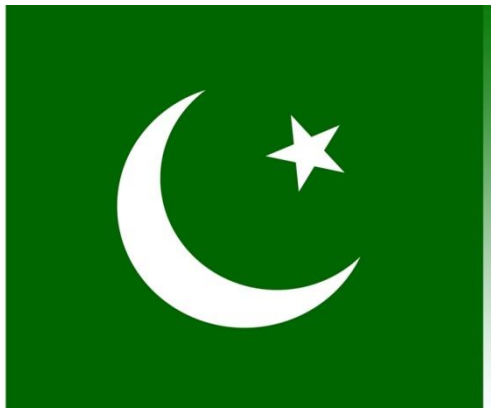
Impacts of Shocks on Household Income and Food Consumption Simulation Modeling

PAKISTAN

Executive Summary



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Synopsis

- Recent increases in global food prices, higher frequency of natural disasters and frequent political crises are all events that adversely effect household food security. Pakistan country case study is the first in a series to quantify the impact of market and climate-related shocks on household food consumption, through a household income and food consumption model.

- The study assesses changes in the baseline vulnerability context for different geographic regions and for a range of household livelihood groups through three profiles: market integration of staple food commodities, nation-wide vulnerability to natural disasters, and household vulnerability.

- The results show that the number of undernourished Pakistanis (as per the Government's calorie consumption threshold of 2350 kcal/adult/day) increased from 78 million in 2005/06 to 96 million by the end of 2010. This increase of about 18 million is attributed to price inflation (13 million people) as well as the massive flood disaster in August 2010 (an additional 5 million people). When applying a relatively more strict minimum per capita consumption standard of 2100 kcal/person/day, the number of undernourished increases by 17 million to 99 million people. Finally using the bare minimum dietary energy requirement of 1730 kcal/person/day, the number of undernourished increases by 21 million to 65 million people. With government and humanitarian interventions, some affected households have certainly recovered from the floods and returned to the food secure category.

- In the absence of any intervention and based on the 2350 kcal/adult/day threshold, the food needs to meet the total requirements of the affected population is estimated at 6 million tons of cereals per annum in wheat equivalent terms. This gap remains about the same, when using 2100 kcal/person/day. At the threshold of 1730 kcal/person/day, the food needs are estimated at about 2.7 million tons of wheat equivalent per annum.

- In response to high prices and falling incomes, Pakistan's per capita wheat consumption has been declining, leading to rising wheat stocks in recent years. In terms of Pakistan's national balance sheet, the country is expected to be balanced in wheat and continue to be a net exporter in rice, although the surplus volume is expected to decline by over one million tons in 2011. The major challenge is therefore to ensure that undernourished households have sufficient purchasing power to close the estimated hunger gap.

Background and Rationale

Recent increases in global food commodity price volatility and climate change with higher frequency of severe natural disasters, and political crises have adverse effects on household food security. Both food producing/exporting countries and low income food deficit countries are affected by reoccurring crises, which often send shockwaves through national economies and households, leading to a heightened situation of food insecurity. Estimates show a substantial increase in the number of undernourished people currently above a billion as a result of these shocks.

National and global methods for prompt assessments and estimates of the impacts of shocks are weak in supporting timely national responses to food crises in many developing countries. Many sudden-onset natural disasters leave little time for assessment, planning, and response, whereas man-made disasters yield even more technical challenges to conduct increasingly complex and in-depth analyses on the socio-economic factors.

In view of the above, a shock impact modeling system (SIMS) is being developed jointly by WFP and FAO to simulate the impacts of shocks on household food consumption. The SIMS builds on existing nationally representative household survey data. This model is regarded as a strong alternative to nation-wide assessments, as it can be used as a cost and time-effective tool by reducing the scope of in-depth ground-truthing assessments to the most affected areas and populations. The results of the simulation can also support early warning for potential shocks and early response to shocks that have taken place. The SIMS provides estimates of the proportion of undernourished people by livelihood and income groups as well as by geographical areas, thus contributing to geographic and community targeting. It is being piloted in five selected Low Income Food Deficit Countries (LIFDCs) that are highly vulnerable to reoccurring crises[1].

Pakistan is the first of the five case studies. In recent years, Pakistan has been faced with the 2008 global food, fuel and financial crises and a series of climate shocks, which have increased undernourishment significantly. Pakistan has experienced several major natural disasters over the past few years, from the massive Kashmir earthquake in October 2005 to the August 2010 flood. These events have all sent shockwaves through the national economy.

In 2008, a United Nations Interagency mission was conducted in Pakistan, supported by the Government of Pakistan and other stakeholders, to conduct an assessment of the impacts of food price hikes in the country[2]. The findings and recommendations of this assessment resulted in the rapid launch of a safety-net program for vulnerable populations in the most affected areas as well as into policy action within the framework of a National Task Force on Food Security, established by the Prime Minister. The analytical method used for the inter-agency assessment was recognized as very useful. As a result, it was recommended to refine the methodology and the tools in order to ensure effective replication in other countries subject to large scale shocks.

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[1] These countries are Bangladesh, Burkina Faso, Malawi, Nepal and Pakistan.

[2] The UN Inter Agency (FAO/UNDP/UNICEF/WFP/WHO) Assessment Mission. High Food Prices in Pakistan: Impact Assessment and the Way Forward
http://www.un.org.pk/wfp/Pakistan_High%20Food%20Prices%20_11%20Aug%202008_.pdf

Approach

The approach to this project is structured into two main parts: the vulnerability profile of the country and the shock simulation model. Part one assesses the vulnerability context of Pakistan using baseline data (i.e. without shocks). It identifies the areas and livelihood groups that are most vulnerable to potential shocks and describes the food security situation of households measured in terms of caloric intake. This vulnerability profile provides contextual information for the modeling by highlighting factors that make household sensible to market and climate shocks. Part two develops a framework for the Shock Impact Modeling System (SIMS) which estimates the impact of the recent market and climate shocks on household food consumption in Pakistan. The simulation results show which population groups are most affected by previous shocks and which ones are likely to be most affected by future shocks.

The vulnerability context of Pakistan is assessed through three profiles. The first vulnerability profile provides a market integration analysis of staple food commodities, and determines the markets that are most receptive or vulnerable to international and domestic food price shocks. This profile also provides parameters on price transmission for the SIMS.

The second profile reviews the historical records of nation-wide vulnerability to natural disasters and highlights the areas that are most vulnerable to climate shocks. It provides an understanding of the relationship between weather patterns and staple crop production and the implications for household food security. This profile provides the parameters for crop production monitoring, taking into account the impacts of weather related variables such as rainfall. The estimated productions are then used in the SIMS.

The third profile estimates the baseline caloric intake of households and analyses the vulnerability of livelihood groups to shocks by combining households' main income sources with the shock factors. In this third profile, it is assumed that the extent to which the impact of a shock is transmitted to households largely depends on their main income sources and on their level of dependency on markets.

The second part, and core of this report, is the simulation of the impact of shocks on household food consumption measured by caloric intake. The simulation model (SIMS) estimates the impacts of market and climate shocks on household caloric intake through a series of modules following three steps: estimation of incomes, allocation of incomes through a two-stage budget allocation demand system by income groups, and estimation of equivalent caloric intake. The SIMS simulates the percentage change of households' caloric intake from the baseline situation, the corresponding number of undernourished people and the food requirements to meet the need of the affected people.

Main Findings of the Vulnerability Analysis

Vulnerability to Food Price Shocks

The market integration[3] and price transmission analysis in Pakistan determines the degree of wheat, IRRI[4] rice and basmati rice price integration between domestic and international markets. Wheat is the staple food in Pakistan, and rice is both an important export and consumption crop.

The findings suggest that the degree of market integration is stronger among domestic markets compared to international markets. The low integration of international to domestic price signals can be explained by various factors, such as government intervention in wheat markets and trading patterns in IRRI and basmati rice markets. Informal trade flows with Afghanistan and India tend to affect integration patterns due to cross-border price differentials. The statistical significance of international price transmission was relaxed to 10% in order to select leading markets. The low integration of domestic markets to the international market could undermine market response to international price decreases. At the same time it could shelter households from being severely impacted by imported price volatility.

The results of the domestic market integration analysis show that price transmission is strongest in wheat and IRRI rice markets. The results of the price transmission in domestic wheat markets are also likely affected by government intervention, but the price signals are strong enough to draw conclusions on the price-setting markets. IRRI rice price is the most integrated among domestic markets and in international price transmission. Table 1 summarizes the list of the main markets that are vulnerable to food price shocks and hence require close monitoring due to their leading role in the domestic economy and their integration to the international market.

Table 1: Most Sensitive Markets to Price Shocks

Commodity	Leading Markets		
	Domestic Price Shocks		*International Price Shocks*
	Retail Markets	*Wholesale Markets*	*Wholesale Markets*
Wheat	Karachi; Rawalpindi	Multan; Peshawar	Hyderabad; Peshawar
IRRI Rice	Islamabad, Karachi, Lahore, Quetta and Rawalpindi	Multan; Rawalpindi	Multan; Sukkur; Peshawar; Rawalpindi; Quetta
Basmati Rice	Peshawar	Hyderabad; Multan	Hyderabad

Among wheat leading markets, Hyderabad and Peshawar are the two markets that show a long-term relationship with international prices. Hyderabad is located near the major port of Karachi, the entry point for wheat imports. Peshawar is a major trading point with Afghanistan

[3] Market integration is the process in which demand, supply and transaction costs in distinct markets jointly determine prices and trade flows, as well as the transmission of price shocks from one market to another or both.
4 International Rice Research Institute

and supplies areas in FATA and Khyber Pakhtunkhwa. Peshawar is also a key market in domestic wholesale price transmission and second to the leading market, Multan. Multan is located in the centre of the largest wheat producing province Punjab. The price of wholesale wheat is set by production levels in production markets.

Price transmission from international IRRI rice markets to domestic markets shows mixed results. The results show a marginal level of price transmission from international to domestic prices. Unlike wheat, domestic wholesale prices of IRRI rice tend to increase before the international price, suggesting that Pakistan plays a role in setting the price in the IRRI rice market. The results of the market integration analysis highlight five IRRI rice markets to monitor in case of an international price shock (Table 1). Sukkur, which is located close to the border with India, has the highest response rate of short-term fluctuations in international prices. Multan also shows a higher level of short-term adjustment to international prices compared to the other markets. This suggests that IRRI rice prices in Sukkur and Multan are responsive to shocks. The domestic price integration analysis suggests that Islamabad, Karachi, Lahore, Quetta, and Rawalpindi are important retail markets to monitor as they play a role in price determination throughout Pakistan's IRRI rice markets. On the wholesale side, the analysis suggests to monitor Rawalpindi and Multan. Rawalpindi is located just outside of Islamabad and is a major supply market for the capital city. Multan is a leading market on domestic wholesale price transmission and likely a price setter among domestic prices.

The basmati rice market efficiency seems quite low. The trends of wholesale and retail prices in Hyderabad and Rawalpindi signal market intervention in the rice market, which can be explained by the government's decision to control exports and manipulate domestic supply levels which indirectly influences prices. Similar to wheat, government intervention prevents market efficiency and makes it difficult for price forecasting. The results indicate that basmati rice markets are weakly integrated between domestic markets and between international and domestic markets. In retail markets, Peshawar is the price setting market and should be monitored in case of a price shock. Such a shock would be transmitted to other markets.

Vulnerability to Natural Disasters

Pakistan is classified as being extremely vulnerable to natural disasters due to its geographical location, the frequency of their occurrence, and the number of affected people. The country has a wide variety of geological features including high mountain ranges, plain lands, deserts and coastal areas. For this reason, Pakistan is particularly prone to a range of natural disasters associated with those features including earthquakes, floods, droughts, storms, cyclones, tsunamis, avalanches, landslides and extreme temperature conditions.

Historically, floods are the most frequently occurring disaster, in particular in the alluvial plains of the Indus river system. At a provincial level, Punjab and Sindh are particularly prone to floods, while hill torrents tend to affect more hilly provinces of Khyber Pakhtunkhwa and Balochistan.

Floods and droughts in Pakistan have caused tremendous damage to livelihoods and infrastructure, with severe implications for food security. As exemplified by the August 2010 flood, the largest losses and impact were suffered by the agriculture, livestock, and fisheries

sectors. Damages to the already old irrigation infrastructure caused by the 2010 floods, combined with the increasing scarcity of water resources in Pakistan pose serious risks to agricultural production. This is particularly alarming when a large portion of the national wheat output depends on irrigation. An analysis was carried out using the historical data on floods, droughts and production by province to estimate the impact of rainfall patterns on wheat production in the main provinces in Pakistan.

The results from the four main provinces indicate that wheat production is impacted by rainfall related shocks. The correlation between crop production and cumulative rainfall is stronger when the weather shock data (droughts and floods) is excluded from the time series. The strongest relationships are in Khyber Pakhtunkhwa and Punjab provinces, which receive the largest amount of rainfall among all the provinces. While Khyber Pakhtunkhwa produces the least amount of wheat, Punjab is the largest wheat producer. The derived parameters serve to estimate changes in wheat production. These estimates are then used in the SIMS. The correlation between wheat production and cumulative rainfall is statistically significant, suggesting that cumulative rainfall is a good predictor of wheat production in Pakistan and helps forecast the impacts of natural disasters such as floods and droughts.

Household and Livelihood Vulnerability

The last aspect of the profiling analyzes which livelihood groups are vulnerable to potential shocks. Vulnerability to shocks is defined as the extent to which the share of the income sources that a livelihood group is dependent on could be affected, and by the level of undernourishment.

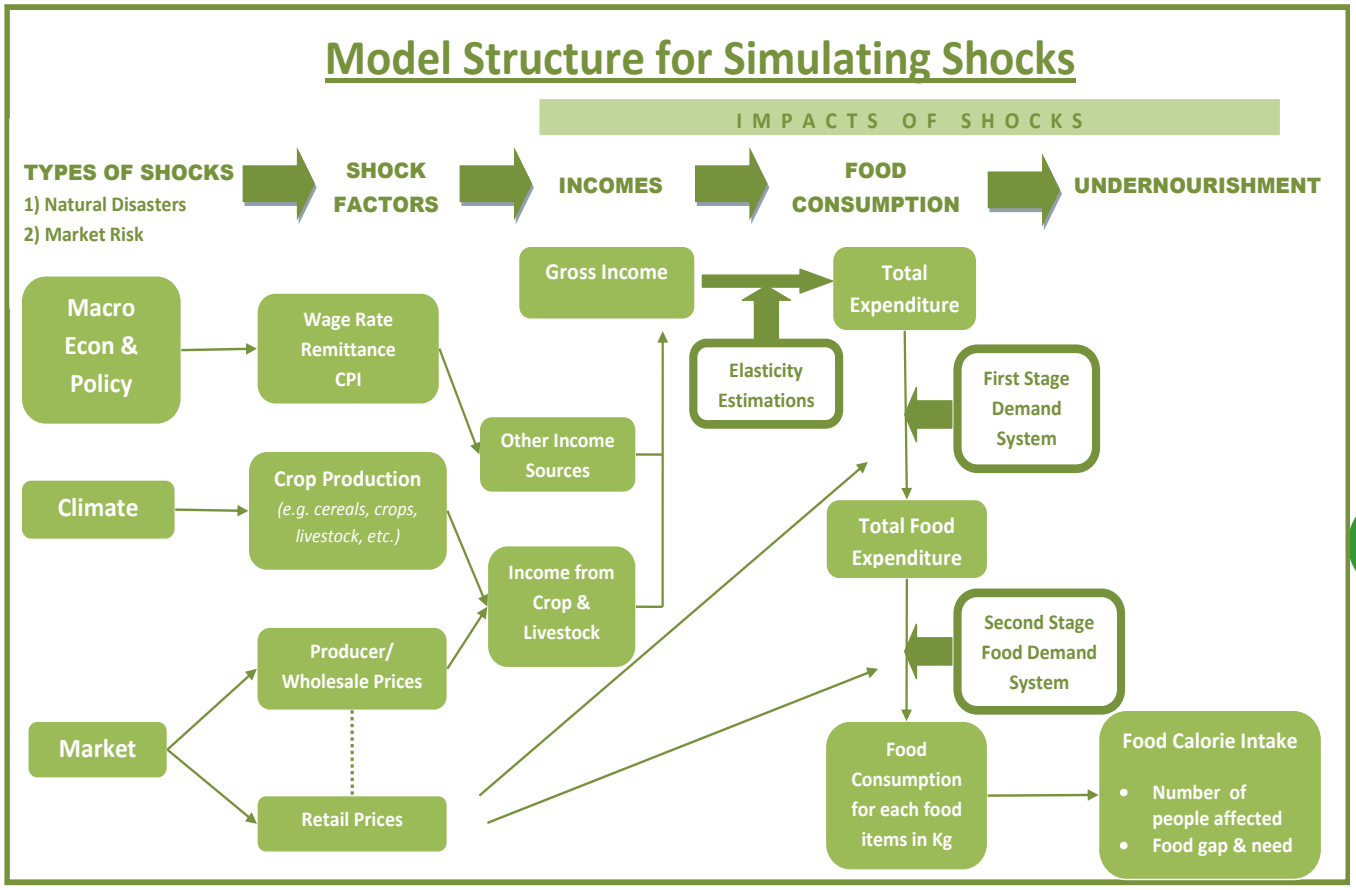
For analytical purpose, income sources are divided into three main groups: crop and livestock income, agricultural wage income, and non-agricultural wage income. Livelihood groups who derive their major income from crop and livestock or receive a significant portion of their income from agricultural wage income would be vulnerable to both market and climate shocks. The household profiling indicates that unpaid family workers, owner cultivators, sharecroppers, contract cultivators and pastoralists fall in this category. Indeed they would be dependent on the market for food expenditures and their agricultural wage labor could be diminished in the case of a climate shock (flood, drought, earthquakes). Non-agricultural wage income groups would be most vulnerable to market shocks, as their livelihoods are dependent mostly on labor and food markets. Households with employers and paid employees in rural areas and traders, social and personal service sector, general service sector, and industrial workers in urban areas all fall in this category as they derive at least 80% of their income from non-agricultural activities.

Simulating the Impacts of Market and Climate Shocks

Framework of the SIMS and Parameter Estimations

The model examines the impact of previous or potential shocks on household income, expenditure and food consumption. As mentioned above and shown in Figure 1, the model links several components together: market monitoring component, crop monitoring, income generation module, a budget allocation module and a food consumption module.

Figure 1: Modeling Framework



The income generation module is used to link shocks to household income which is aggregated into the following groups: crop, livestock, agricultural wage, non-agricultural wage, public wage, remittance, and other income. The Crop income module is further separated into wheat, rice, maize, pulses, cotton, sugarcane, and other crops. Crop production is specified as a function of rainfall and time trend, which is a proxy indicator of technology development. Other incomes, such as wage incomes, are a function of GDP, wage rate, and the consumer price index. The market monitoring module includes a commodity partial equilibrium model and a set of price transmission equations. Total expenditure is directly linked to the income by a single equation.

The food consumption module simulates the effects of income and price changes on food consumption. The total expenditure is allocated by a two-stage demand system. In the first stage, total household expenditure is broken down in eight broad consumption groups which

include: food, clothing, fuel, housing, durable goods, education, medical, and other items. The food expenditure is then allocated to the food subgroups which include: rice; wheat; other cereals; potatoes; meat, fish and eggs; milk and milk products; vegetables and fruits; fats and oils; spices and sugar; and non-alcoholic beverage.

More than 500 crop income and (own and cross-) price elasticities were estimated from household survey data. A non-linear Seemingly Unrelated Regression was used to estimate a linear expenditure system (LES) of seven equations for the first-stage budgeting. The panel data of cross sector (by province and income group) of the Pakistan Social and Living Standard Measurement Survey (PSLM) data of 2001/02, 2003/04, 2005/06, and 2007/08 data were used to estimate all the elasticities. In the second stage, a Linear Approximate Almost Ideal Demand System (LAIDS) was estimated for 13 food subgroups by using the household level 2005/06 PSLM data of 15,400 households. Households generally respond differently to changes in income and food prices. However, households in low income groups are more responsive than high or middle-income groups to such changes.

Shock Scenarios

The shock model simulated two different scenarios to provide the most likely situations of market and climate shocks. The first scenario (market shock) is based on actual changes in real wholesale prices, retail prices, and wage rates between 2005/06 and 2010/11. These changes were estimated for 20 commodity prices and wage rates in each province.

The second scenario combines scenario one and the impact of the flooding in August 2010. The impact of flood is captured by the actual losses in crop and livestock production. These losses were estimated through assessments covering roughly 94 percent of the population in more than 120 districts in Pakistan.

Impact of Shocks on the Proportion of the Population with Inadequate Food Intake

Table 2 shows the results of the simulation applied on rural and urban areas, among livelihood groups, and income groups, using the minimum dietary energy requirement (MDER)[5] of 2350 kcal/adult/day. The simulation results of scenario one show that price increases had a substantial impact on the prevalence of undernourishment nationwide (7.5 percentage points increase), but rural areas were impacted more (9.3 percentage points increase) than urban areas (4.8 percentage points increase). In scenario two, the level of undernourishment in urban areas remained almost unchanged compared to scenario one, suggesting that urban households are less vulnerable to floods.

The results categorized by livelihood groups show similar findings from the baseline situation. Unsurprisingly, the livelihood groups that are less dependent on the agricultural sector, as their main source of income, are most affected by price increases in rural areas (first two rural livelihood groups in Table 2). Paid employee and pastoralists are the worst affected livelihoods, as the percentage of those having an inadequate food intake both increased by 12.4 percentage points to 62.7 percent and 46.0 percent respectively. Price increases also seem to have resulted

[5] Other definitions for undernourishment such as, 2100 kcal and 1730 kcal are applied to all categories of the simulation results and provided in the Appendix of the full report.

in a substantial increase of undernourishment figures among employer based households. Overall, household groups with agricultural production face relatively smaller impacts of price increases on the prevalence of undernourishment. Rural non-farming households are worst hit by price increases because they cannot rely on own production for food consumption.

Table 2: Simulated Impact of Flood and Price Increases on Undernourishment (Caloric Intake: % of adults <2350 kcal/per day)

Category	Baseline (2005/2006)	Post-shock (2010)	
		Scenario 1	*Scenario 2*
Rural	41.0	50.3	55.4
Urban	50.6	55.4	55.2
Total	44.8	52.3	55.3
Rural Livelihood Grouping			
Employer[6]	40.8	50.7	55.1
Paid Employee	50.3	62.7	67.7
Unpaid Family Worker	36.8	36.6	37.8
Owner Cultivator	28.4	33.0	40.5
Sharecropper	41.3	49.6	63.2
Contract Cultivator	29.6	34.7	38.9
Livestock Only	33.6	46.0	46.8
Urban Livelihood Grouping			
Agriculture	41.5	44.8	47.3
Traders	54.1	58.8	59.9
Social & Personal Service	49.5	53.5	53.9
Service Sector[7]	49.9	56.4	56.3
Industrial Sector	53.1	60.0	60.2
Income Grouping-Rural			
Low	49.1	61.6	68.0
Middle	24.2	23.8	25.0
High	11.4	13.2	14.8
Income Grouping-Urban			
Low	74.2	83.2	83.4
Middle	51.2	50.6	49.5
High	24.9	28.6	28.6

When applying scenario two (i.e. combined flood and price increases), the livelihood groups whose main income sources are derived from the agricultural sector are most affected. Sharecroppers suffered the most, showing the highest increase of undernourishment (+21.9 percentage points) due to flood. The owner cultivators faced a relatively high percentage increase of about 7.6 points. Overall, rural farming households are worst hit by the 2010 floods because they rely on production as their source of food and income.

Among urban livelihood groups, price increases had a larger impact on households' undernourishment than floods. Service sector and the manufacturing sector based households were the worst affected urban livelihoods, as inadequate food intake increased by 6.5

[6] Employers is a livelihood group composed of mainly large employers (>= 10 employees), small employers (<10 employees) and self employed non-agricultural businesses.
[7] Service sector is an urban livelihood group composed of transport, storage, real estate, & insurance sectors.

percentage points to 56.4 percent and by 6.9 percentage points to 60 percent respectively. The simulation results found the situation of flooding to only affect agricultural based households among the urban livelihood grouping (2.5 percentage point increase).

Looking at the income groups, the shock impact simulation shows that a larger proportion of households of low income groups became undernourished as a result of price increases in both rural (12.5 percentage points) and urban (9.0 percentage points). In the case of flooding, only low income households in rural areas are affected (6.45 percentage points increase in rural). As the average income increases, the impact of price increases and flooding on households' food consumption becomes less.

Implications in Terms of Number of Undernourished People, Depth of Hunger, and Food Needs

When applying the MDER of 2350 kcal/adult/day, the number of severely food insecure people nationwide increased from 77.6 million in the baseline situation to 95.7 million due to price increases (+12.9 million people) and flooding in August 2010 (+5.2 million people). The increase of undernourishment was largest in rural areas, as an additional 9.9 million people became undernourished due to the market shock and an additional 5.2 million people due to the climate shock. The increase of undernourishment in urban areas was small compared to rural areas, as urban areas were only impacted by the market shock (3.0 million people). With government and humanitarian interventions, some newly undernourished households have certainly recovered from the floods and returned to the food secure category.

Applying additional definitions of undernourishment, such as the MDER of 2100 kcal/person/day and the MDER of 1730 kcal/person/day, can be useful to target the varying degrees of undernourishment with specific interventions. When applying the relatively more strict minimum per capita consumption standard of 2100 kcal/person/day, the number of undernourished increases by 17 million to 99 million people. Lastly, the MDER of 1730 kcal/person/day increases the number of undernourished by 21 million to 65 million people.

The depth of hunger and the cereal gap are used to quantify the food required to mitigate the impacts of price and flood shocks on household consumption. The depth of hunger calculates the gap between the estimated food consumption and the MDER for the households with inadequate food calorie intake. In the absence of any intervention and when consuming less than 2350 kcal per day, the depth of hunger increased nationwide from 475 kcal per day in the baseline situation to 603 kcal per day in a combined scenario of price increases (+78 kcal/day) and flooding (+50 kcal/day). When applying the MDER of 2100 kcal/person/day to the depth of hunger, the hunger gap increased by a smaller margin from 445 kcal per day to 562 kcal per day, due to the market shock (+75 kcal/day) and to the flood shock (+42 kcal/day). With the MDER of 1730/person/day, the amount of kilocalories needed to reach the daily minimum requirement increased from 301 kcal per day in the baseline to 388 kcal in scenario two (price increases +52 kcal/day and flooding +35 kcal/day).

Table 3: Hunger Gap Quantified in Kilocalories and Tons of Wheat

Depth of Hunger (kcal/person/day)	**Baseline (2005/2006)**	**Post-shock (2010)**	
		Scenario 1	*Scenario 2*
MDER 2350	475	553	603
MDER 2100	445	520	562
MDER 1730	301	353	388
Nationwide Cereal Gap (millions of tons per year)			
MDER 2350	3,956	5,380	6,197
MDER 2100	3,946	5,263	5,990
MDER 1730	1,428	2,208	2,706

To quantify the consumption shortfall in terms of cereal in Pakistan, the cereal gap is calculated by converting the depth of hunger calculations from calories to the equivalent quantity of wheat in kilogram terms. Pre-crisis, the total food needs in 2005/06 to fill the cereal gap was 3.95 million tons of cereals, when using the minimum requirement of 2350 kcal/adult/day (2.24 million tons in rural areas and 1.71 million tons in urban areas). The total combined effects of price increases and flood resulted in an increase of the food gap from 3.95 million to 6.20 million tons of wheat nationwide. In addition, 978,126 tons of cereal is needed in rural areas and 446,242 tons in urban areas in 2010/11 to fill the gap created by price increases. To cover the gap caused by flood, an additional 817,118 tons of cereal is required. When measuring the results of the simulation by the MDER of 2100 kcal/person/day, the quantity of cereal increased from 3.94 million tons in the baseline situation to 5.99 million tons due to price increases (+1.32 million tons) and flooding (+726,777 tons). When applying the MDER of 1730 kcal/person/day, the cereal gap increased from 1.43 million tons to 2.71 million tons in scenario two (market shock +779,898 tons and flood shock +498,084 tons).

Cereal gap calculations allow for an assessment of the equivalent amount of cereal needed (in wheat equivalent terms) to meet requirements of the undernourished based on the consumption shortfall, but do not intend to overlook the issue of access. Lack of purchasing power and access play a major role in the hunger gap as households lost the ability to access cereals due to price increases, income loss, and crop loss. Insuring sufficient-levels of purchasing power is essential to closing the gap.

As a result of high prices and falling incomes, Pakistan's per capita wheat consumption has been declining and led to the rising wheat stocks before floods in recent years. In Market Year 2010/11 (May/April), Pakistan is expected to be balanced in wheat due to the reduced demand and by using the stocks and is expected to continue to be a net exporter in rice with favourable world rice prices and government rice policy. However, the surplus volume of rice is expected to decline by over one million tons in 2011.

Conclusions

The Pakistan case study shows that price increases and floods had a negative impact on food security. The leading markets, such as Hyderabad, Peshawar, Multan, Karachi, Rawalpindi, Islamabad, Lahore, Quetta and Sukkur, are more sensitive to domestic and international wheat and rice price fluctuations according to market integration and price transmission patterns. As such they require a close monitoring for early warning and field assessments purposes. Likewise, the analysis of the relationship between crop production and natural disasters suggests that all the major wheat production areas of Pakistan are significantly vulnerable to climate shocks, with Punjab and Khyber Pakhtunkhwa being the most vulnerable to weather shocks.

The results of the simulation model indicate that households of employers, paid employees, and pastoralists in rural areas and service sector and industrial based households in urban areas are most affected by price increases. The main income source of employers, paid employees, service sector and industrial livelihood groups is non-agricultural wage income, which accounts for over 80 percent of income on average in the four main provinces of Pakistan. A new face of hunger appears as more paid employees and pastoralists became undernourished compared to other livelihood groups, as a result of price increases. More low income households are also affected by price increases in both rural and urban areas. When floods are taken into account, low income groups and agricultural income dependent livelihoods are worst hit, with the highest increase of undernourishment among sharecroppers.

In total, it is estimated that an additional 18 million people became undernourished from price increases and the severe flood of August 2010, increasing the total number of undernourished population from the baseline situation of 77.6 million people in 2005/2006 to 95.7 million people. On average, the undernourished population is about 603 kcal per day below the minimum requirement of 2350 kcal/adult/day and about 6 million tons per annum of food (wheat equivalent) is necessary to meet their requirements. Pakistan's national balance sheet shows the country is expected to be balanced in wheat and continue to be a net exporter of rice. However, increasing purchasing power is essential for the undernourished people to obtain access to food.

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