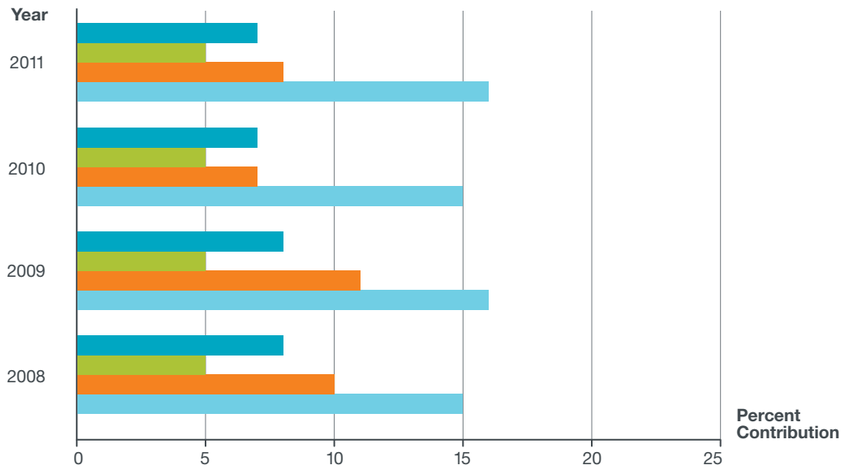


Policy and Trade | Environmental Factors | Demand and Price | Farm-level Factors

ANNEX 1: THE RESULTS OF THE RICE BOWL INDEX
CONTINUED

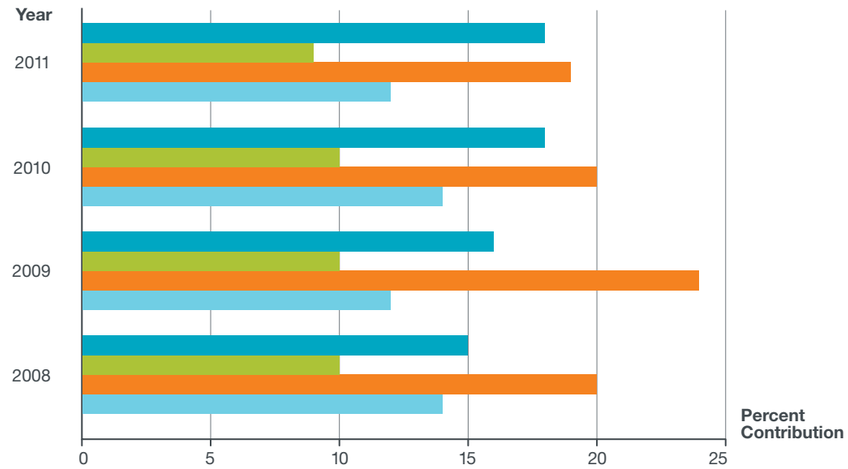
China

India



Indonesia

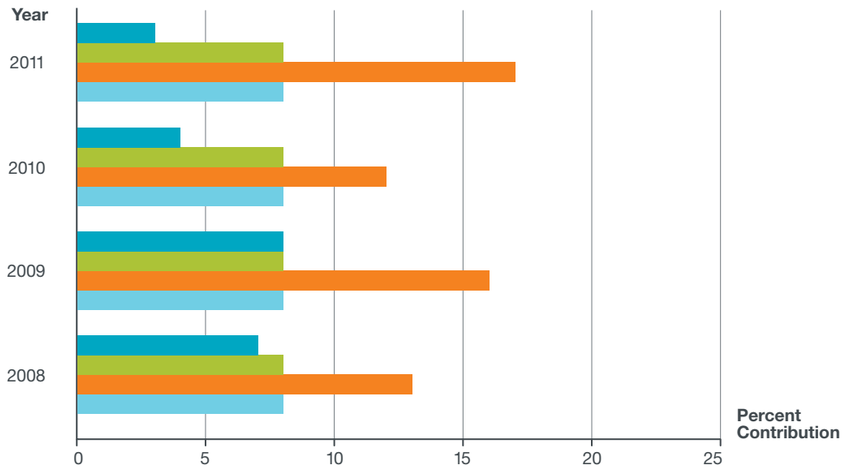
Japan



ANNEX 1: THE RESULTS OF THE RICE BOWL INDEX CONTINUED

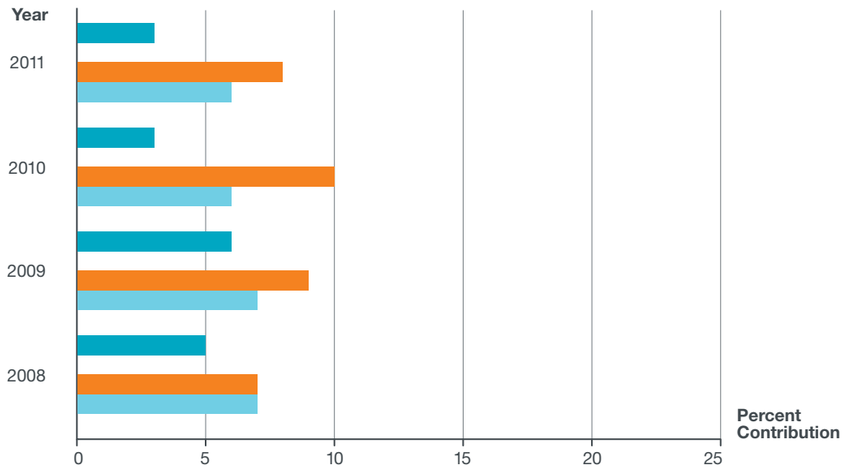
Malaysia

Myanmar



New Zealand

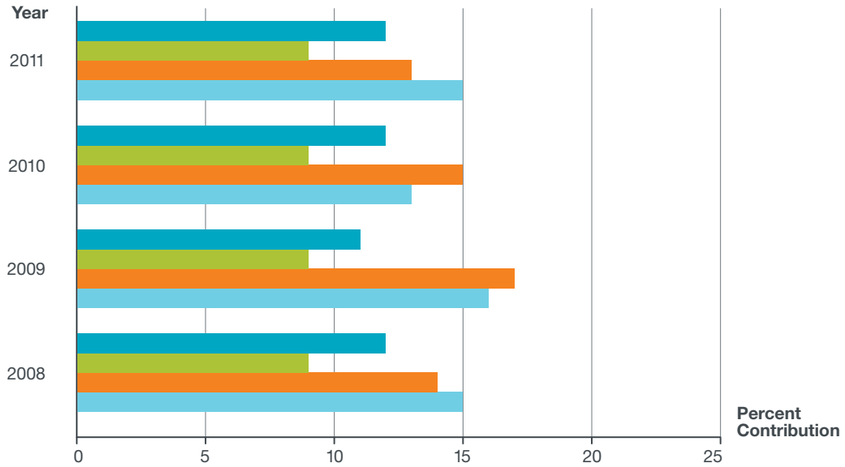
Pakistan



ANNEX 1: THE RESULTS OF THE RICE BOWL INDEX
CONTINUED

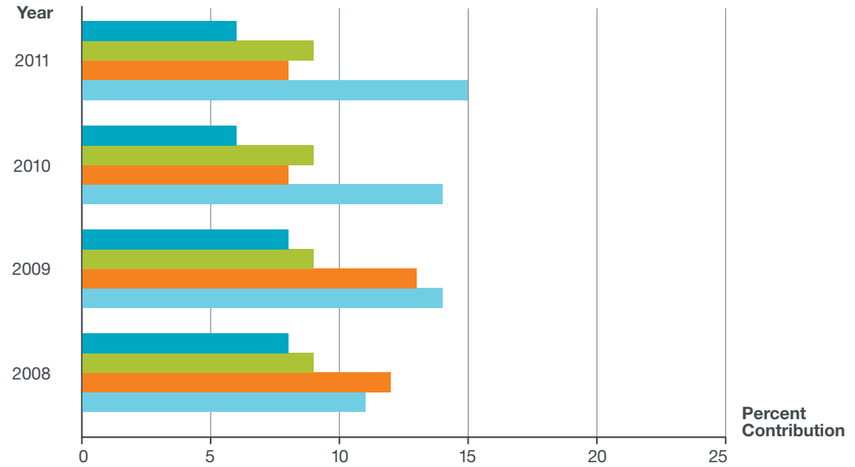
Philippines

South Korea



Thailand

Vietnam



ANNEX 2: TECHNICAL ASPECTS OF THE RICE BOWL INDEX

Components

The Rice Bowl Index consists of four rubrics: Farm-level Factors, Environmental Factors, Policy and Trade, and Demand and Price.

Each rubric in turn comprises a set of indicators (metrics or proxies) which may be considered to have a direct or indirect enabling or disabling effect on food security.

Each metric is given a weight to indicate its relative importance in this rubric.

Farm-Level Factors

Metric	Weight
Cereal yield (kg per hectare)	5%
Adult literacy rate (% aged 15 and above)	1%
Arable Land (ha '000)	5%
Mobile Phone Subscribers, per 100 Fixed Line Subscribers	3%
Roads & Bridges Infrastructure Industry Value (US$bn)	3%
Short-Term Household Credit per Capita	3%
Total Area Equipped for Irrigation (ha '000)	3%
Unit Labor Cost Index (%YOY)	3%
Rural Electification Rate (%)	4%
Sub-Total	**30%**

Environmental Factors

Metric	Weight
Total Internal Renewable Water Resources (qm, per-Capita)	7%
Annual change in forest area (%YOY)	4%
Electricity Cons. (Mwh, per Capita)	2%
Change in Water Quantity (% reduction)	2%
Sub-Total	**15%**

Policy and Trade

Metric	Weight
Net Trade in Agricultural Products (US$bn)	4%
Ports Harbours & Waterways Infrastr. Industry Value (US$bn)	
Railways Infrastructure Industry Value (US$bn)	4%
Short Term Political Rating (%)	5%
Ease of Doing Business Rating	5%
Government Spending (US$, Per-Capita)	4%
Intellectual Property Rights Index	3%
Sub-total	**25%**

Demand and Price

Metric	Weight
Consumer Price Index	6%
Food: Per-Capita Food Consumption US$	4%
Oil Imports ('000, B/D %YOY)	1%
Personal Disposable Income (US$, per Capita)	5%
Urban Population (%, Change To Prev. Year)	4%
Livestock: Beef & Veal Consumption Livestock: Pork Consumption Livestock: Poultry Consumption ('000, Tonnes, %YOY)	4%
Population (%YOY)	6%
Sub-total	**30%**

The set of metrics comprising each rubric is not intended or claimed to be exhaustive; however, the conceptual framework used in the Rice Bowl Index is a pragmatic one and selection of metrics is based not only on their importance to the rubric but also on the availability and consistent quality of data across most countries. At times, specific metrics are used as proxy (e.g. mobile phone subscribers as a proxy for access to information).

The weights for each metric are intended to reflect the significance or 'importance' of each metric in determining the result of the index. As currently developed and contained in the Rice Bowl Index the weights were determined subjectively by Syngenta in consultation with Frontier Strategy Group. The weights as they stand represent one view and can be changed should it be considered appropriate and to also support "if – then" analysis. The weights for each metric are used to calculate a country score for a particular metric. A formula is used to calculate the weighted score of each metric for each country, relative to other countries in a set.

The metrics included across the Rice Bowl Index have a variety of units, for example, kg, ha or $. However, the calculations normalize each value relative only to its 'peers' within the same metric across countries. Since values are being normalized relative only to values with like units, the index does not conflate disparate dimensions within or across countries.

An illustrative example of an estimated country score is shown below:

$$\text{Absolute Value}\left[\frac{\text{Metric - Min Value}}{\text{Min Value - Max Value}} * \text{Weight}\right] = \text{Metric Score}$$

Metric = A single economic or industry data point. For example, the metric for Bangladesh's Cereal yield, in kg/ha, for year 2000 is 3,384.3 kg (Table is on following page).

Series = A list of countries for a given metric, e.g. a Cereal yield series for Asia.

Weight = A value, out of 100, assigned to the metric, e.g. 5% for Cereal yield

The automatic calculations performed by the system treat the weighting as though the total were 1000 as opposed to 100, so when doing manual calculations everything should be adjusted by a factor of 10.

ANNEX 2: TECHNICAL ASPECTS OF THE RICE BOWL INDEX CONTINUED

Cereal Yield, kg/ha

Country	2000	2009	2010	2011
Bangladesh	3,384.3	3,890.4	3,980.0	4,071.7
China	4,756.3	5,459.5	5,515.5	5,572.0
India	2,294.1	2,470.7	2,490.9	2,511.2
Indonesia	4,026.3	4,812.6	4,915.9	5,021.3
Japan	6,256.8	5,919.9	5,921.2	5,922.5
South Korea	6,435.7	7,072.8	7,165.2	7,258.8
Malaysia	3,039.5	3,750.4	3,847.4	3,946.9
Myanmar	3,190.8	3,585.0	3,644.7	3,705.4
Pakistan	2,407.8	2,803.2	2,873.2	2,945.0
Thailand	2,719.1	2,953.7	3,000.3	3,047.7
Vietnam	4,112.3	5,074.6	5,201.5	5,331.6

Source: World Bank.
Cereal yield, measured as kilograms per hectare of harvested land, includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded. Last Updated: December 2011

Weighted scores estimated using MarketView formula for year 2000

source		manual	
step	calculation	rounding formula	rounded values
year / geography	**2000**	**2000**	**2000**
Bangladesh	13.16158	13	13
China	29.725227	30	30
India	0	0	0
Indonesia	20.912208	21	21
Japan	47.840207	48	48
South Korea	50	50	50
Malaysia	8.9989376	9	9
Myanmar	10.825526	11	11
Pakistan	1.3726579	1	1
Thailand	5.1308673	5	5
Vietnam	21.950454	22	22

Calculating for Bangladesh, Year 2000, using data in the table above.

Absolute value of (3384.3 – 2294.1)/ (2294.1-6435.7) = 0.2632

Multiply by weighting for cereal yield, 5% = 0.2632*5 = 1.3162

Multiply by 10 to account for manual calculation = 13.162

Rounded-off as 13.

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