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# Assessing Food Security in Yemen

## An Innovative Integrated, Cross-Sector, and Multilevel Approach

**Olivier Ecker**

**Clemens Breisinger**

**Christen McCool**

**Xinshen Diao**

**Jose Funes**

**Liangzhi You**

**Bingxin Yu**

**Development Strategy and Governance Division**

## INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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## AUTHORS


**Olivier Ecker**
Visiting Fellow, Development Strategy and Governance Division

**Clemens Breisinger (corresponding author)**
Research Fellow, Development Strategy and Governance Division

**Christen McCool, Consultant**
Development Strategy and Governance Division

**Xinshen Diao**
Senior Research Fellow, Development Strategy and Governance Division

**Jose Funes**
Research Analyst, Development Strategy and Governance Division

**Bingxin Yu**
Postdoctoral Fellow, Development Strategy and Governance Division

**Liangzhi You**
Senior Scientist, Environment and Production Technology Division


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# Contents

## List of Tables

# List of Figures

## ABSTRACT

The lack of updated information about food security is of concern to many countries, especially during and after economic crises, natural disasters, and conflicts. In this paper we present an analytical framework for assessing the effects of such crises on food security. This methodology can compensate for the lack of recent data in the aftermath of various crisis situations and thus provide important information to policymakers. We apply this methodology to Yemen, a country where the recent food price crisis and global economic recession have been especially damaging. Little is known about how the recent triple crisis (food, fuel, and financial crisis) has affected food security and what the current state of food security is on the macro- (national) and microlevels (local). The results of our findings suggest an alarming state of food insecurity. Food security at the macrolevel has dramatically deteriorated in recent years, and it is projected that the country will remain highly vulnerable to external shocks in the future if no action is taken. At the household level we found that 32.1 percent of the population in Yemen is food insecure and that 57.9 percent of all children are malnourished. Rural-urban inequalities are high in Yemen. The number of food-insecure people living in rural areas (37.3 percent) is more than five times higher than in urban areas (17.7 percent). Underweight children and children with stunted growth are found more commonly in rural than urban areas. Major challenges for food security are the lack of job-creating growth within the oil-dependent economic structure; a distorted economic incentive system, coupled with an inefficient social transfer system rapidly depleting oil and water resources; and the growing production and consumption of qat.



**Keywords: food security, poverty, child malnutrition, Yemen, Middle East and Northern African (MENA) region**

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# 1. INTRODUCTION

Food security is defined as a situation in which "all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 2009a, 1). This definition makes clear that food security goes beyond a focus on poverty and includes multiple dimensions, including food trade, household income, health, and nutrition. However, conventional food security analysis often focuses only on the household, not the national situation.

Three principal approaches are commonly used for assessing food security. The first assesses the consumption of calories relative to calorie requirements and thus focuses on the sufficient consumption of food in quantitative terms. To determine the amount of calories consumed in a country, the Food and Agriculture Organization (FAO) uses food balance sheet data that typically are related to an average calorie requirement (for example, 2,100 kcal per capita per day). Alternatively, per capita calorie consumption can be estimated from detailed household expenditure surveys such as the Living Standard Measurements Study surveys. And, data on the household age and gender composition can be used to calculate household-specific calorie requirements per capita using standard requirement levels as suggested by the World Health Organization (FAO-WHO-UNU 2001). The calorie status is then determined by relating calorie consumption amounts to calorie requirements. More precisely, calorie intakes can be derived from repeated 24-hour dietary recalls; and, the World Health Organization's calorie requirements can serve as reference levels again. The second approach looks at the composition of diets and thus also considers aspects of dietary quality. This approach is used by the World Food Programme (WFP) to calculate the Food Consumption Score, which is based on the frequency of consumption of specific food groups, which are weighted according to their nutritional importance. Food insecurity typically is identified by using a universal cutoff benchmark. The third approach is qualitative, an analysis of people's perceptions.

These concepts thus often are inadequate for analyzing food security in a way that reflects macro- and microlevel dimensions and considers various sectors that are relevant to achieving food security and their institutional responsibilities within the government. To fill this gap in the literature, this paper presents an innovative analytical framework for assessing food security. We use this tool to assess the effects of the recent global crises and to identify major sector-level challenges for improving food security in Yemen.

It is clear that the recent food and fuel crisis and the economic recession have severely compromised food security in many countries. The FAO estimates that the number of food-insecure people has increased to more than one billion. At the same time the external balances of net food-importing countries have deteriorated during the food crisis, and government budget deficits have increased sharply during the economic recession. The recent crises have been especially damaging to Yemen. Growth slowed sharply, the percentage of poor people on the total population increased to 42.8 percent in 2009, up from 34.8 percent in 2005–2006 (Breisinger et al. 2010). In addition, Yemen faces severe structural challenges that affect food security, including a lack of job-creating growth within the oil-dependent economic structure; a distorted economic incentive system, coupled with an inefficient social transfer system; rapidly depleting oil and water resources; and the growing production and consumption of qat.[1]

The main objective of this paper is to assess the food security situation in 2009, after the triple global crisis; this paper serves as a background paper for the National Food Security Strategy Paper (NFSSP).

The paper is structured as follows: The next section presents the concept and methodology, including the analytical framework, methods used to determine macro- and microlevel food security, and the approach applied to link macro- and microlevels. Based on this analytical framework, the third section presents the current state of food security in Yemen. The fourth section reviews the major international and national challenges for improving food security. These challenges are presented according to the key sectors for food security, as identified in the analytical framework. The last section is a summary of the main findings.

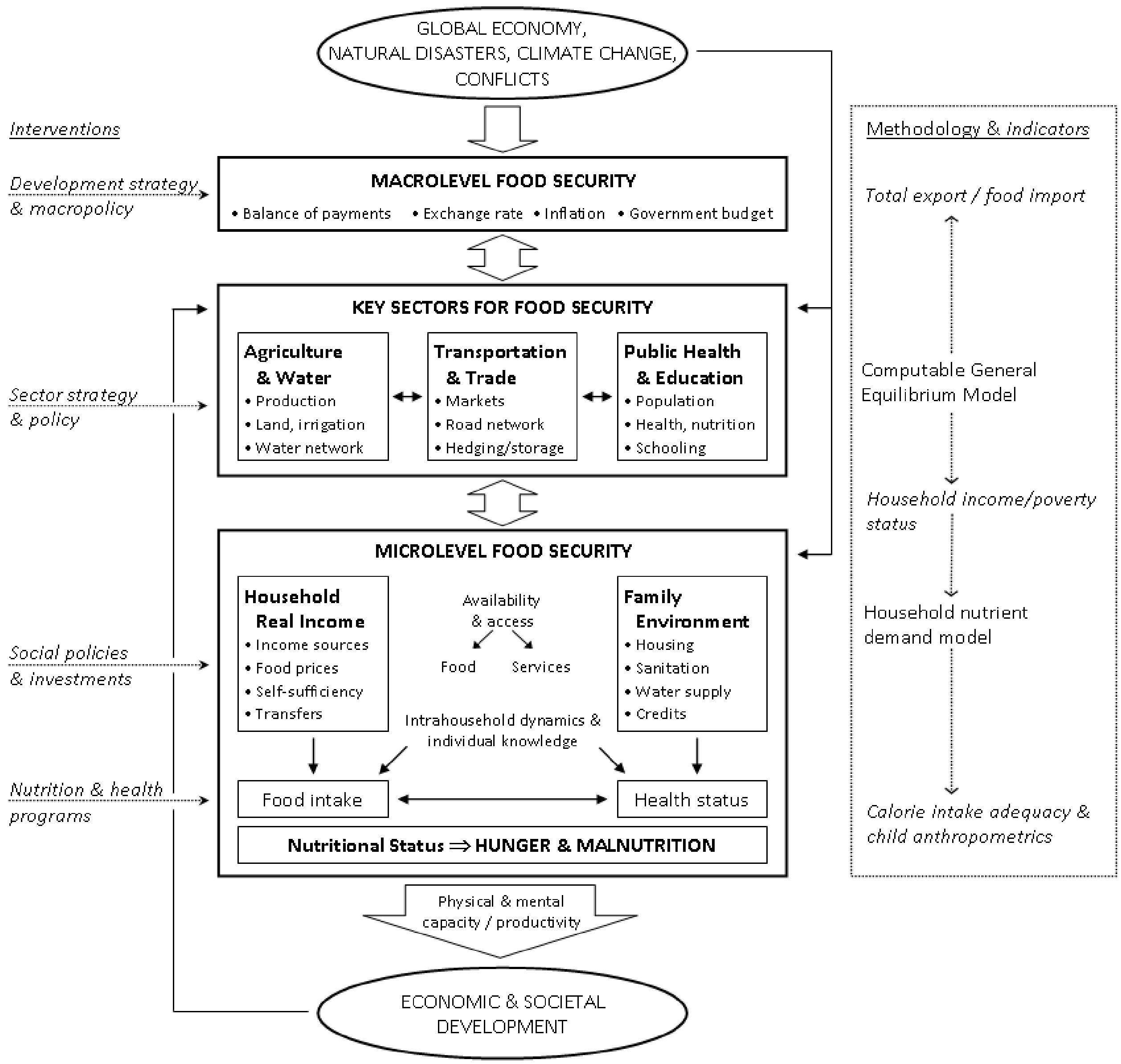
[1] Qat is a stimulating drug. Qat are the fresh, young leaves of an evergreen tree that are usually chewed over hours.

# 2. CONCEPT AND METHODOLOGY

## 2.1. Analytical Framework: An Integrative Approach

We consider food security to be an integrated, multidimensional, and cross-sector concept, as depicted in Figure 1. This paper differentiates food security on the national level (macrolevely) and food security on the household and individual level (microlevel) and emphasizes that improving food security is a multisector challenge. To measure food security at all levels, we use three types of indicators: a macroeconomic indicator, dietary energy (calorie) consumption, and three measures of children's nutritional status.

**Figure 1. Analytical framework**




Source: Author's creation.

Macrolevel food security is not the same as national food self-sufficiency; rather, the former is understood as a national availability of food (at least) equal to the demand of the nation's population at each point in time. The nation thus can meet food demand either by producing food or importing it or—usually—using a combination. In Yemen's situation of limited production potential and rapidly increasing food demand, a secure supply of food can be achieved only by trading in the global market. To be able to import food, Yemen must export enough goods and services to generate foreign exchange. Therefore this paper adopts a commonly used indicator, the ratio of total exports to food imports, to measure the level of national food security and its changes over time in Yemen (see Section 2.2 for more information). However, macrolevel food security is a necessary but not a sufficient condition for ensuring overall food security in a country.

Microlevel food security considers both household food security and the intrahousehold distribution of food, although the nutritional dimension is also integral to the concept. Household food security exists when a household has "access to the food needed for a healthy life for all its members (adequate in terms of quality, quantity, safety, and cultural acceptability), and when it is not at undue risk of losing such access" (UNSCN 1991, 1). Beyond that, this paper takes into account the dual nature of a people's nutritional status, which is influenced by food intake, and individual health, and the physiological interaction of health status and the individual's ability to absorb nutrients. Because of the special role of children in the future development of a society and its economy and children's high level of vulnerability, this paper pays special attention to the nutrition and health of children. Accordingly, to measure microlevel food security and how it may be affected by changes in policies and investments, we use two main indicators: per capita dietary energy (calorie) consumption at the household level and a set of three anthropometric measures for child nutrition (see Section 2.3).

Both macro- and microlevel food security can be compromised by external shocks, events that are often beyond the control of the government and people. Important examples include global economic crises, such as the 2007–2008 global food crisis and the 2009–2010 global recession, natural disasters such as floods and droughts, and conflicts. In addition, long-term changes in natural conditions, most notably climate change, can affect food security. Preventing external shocks often is impossible. But preparedness, emergency relief, and disaster management plans can cushion the adverse effects of these shocks on food security.

The key to improving food security is sector-level strategies, policies, and investments in trade and transportation, agriculture and water, and public health and education. Therefore this paper emphasizes that achieving food security is a multisector challenge that requires a combined effort by all relevant ministries, agencies, and other actors. In the effort to improve food security in Yemen, the ministries of Planning and International Cooperation, Finance, Industry and Trade, Public Health and Population, Agriculture and Irrigation, Water and Environment, and Fish Wealth, as well as the Social Welfare Fund, Social Fund for Development, and civil society groups are all key players.

## 2.2. Assessing Macrolevel Food Security and Data

*The ratio of total exports to food imports* is an indicator of a nation's ability to finance its food imports from its total export revenues. This indicator, a measure of access to world food supply by an individual country, is more relevant for food security analysis than the net food trade position (that is, food exports minus food imports). The latter informs only whether a country is a net food importer or exporter but does not reflect the relative cost of access to food in each country and therefore how vulnerable it may be to changes in food prices and international food availability. A country that is a net food exporter but whose the total food bill takes a large percentage of total exports (for example, Bangladesh, with a food bill of about 20 percent of total exports) is likely to be more vulnerable than a country that is a substantial net food importer but whose food bill takes only a small percentage of its total exports (for example, Venezuela spends about 5.7 percent of total exports, including its substantial oil sales, to import food).

The ratio of the food import cost in relation to total exports also presents a broader and more complete picture of the role of trade, and the potential impact of trade policies, on food security. Focusing only on the expense of importing food (gross or net) does not take into account the broader contribution of trade to food security, which includes both the availability of food on world markets and the generation of export income to finance those imports. A country whose food import bill increases may not be more vulnerable than in the past if its total exports have increased proportionately. Conversely, a country may become more vulnerable even as its food import bills are decreasing, if export receipts have dropped even more. Therefore, in the context of trade policies, the important issue is whether those policies cause total exports to grow faster than the food import bill.

### 2.3. Assessing Microlevel Food Security and Data

This paper's focus on microlevel food security targets household food adequacy in quantitative terms—which we addressed by examining calorie consumption—and the nutritional status of the most vulnerable population groups, infants and children younger than five years. In addition, this paper recognizes the important role of dietary quality, especially the micronutrients, for household food security. The analysis of calorie consumption is complemented with an indicator of dietary diversity (the Food Variety Score) and a comparative analysis of common food consumption patterns.[2] The paper thus acknowledges that a diversified, well-balanced diet that includes all important food groups—staple staples (grains, starchy roots and tubers), vegetables, fruits, legumes, meat, fish, dairy products, and fats and oils—is necessary for good nutrition and especially for sufficient intake of essential bioavailable micronutrients.

The primary data source of this paper is the Yemen Household Budget Survey (HBS) from 2005–2006 (HBS 2005-06). The database includes data from 13,136 households—8,273 urban and 4,863 rural. The HBS is designed to be representative nationally, for urban and rural areas, and for each of Yemen's 21 governorates. It contains data from 300 of Yemen's 333 districts, with an average of 38.3 households per district. Given that the sample size for many districts is quite large, reasonable estimates can be obtained for these districts, too.

#### *2.3.1. Household Dietary Energy Adequacy*

Per capita calorie consumption is the measure of household food security that we used to capture the quantitative dimension of food—that is, food adequacy in terms of dietary energy provision. For identifying whether a household's food supply is adequate, we used the HBS to estimate per capita calorie consumption and compared those figures with calorie requirements based on reference levels that are reported in FAO-WHO-UNU (2001). The prevalence of food insecurity in a population is defined as the proportion of people with calorie consumption amounts below their individual calorie requirements, expressed as a percentage. The number of food-insecure people is the number of people with calorie consumption below their individual calorie requirements.

Based on the HBS data from 2005–2006 and macro- and microeconomic modeling (see Section 2.4 for details), we estimated the state of food security in Yemen in 2009. To check our estimates for 2009, we compared our food-insecurity prevalence estimates with results from other sources, especially the food-insecurity prevalence estimates from the 2009 Comprehensive Food Security Survey (CFSS) of

[2] Dietary diversity is generally defined as the number of different foods or food groups consumed over aspecific time period. Given that diversified diets, which contain many different foods and therefore many different nutrient sources, are more expensive than diets consisting mostly of calorie-dense staples, a high dietary diversity is typically more prevalent among food-secure and well-off households. Several earlier studies show a positive and strong association between dietary diversity and calorie and nutrient adequacy, and they therefore posit dietary diversity as a good complementary measure of household food security (Hatloy et al. 2000; Hoddinott and Yohannes 2002; Ruel 2003; Steyn et al. 2006; Torheim et al. 2003). To measure dietary diversity we use the Food Variety Score (FVS), a common indicator that counts food items consumed over a specific time period, in this instance, one week. The composition of diets can be easily explored by examining the share of different food groups in the total food consumption in quantitative terms (measured in kilograms), that is, the food consumption patterns. A general recommendation for the composition of healthy diets is provided by the food pyramid, which can be used as a rough reference. The food pyramid is a universally accepted concept that expresses the relative composition of healthy diets in servings that can be easily translated into quantitative shares.

the World Food Programme. The 2009 CFSS, which used a different method, finds a national food insecurity prevalence rate similar to ours.

In addition, we estimate a regional 'food security gap,' which is a measure of the availability of sufficient food quantities in the region. Its interpretation is similar to the well-known 'poverty gap.' The per capita calorie gap is calculated as the difference between individual calorie consumption and requirements, averaged for a specific administrative or geographic area such as governorate or agro-ecological zone. A negative sign implies that the food energy available in this region is not sufficient or affordable (at current prices) for provisioning the entire population in this area adequately. Thus it identifies a situation of regional food shortage. However, a positive sign should not be interpreted as an absence of food insecurity, considering that the distribution of food and calories are not distributed equally across the population. A positive sign indicates only a situation in which the average person has just enough calories available to meet their essential dietary energy requirements.

When estimating individual calorie consumption from household surveys, it is necessary to make a standard, implicit assumption: a person in a household is considered calorie deficient if the surveyed household reports (household-level) calorie consumption amounts below standard individual calorie intake requirements. And, a person is considered as sufficiently supplied with calories, if the household consumes more calories than the sum of the calorie requirements of all members. The data-caused limitation of this approach is that the true intrahousehold distribution of food cannot be determined. Empirical evidence suggests that in some countries (with male-dominated societies), females and young children in particular are disadvantaged. This has been a reason for using child anthropometrics to analyze the nutritional status of children.

*Estimation of Food and Calorie Consumption.* The food consumption (dietary) recall used by the HBS provides the raw data for estimating quantities of food consumed, figures that are then used to derive calorie consumption amounts. Household food consumption was surveyed weekly for a month, using four repeated seven-day recalls. Data are available for food consumption quantities purchased in the market, consumed from the household's production, and received as gifts. The recall includes 12 food groups (grains and grain products, legumes, vegetables, fruits, meat, fish, dairy products, oils and fats, sugars and sweets, condiments, tea and coffee, and other beverages) and 130 categories of food items.[3]

Food quantities are usually recorded in metric measurement units (kilograms, liters), some in numbers of pieces. To convert the number of pieces to quantity units, we used conversion factors produced by the U.S. Department of Agriculture (USDA) National Nutrient Database for Standard Reference (USDA, 2009). Data for food refuse (measured as a percentage of total quantity) were obtained from the same data source. Few processed food items were available and only as purchases; we provide their prices in Yemeni riyals. We converted processed food items into quantity units by applying price data for similar food items reported in the survey or other sources, including the 2006 Yemen Agricultural Statistics Yearbook (MOAI 2007) and trade statistics. We cross-checked our estimates with other data from local sources.

For converting food consumption quantities (measured in kilograms) into calorie consumption amounts (measured in kilocalories), we use the conversion rates from two food composition databases, the Food Composition Table for Egypt in the World Food Dietary Assessment System of the Food and Agricultural Organization (FAO) (WFOOD, 1996) and the USDA Nutrient Database (USDA, 2009). Given the agroecological proximity and similarity in food consumption in Yemen and Egypt, we gave priority to the Egypt database. We were able to match more than half the foods reported in the HBS with foods in the FAO database. For the remaining internationally marketed foods, we used data from the USDA nutrient database. Matching was straightforward for most food items. For others we used country-specific knowledge, for example, the common variety of beans or type of fish consumed.

[3] In each food group the recall shows one to two "other" categories of food items. To identify the "other" foods consumed, we linked them to specific foods—using local expertise—that are typically available in Yemen but not categorized in the HBS, or we linked them to an equivalent substitute listed in the particular food group.

For food quantities purchased in the market, food expenditures are reported as well.

Before converting food quantities into calorie consumption amounts, we made adjustments to the food quantity data to eliminate inconsistencies and missing observations. If consumption quantity was missing or recorded as zero but the data reflected a purchase of a quantity, we assumed that consumed quantity equals purchased quantity. If both consumption and purchase quantity were missing or showed zero value but the household reported expenditure, we used the item's median unit value to calculate the consumption quantity. We had to make such adjustments for fewer than 1 percent of all food records. Clearly incorrect observations were treated as errors and discarded.

To control for outliers caused by incomplete or incorrect recording of food quantities consumed, we defined for each household a certain range of possible calorie consumption in which we allowed the calorie consumption amounts observed to vary. This range is bounded by a lower cutoff level equivalent to the household-specific minimum calorie requirement minus 1,000 kcal and by an upper cutoff level equivalent to the household-specific maximum calorie requirement plus 1,000 kcal. On average the calorie consumption ranged from 750 kcal to 3,680 kcal per capita per day. Given that respondents' memory of their food consumption is more accurate in the short term, we used food consumption observations of the fourth week (that is, the last week surveyed) for our estimation in general. If household calorie consumption amounts were outside the range, we used food consumption observations of the third week, followed by the second and first weeks, respectively. We dropped households from the sample that reported calorie consumption amounts outside the plausible range for all four weeks and adjusted sample weights accordingly. In all we retained observations from 12,093 households (92 percent), with 7,793 households in urban areas and 4,300 households in rural areas. The cleaned dataset consists of 10,254 household observations from the fourth week, 1,220 from the third, 393 from the second, and 226 from the first week. As expected, we found a clear tendency toward overreporting, particularly for the first and the second weeks compared with the third and fourth weeks, in both rural and urban households.

Finally, we adjusted the calorie consumption amounts for those households eating meals in restaurants. The HBS reports only food expenditures for meals eaten outside the home, with no food quantity information or number of meals eaten outside the home. Therefore calories obtained from restaurant meals could not be estimated directly from the reported data. This occurred far more frequently in urban areas, where more people eat away from home than do people in rural areas. To solve this problem we estimated the calorie amounts contained in a typical Yemeni restaurant meal and its costs (including service charge). From that we calculated the price per kilocalorie and multiplied it by the expenditures reported in the HBS to obtain total calorie consumption away from home. In addition, to account for the higher prices of restaurant meals in urban areas (especially because of service charges), we made the principal assumption that households that can afford to eat in restaurants are not food insecure. Accordingly, we lifted the calorie consumption amounts of urban households above their calorie requirement levels, if they had meals in restaurants but insufficient calorie consumption amounts. To maintain continuity in calorie consumption amounts across those households, we used the food budget shares for restaurant meals to calculate the final level of calorie consumption amounts. This procedure led to adjustments for calorie consumption of 2,474 urban households.

*Estimation of Calorie Requirements.* For each household, we defined minimum, average, and maximum requirements for percapita calorie consumption by using the standard calorie requirements for individuals from FAO-WHO-UNU (2001). First, we estimated individual calorie requirements; then, we added them up for each household and divided the household-level estimates by the household size to arrive at per capita calorie requirements. For determining minimum, average, and maximum calorie requirements, we considered household sex and age composition, physical activity levels, average heights of Yemeni men and women, and pregnancy status of women, applying HBS data. Because we had insufficient information about individual breast-feeding practices, we were not able to account for lactation.

We define the minimum, average, and maximum calorie requirements according to the requirement levels for light, moderate, and heavy physical activity, respectively. To determine calorie requirements for infants, children, and adolescents, we used the requirements for age instead of weight, given the data available in the HBS. For infants and children younger than six, the HBS gives only one activity level (for explanation, see FAO-WHO-UNU 2001). Adults' and elders' minimum, average, and maximum calorie requirements are derived for body mass indexes (BMIs) of 18.5, 21.0, and 24.9 and physical activity-level (PAL) factors of 1.45, 1.75, and 2.20, respectively (FAO-WHO-UNU 2001). We assumed average heights—1.64 meters for men with a low BMI (that is, the lowest value given in FAO-WHO-UNU (2001), 1.62 meters for a man with a moderate or high BMI. For women we assumed heights of 1.56 meters for someone with a low BMI, 1.54 meters for a woman with a moderate BMI, and 1.55 meters for a high BMI. According to the HBS and other data sources, 1.63 meters is the average height of Yemeni men, and 1.53 meters is the average for Yemeni women. The individual calorie requirements we used to calculate per capita calorie requirement cutoff levels are shown in Table 1 for infants and Table 2 for children and adults. We added an average pregnancy allowance amounting to 282 kcal/day, calculated as a (rounded) mean of the energy costs of pregnancy per trimester in FAO-WHO-UNU (2001).

The cutoff levels for defining the proportion and number of food-insecure people in urban areas are based on requirements for older children, adolescents, and adults and allow for low level of physical activity, while the cutoff levels for rural areas are based on requirements that assume a moderate physical activity level. This distinction is necessary since a person from rural areas has significantly higher basic calorie expenditure than a person living in urban areas, on average. For example, almost all rural households draw their income from manual labor, including agricultural and fishery activities, and they have to draw almost all their water from wells and carry it home. Rural people also usually have to carry home any purchases they make at markets, and children often have to walk long distances to school. The average daily per capita calorie requirements for Yemen are 2,017 kcal nationwide, 1,780 kcal in urban areas, and 2,099 kcal in rural areas.

**Table 1. Calorie requirements (kcal/day) of infants during the first year of life**

| Age (months) | Male | Female |
|---|---|---|
| 0 | 518 | 464 |
| 1 | 570 | 517 |
| 2 | 596 | 550 |
| 3 | 569 | 537 |
| 4 | 608 | 571 |
| 5 | 639 | 599 |
| 6 | 653 | 604 |
| 7 | 680 | 629 |
| 8 | 702 | 652 |
| 9 | 731 | 676 |
| 10 | 752 | 694 |
| 11 | 775 | 712 |

Source: FAO-WHO-UNU (2001).

**Table 2. Minimum, average, and maximum calorie requirements (kcal/day) of children and adults**

| Age | Minimum | | Average | | Maximum | |
|---|---|---|---|---|---|---|
| (years) | Male | Female | Male | Female | Male | Female |
| Children | | | | | | |
| 1 | | | 950 | 850 | | |
| 2 | | | 1,125 | 1,050 | | |
| 3 | | | 1,250 | 1,150 | | |
| 4 | | | 1,350 | 1,250 | | |
| 5 | | | 1,475 | 1,325 | | |
| 6 | 1,350 | 1,225 | 1,575 | 1,425 | 1,800 | 1,650 |
| 7 | 1,450 | 1,325 | 1,700 | 1,550 | 1,950 | 1,775 |
| 8 | 1,550 | 1,450 | 1,825 | 1,700 | 2,100 | 1,950 |
| 9 | 1,675 | 1,575 | 1,975 | 1,850 | 2,750 | 2,125 |
| 10 | 1,825 | 1,700 | 2,150 | 2,000 | 2,475 | 2,300 |
| 11 | 2,000 | 1,825 | 2,350 | 2,150 | 2,700 | 2,475 |
| 12 | 2,175 | 1,925 | 2,550 | 2,275 | 2,925 | 2,625 |
| 13 | 2,350 | 2,025 | 2,775 | 2,375 | 3,175 | 2,725 |
| 14 | 2,550 | 2,075 | 3,000 | 2,450 | 3,450 | 2,825 |
| 15 | 2,700 | 2,125 | 3,175 | 2,500 | 3,650 | 2,875 |
| 16 | 2,825 | 2,125 | 3,325 | 2,500 | 3,825 | 2,875 |
| 17 | 2,900 | 2,125 | 3,400 | 2,500 | 3,925 | 2,875 |
| Adults | | | | | | |
| 18-29 | 2,100 | 1,650 | 2,650 | 2,150 | 3,700 | 3,050 |
| 30-59 | 2,100 | 1,750 | 2,650 | 2,200 | 3,550 | 2,950 |
| >=60 | 1,700 | 1,550 | 2,150 | 1,950 | 2,950 | 2,650 |

Source: FAO-WHO-UNU (2001).

### *2.3.2. Child Nutritional Status*

To acknowledge the important role of children in societal and economic development, account for their high vulnerability to food shortages and adverse health conditions, and direct attention to the population group most in need of care and potential intervention, this paper complements the calorie consumption–based analysis with analysis of the nutritional status of infants and young children. Using anthropometrics data, it analyzes the nutritional status of the last-born child younger than five in the households surveyed by the HBS. Analyzing child nutrition might also yield critical information about intrahousehold food distribution and the risk of food insecurity among other vulnerable household members, considering that—according to the food security definition given earlier—a household is food secure only when all its members are secure.

The child anthropometrics data we used are available from the child anthropometrics section of the HBS. Consistent with other studies, this paper defines children to be underweight, stunted, or wasted if their weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ), or weight-for-height z-scores (WHZ) are below a certain critical value. Z-scores are generally defined as the deviation of an individual's value from the median value of the respective reference population, divided by the standard deviation of the reference population. For defining moderate and severe forms, these critical values are commonly set at minus two and minus three standard deviations of the weight-for-age, height-for-age, and weight-for-height in the respective healthy reference population of the same sex and age. The z-scores in the HBS are based on the recently revised WHO reference levels (WHO 2006).

The three anthropometric indicators detecting low weight for age, low height for age, and low weight for height have different implications for the nutritional status of children and cannot be used interchangeably (WHO 1995). Low weight for age identifies underweight. Thus the child has gained insufficient weight relative to age or lost weight. Low weight for age implies stunting or wasting or both and is influenced by both the child's height (height for age) and weight (weight for height). The composite nature of this indicator makes interpretation complex. Low height for age indicates stunting and implies long-term malnutrition and poor health. Stunting, that is, gaining insufficient height relative to age, reflects a process of failure to reach linear growth potential as a result of suboptimal nutritional conditions or health conditions or both. However, this indicator fails to differentiate between a deficit associated with a past event and one associated with a long-term, continuing process. Low weight for height describes wasting and implies recent or continuing current severe weight loss. Wasting, that is, gaining insufficient weight relative to height or losing weight is usually a consequence of acute starvation or severe disease or both (WHO 1995).

The prevalence rate of moderate and severe child underweight/stunting/wasting is defined as the percentage of children who are below, respectively, two and three standard deviations from the median weight for age/height for age/weight for height of the WHO reference population (WHO 2006). For the sake of comparability with previous studies, such as the 2003 Family Health Survey (FHS), we generally provided estimates for the nutritional status of the last-born child in the household younger than 59 months. However, because of obvious measurement errors for some children's nutritional status, we dropped outliers from the sample.

Screening child anthropometrics for biologically implausible measurements suggests that the data quality is particularly weak for height measurements. Considerably more than 1 percent of HAZ and WHZ observations showed values below or above the cutoff levels suggested by WHO for data exclusion (see below). In the original dataset 682 of 11,815 HAZ observations (5.8 percent) and 503 of 11,804 WHZ observations (3.3 percent) are outside the biologically plausible range, whereas less than 0.5 percent of the WAZ measurements (53 of 11,826 observations) are below or above the extreme values. For all three measurements error values occur significantly more frequently among infants older children. This might be explained by the difficulties in measuring the exact height (and weight) of young children. Given that the HBS often provides anthropometric data for more than one child in the household, and our analysis requires data for only one child, we defined a fixed exclusion range for identifying outliers and used the measurement of the next-oldest child, when the measurement of the youngest one is outside that range. Following the WHO recommendations, we used observations, if a child's WAZ was above or equal to -6 and below or equal to +5. The applied HAZ and WHZ cutoffs are -6 and +6 and -5 and +5, respectively. Table 3 shows the number of observations in the cleaned dataset.

**Table 3. Number of child anthropometrics observations**

| | **Underweight** | | | **Stunting** | | | **Wasting** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | *Total* | Male | Female | *Total* | Male | Female | *Total* |
| **All** | **3,692** | **3,446** | ***7,138*** | **3,548** | **3,306** | ***6,854*** | **3,576** | **3,333** | ***6,909*** |
| Urban | 2,228 | 2,030 | *4,258* | 2,140 | 1,951 | *4,091* | 2,148 | 1,954 | *4,102* |
| Rural | 1,464 | 1,416 | *2,880* | 1,408 | 1,355 | *2,763* | 1,428 | 1,379 | *2,807* |

### 2.4. Estimating the State of Household Food Insecurity in 2009

The latest nationally representative HBS dates to 2005–2006. However, since then three major global crises (food, fuel, and financial) have occurred, with potentially strong impacts on food security in Yemen. To estimate the state of household food security in 2009, we therefore used a forward-looking modeling approach, more specifically, a computable general equilibrium model (CGE) linked to a household demand–oriented simulation model to assess changes in people's calorie consumption.

On the macroeconomic level we use a CGE model to estimate changes in the Yemeni economy as a result of the externally induced shocks from the recent crises, including changes in oil and food prices and changes in remittances. Outcomes of this simulation include changes in real incomes of various household groups, influencing household incomes and poverty status. On the microeconomic level an econometric household calorie consumption model is applied to estimate the effects of changes in household real incomes on calorie consumption. In economics the relationship between changes in incomes and "demanded" calories is typically expressed in terms of elasticities—here, calorie-income elasticities. Elasticities express the percentage change of the dependent variable (calorie consumption amounts) as a result of a change in the independent variable (household incomes) by one percentage point.

The estimated income changes from the CGE model and the estimated calorie-income elasticities from the household calorie demand model enter a microsimulation that expresses each household's per capita calorie consumption in 2009 as an outcome of its real income in 2005 and the change in calorie consumption in response to the change in income between 2005 and 2009 as a result of the recent triple crisis. We then used the new per capita calorie consumption amount and Yemen's population growth between 2005 and 2009 (three percent annually) to estimate the proportion and number of food-insecure people in 2009.

#### *2.4.1. Dynamic Computable General Equilibrium Model*

The CGE model captures the major channels through which the food, fuel, and financial crises affected the Yemeni economy and households between 2007 and 2010. The CGE model is dynamic and thus also captures the links between the three crises that occur over several years. The dynamic CGE model for Yemen is based on a new social accounting matrix (SAM) to represent Yemen's economy in 2007 as the main database for the model. Major data sources for SAM construction include national accounts and the latest supply-use table from the Central Statistical Organization of Yemen (CSO 2007), balance of payments from the Bank of Yemen, and government budget data from the Ministry of Finance, the 2008 Agricultural Yearbook from the Ministry of Agriculture and Irrigation, and the 2005–2006 HBS.[4] These data sources are complemented with information from the International Monetary Fund and the World Bank. Based on this structure, and consistent with the changes in the recent years, we modeled the food and fuel crisis in 2008 and the financial crisis in 2009 on Yemen by designing a scenario that reflects events from 2007 to 2010. The scenarios follow the general price trends observed during 2007 to 2010: food and oil prices rose dramatically in 2008, fell back in 2009, but stayed at above 2007 levels throughout 2009 and 2010. The change in government spending and remittances related to the financial crisis follow trends observed in the country during 2009 and then return to precrisis annual growth levels in 2010. A detailed description of the model can be found in Breisinger et al. (2010). Table 4 presents the changes in household incomes derived from this comprehensive model.

[4] Data quality and availability can be challenging in Yemen since its data management system is in transition, with major overhauls of the national accounting system. However, one strength of social accounting matrixes is that they can reconcile different data sources, which can help improve data estimates.

**Table 4. Percentages of per capita household income change by agroecological zone and residential area, 2007–2009**

| | Urban (% change) | Rural (% change) |
|---|---|---|
| Lower Highlands | -9.7 | -4.6 |
| Upper Highlands | -9.4 | -3.5 |
| Red Sea & Tihama | -4.2 | 1.3 |
| Arabian Sea | -12.4 | -7.5 |
| Internal Plateau | -2.8 | -6.3 |
| Desert | -6.9 | -1.4 |

Source: IFPRI Yemen Computable General Equilibrium (CGE) model results.

### *2.4.2. Household Calorie Demand Model*

To link household income, food consumption, and calorie adequacy status, we used household demand theory. Based on household food consumption data, household food demand is typically estimated using an econometric approach. The estimation assumes that food consumption—the food quantity demanded—is a function of household income, prices (if available from the dataset applied), and different socioeconomic and location-specific factors that are considered as influencing household food consumption decisions. As household income changes, households are likely to change their food consumption and thus their nutrient intake. Higher household incomes in developing countries, and especially among the poor and food-secure populations, generally lead to increases in food consumption both with respect to food quantity (meaning higher calorie intake) and food quality (meaning higher protein, mineral, and vitamin intake).

The relationship between calorie consumption and income and other household consumption–related variables is usually estimated in a similar fashion, by replacing consumed food quantities with calorie consumption amounts as dependent variables in the estimation function. Given that calorie content in food is only one characteristic of foods but likely the most important in populations at high risk of food insecurity, this model can be considered a reduced-form food demand model, theoretically derived from Lancaster's good characteristics model (Lancaster 1971).

In this report we used the following functional form and a parametric regression to estimate the relationship between household per capita calorie consumption and household real income:

$$y = \alpha + \beta_1 x^2 + \beta_2 x + \gamma z + \varepsilon$$

where y is the amount of household per capita calorie consumption (in kcal/day), x is the household's percapita expenditure (including opportunity values for home consumption of food), and z is a vector to control for different household and location-specific factors. Instead of reported income data, we used reported total expenditure data, which are usually a better proxy for household real income (Deaton 1997). The vector z includes variables measuring household size (in number of heads), three dichotomous variables for the education level attained by the household head (primary school, secondary school, high school), one dichotomous variable identifying household access to land, and five dichotomous variables for the six agroecological zones of Yemen. The parameters α, β, and γ are to be estimated, and ε is a random error term. All continuous variables enter in logarithmic terms. To account for the structural differences in the food consumption of urban and rural households, we estimated the model for urban and rural areas separately. In conformity with Engel's Law, we allowed for curvature in the relationship between calorie consumption amounts and income. The regression results are presented in Table 5.

We chose a double-log functional form and quadratic specification for the relationship between calorie consumption and income, as this shows the best fit overall. We tested this specification against all possible and theoretically sound combinations of linear relationships, logarithms in calorie consumption and income, and additional quadratic and inverse specifications of income as well as nonparametric specifications (quantile regressions). In addition, based on the correlation results presented in the results section (later), we tested the variables to be included in the functional form. Moreover, we ran the Breusch-Pagan/Cook-Weisberg test, which suggested heteroscedasticity for rural areas, but we could not detect patterns of heteroscedasticity, so we chose a robust estimation procedure.

Finally, from the coefficient estimates for per capita household expenditure and per capita household expenditure squared, presented in Table 5, we calculated calorie-expenditure elasticities for expenditure quintiles. The elasticities and the per capita expenditure at population expenditure quintile means also are shown in Table 6.

**Table 5. Regression results for urban and rural households**

***Dependent variable: per capita calorie consumption (kcal/day; log)***

| **Independent variables** | | **Urban** | | | **Rural** | | |
|---|---|---|---|---|---|---|---|
| ***Name*** | ***Form*** | ***Coef.*** | | ***Robust std. err.*** | ***Coef.*** | | ***Robust std. err.*** |
| Per capita household expenditure (riyals/day) | log | 0.516 | *** | 0.049 | 1.482 | *** | 0.208 |
| Per capita household expenditure squared (riyals/day) | log | -0.029 | *** | 0.004 | -0.114 | *** | 0.019 |
| Household size (heads) | log | -0.038 | *** | 0.007 | -0.028 | * | 0.014 |
| Household head completed primary school | 0 = no, 1 = yes | -0.007 | | 0.011 | -0.045 | *** | 0.017 |
| Household head completed secondary school | 0 = no, 1 = yes | -0.017 | | 0.013 | -0.028 | | 0.023 |
| Household head completed high school | 0 = no, 1 = yes | -0.023 | ** | 0.011 | -0.005 | | 0.021 |
| Household has access to land | 0 = no, 1 = yes | 0.072 | *** | 0.010 | 0.037 | *** | 0.013 |
| Household is located in the Upper Higlands Zone | 0 = no, 1 = yes | -0.010 | | 0.009 | -0.051 | *** | 0.013 |
| Household is located in the Red Sea & Tahama Zone | 0 = no, 1 = yes | 0.015 | | 0.009 | -0.022 | | 0.018 |

**Table 5. Continued**

| Independent variables | | Urban | | | Rural | | |
|---|---|---|---|---|---|---|---|
| ***Name*** | ***Form*** | ***Coef.*** | | ***Robust std. err.*** | ***Coef.*** | | ***Robust std. err.*** |
| Household is located in the Arabian Sea Zone | 0 = no, 1 = yes | -0.042 | *** | 0.010 | -0.226 | *** | 0.031 |
| Household is located in the Internal Plateau Zone | 0 = no, 1 = yes | 0.011 | | 0.013 | -0.265 | *** | 0.023 |
| Household is located in the Desert Zone | 0 = no, 1 = yes | 0.008 | | 0.025 | -0.089 | *** | 0.024 |
| Constant | | 5.756 | *** | 0.153 | 3.229 | *** | 0.555 |
| Observations | | | | 7793 | | | 4300 |
| F-value | | | | 108.75 | | | 74.04 |
| R-squared | | | | 0.188 | | | 0.202 |

Source: IFPRI household calorie consumption model results based on 2005–2006 HBS data.
Note: *, **, *** Coefficient is statistically significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

**Table 6. Calorie-income elasticities and average per capita expenditures (riyals/day) by expenditure quintiles**

| Expenditure quintile | Urban | | Rural | |
|---|---|---|---|---|
| | ***Elasticity*** | ***Expenditure*** | ***Elasticity*** | ***Expenditure*** |
| 1st | 0.230 | *142.4* | 0.427 | *101.4* |
| 2nd | 0.207 | *213.2* | 0.340 | *148.6* |
| 3rd | 0.190 | *286.4* | 0.283 | *190.4* |
| 4th | 0.170 | *403.8* | 0.227 | *243.4* |
| 5th | 0.127 | *863.4* | 0.111 | *404.4* |

Source: IFPRI household calorie consumption model results based on 2005–2006 HBS data.

## 2.5. Adjustments for Mapping Household Food Security

Given that the HBS is designed to provide representative data at the governorate level, adjustments were made to obtain reliable district-level estimates that form the basis for the Yemen Food Security Maps presented in Section 3. We assumed that districts with more than 50 observations provided reasonable food-insecurity prevalence estimates. For districts showing fewer than 50 observations, we replaced the district-level estimates with the governorate-level estimates, for which the HBS is believed to be representative. Because of the recent civil unrest in Sa'adah governorate in northern Yemen, simulations based on estimates from 2005–2006 are not reasonable. The proportion of food-insecure people in the districts of this governorate is considered to be at least as high as the national average. Therefore we replaced the respective district estimates with the national food-insecurity prevalence rate.

# 3. THE STATE OF FOOD INSECURITY

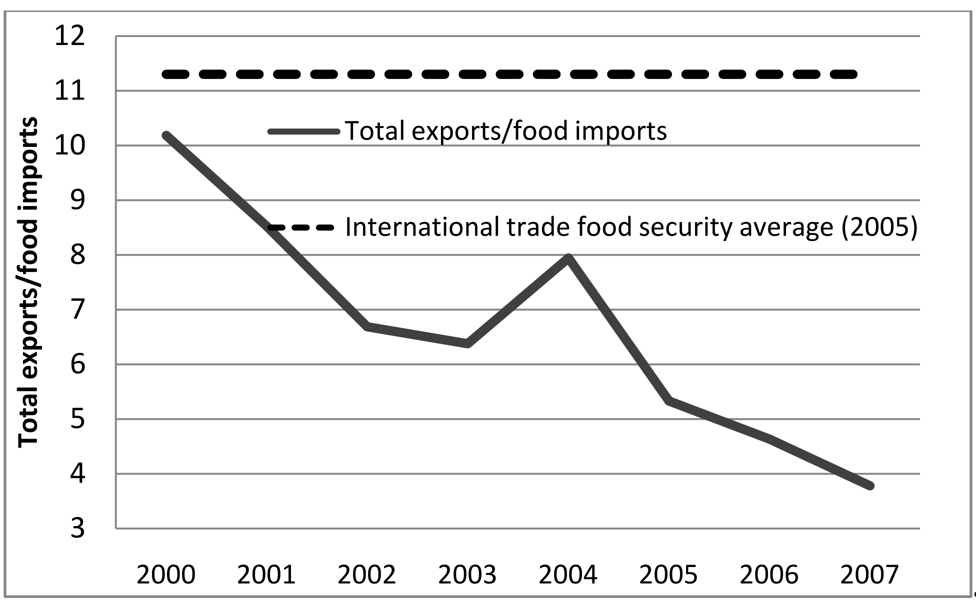
Understanding Yemen's state of food security, and knowing how many people are food insecure and malnourished and where they are located, is fundamental for designing an effective food-security strategy. Hence, this section first analyzes the macrolevel food security situation and the distribution of food insecurity and malnutrition among the Yemeni population by using various indicators that capture the different dimensions of food security. These results are then set into an international context and related to poverty in subsequent sections.

## 3.1. Macrolevel Food Security

The availability of food from a macroeconomic perspective depends on the ability of a country to finance food imports, which in turn depends on on a number of factors, including its balance of payments position, exports of goods and services, and foreign exchange reserves and movements. Macrolevel food security is especially important for countries like Yemen that are highly dependent on food imports.

Yemen's macrolevel food security has deteriorated dramatically in recent years, mainly because of declining oil exports and increasing food imports. In 2000 Yemen's total export to food import ratio was only about one percentage point below the international food-security line (Figure 2). By 2007, however, the ratio had dropped from more than 10 to less than 4—an alarming deterioration of food security.[5] The ratio of 4 means that Yemen uses 25 percent of its total exports to buy imports, compared to the international average of 9 percent. Yemen macro food security is also low compared to other countries in the Middle East and North Africa region, where 11.5 percent of export earnings are used for food imports (Breisinger et al. 2010). Section 4.1 will shed further light on the underlying causes and challenges of the state of macro food security in Yemen.

**Figure 2. Macrolevel food security in Yemen (2000–2007)**

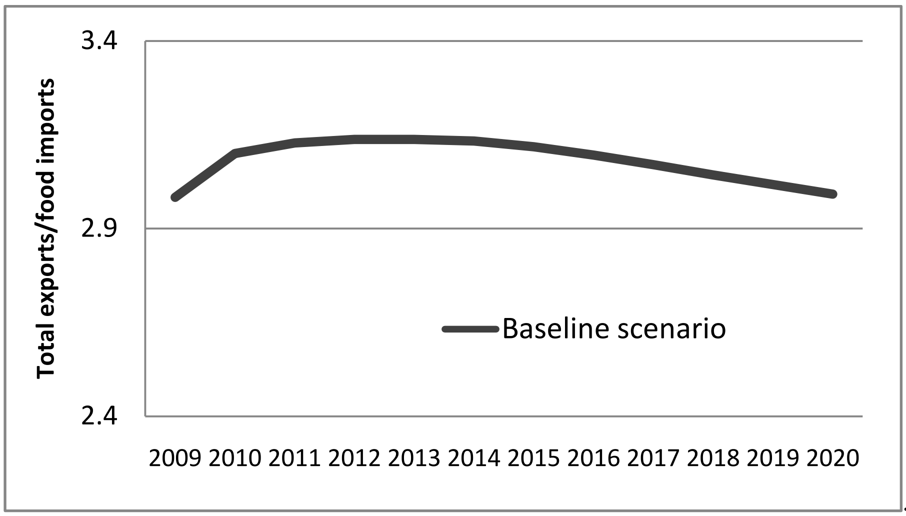



Source: IFPRI estimation, based on World Bank (2009) and Yu, You, and Fan (2009).

[5] We use the export/food import ratio to ensure that a lower value is associated with higher vulnerability of a country to secure food imports. However, to derive the share of total foreign exchange used to import foods, the inverse of the ratio must be used; it can be derived as 1/ratio x 100

If no action is taken, macrolevel food security will remain at low levels through 2020, and Yemen will remain highly vulnerable to external shocks and disasters. The growth spike expected from increasing gas exports in 2010 will slightly improve macrolevel food security, yet it will not be able to compensate for declining oil exports in the next decade (Figure 3). IFPRI projections expect overall economic growth rates of 2.5 to 3.0 percent from 2010 to 2020 in a "baseline," or business-as-usual, scenario (meaning if no action is taken). Under these conditions macrolevel food security will remain extremely low through 2020, by both international standards and those of other Middle East and North African countries.

**Figure 3. Yemen macrolevel food security under a business-as-usual scenario, 2010–2020**




Source: IFPRI Yemen Computable General Equilibrium (CGE) model results.

## 3.2. Microlevel Food Security

### *3.2.1. Prevalence and Incidence of Food Insecurity in 2009*

Today, the Yemeni population accounts for about 23 million people, of which about three-quarter live in rural areas but only about 15 percent draw their main income from agricultural activities. Most of the population is concentrated in the highlands. Food insecurity affects 32.1 percent of the population. In other words, almost one-third of the population, or 7.5 million people, do not have enough food. Table 7 shows that almost one-third of the Yemeni people suffer from food insecurity.

Food insecurity is far more widespread in rural areas than in urban areas—37.3 percent in rural compared with 17.7 percent in urban areas. Estimates reveal an urban-rural divide in food insecurity, with a strong tendency toward a considerably higher prevalence in rural areas. Food insecurity among the rural population is almost ten percentage points higher than it is among the urban population.

The absolute number of food-insecure people living in rural areas is more than five times higher than in urban areas. As Table 6 shows, the vast majority of food-insecure people live in rural areas. About 6.4 million rural people are suffering from food insecurity, while in urban areas 1.1 million are deficient in food.

**Table 7. Food insecurity by residential area and agroecological zones in 2009**

| | Food insecurity rate (percent) | Number of food-insecure people (thousand) | Per capita calorie consumption (kcal/day) | Per capita calorie gap (kcal/day) | Food Variety Score (foods/week) |
|---|---|---|---|---|---|
| **All** | **32.1** | **7,481** | **2,301** | **282** | **17.3** |
| Urban | 17.7 | 1,102 | 2,160 | 380 | 21.0 |
| Rural | 37.3 | 6,378 | 2,352 | 246 | 16.0 |
| Agroecological zones | | | | | |
| Lower Highlands | 19.4 | 1,197 | 2,411 | 443 | 18.9 |
| Upper Highlands | 36.5 | 3,739 | 2,323 | 252 | 16.5 |
| Red Sea & Tihama | 27.7 | 920 | 2,362 | 360 | 17.7 |
| Arabian Sea | 35.3 | 568 | 2,027 | 142 | 17.6 |
| Internal Plateau | 56.5 | 868 | 1,909 | -142 | 16.6 |
| Desert | 44.0 | 189 | 2,167 | 119 | 13.7 |

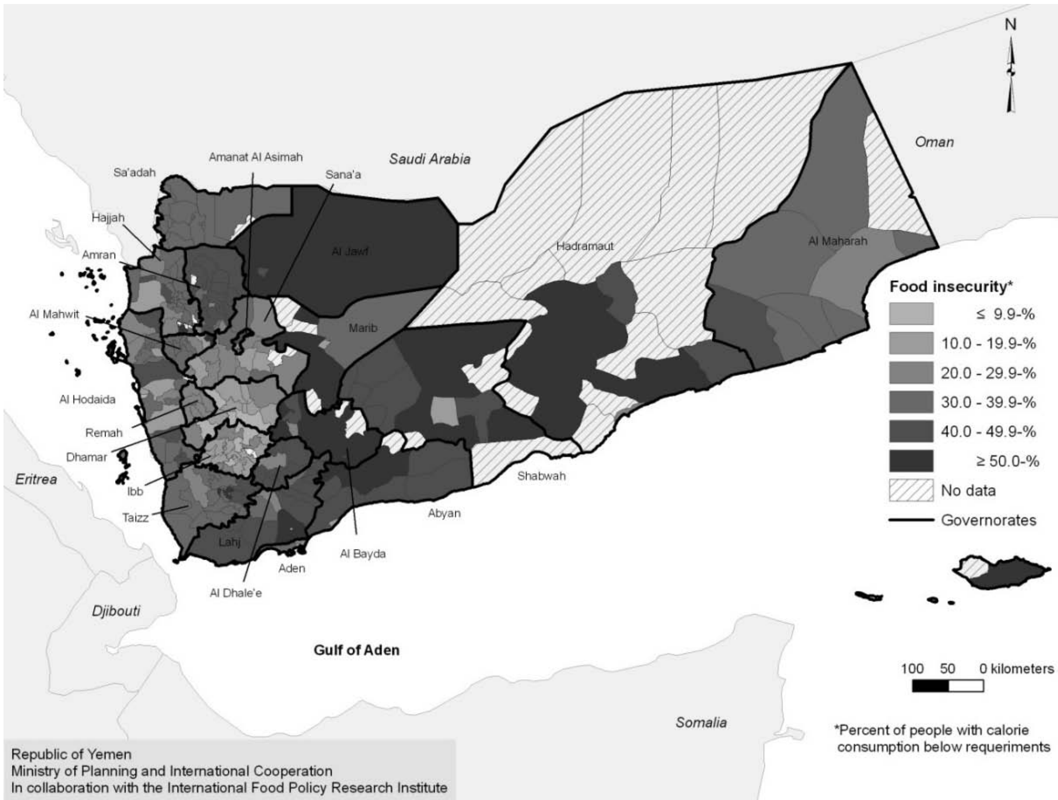
Source: IFPRI estimation based on 2005–2006 HBS data.

In general the nutrition situation in Yemen is highly vulnerable to shocks such as food price surges and climate variability. The vulnerability is demonstrated by the relatively small difference between what Yemenis consume every day and what they need to stave off hunger at their current level of activity—less than 300 kcal/day nationwide. This means that the average Yemeni consumes only 15 percent more than the 2,019 kcal/day needed to avoid hunger.

People in rural areas are more likely to fall into food insecurity than people living in urban areas. Although the average per capita calorie consumption is higher by 200 kcal/day in rural areas than in urban areas, the average per capita calorie gap is lower by about 130 kcal/day. This difference is the result of the significantly higher calorie needs of rural people (2,106 kcal/day on average) compared with urban people (1,708 kcal/day on average). Rural people need more calories for fetching water from wells, carrying goods to and purchases from markets over long distances, and working hard on farms and in fisheries.

At the regional level the prevalence of food insecurity strongly varies between agroecological zones and is alarmingly high in the Internal Plateau. The food insecurity rate presented in Table 7 reveals large differences in the spread of food insecurity across agroecological zones. The prevalence rate is lower along the Red Sea coast (Red Sea and Tihama Zone) and in the Upper Highlands Zone (which starts at 1,900 meters above sea level), where the country's capital, Sana'a, is located. The food-insecurity rate rises toward the eastern inland region, which is comprised of the Internal Plateau and the Desert Zone. The food-insecurity rate is lowest in the Upper Highlands (located at an altitude of 1,500 to 1,900 meters above sea level), home to less than 20 percent of the population. It is highest in the Internal Plateau, where more than half the population is food insecure. The agroecological zones that are better off in terms of food security also have high percentages of urbanized population. The Internal Plateau is the only zone showing an average calorie deficit, which exceeds 140 kcal/day. Thus the availability of dietary energy (at affordable prices) in this zone is insufficient to supply all people there with adequate calories. However, as Figure 4 shows, districts have considerable differences in the prevalence of food insecurity.

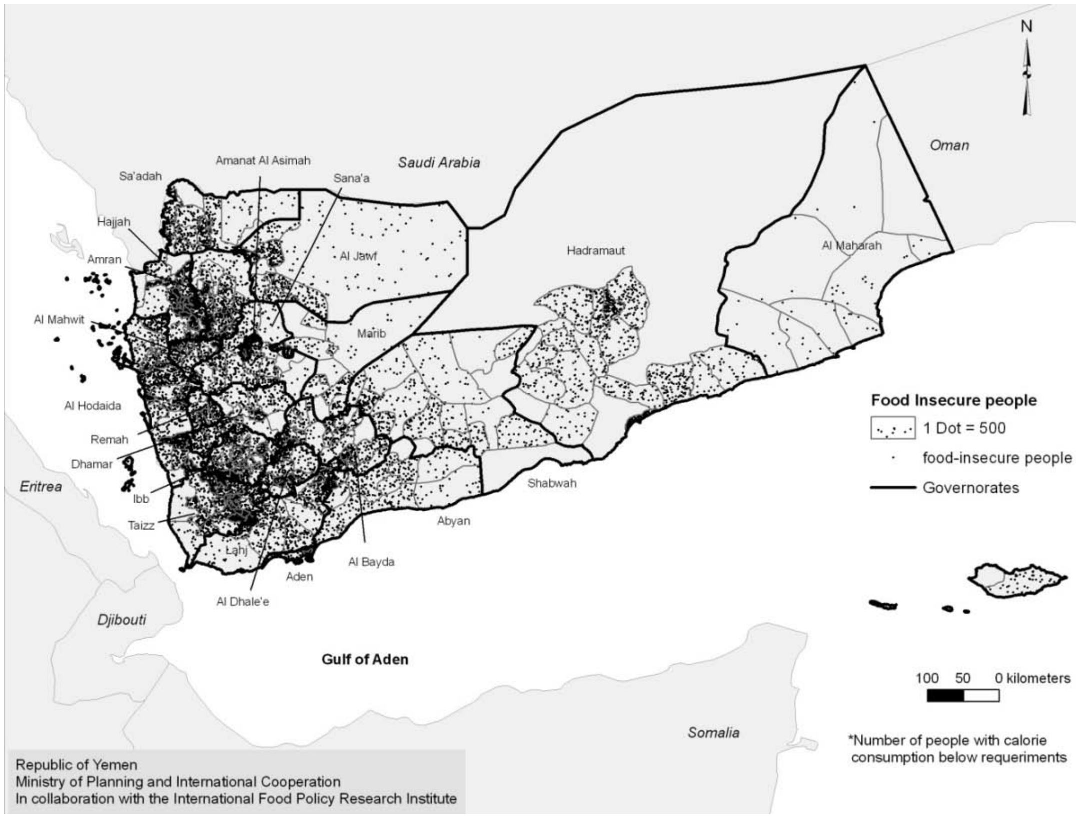
**Figure 4. Food insecurity by severity in 2009**




Source: IFPRI estimation based on 2005–2006 HBS data and IFPRI modeling.
Note: Map in color is available from the authors upon request.

Although the rate of prevalence of food insecurity in the highlands is low, in absolute numbers most food-insecure people are living there. Yemen's highland region (comprised of the Lower and Upper Highlands zones) is the most densely populated region in the country. Seventy percent of the Yemeni population and 66 percent of the food insecure live in this region, and most of them live more than 1,900 meters above sea level. Half of all Yemen's food-insecure people reside in the Upper Highlands. Figure 5 highlights this concentration graphically.

**Figure 5. Food insecurity by number of food-insecure people in 2009**




Source: IFPRI estimation based on 2005–2006 HBS data and IFPRI modeling.
Note: Map in color is available from the authors upon request.

### *3.2.2. Dietary Diversity and the Risk of Micronutrient Deficiencies*

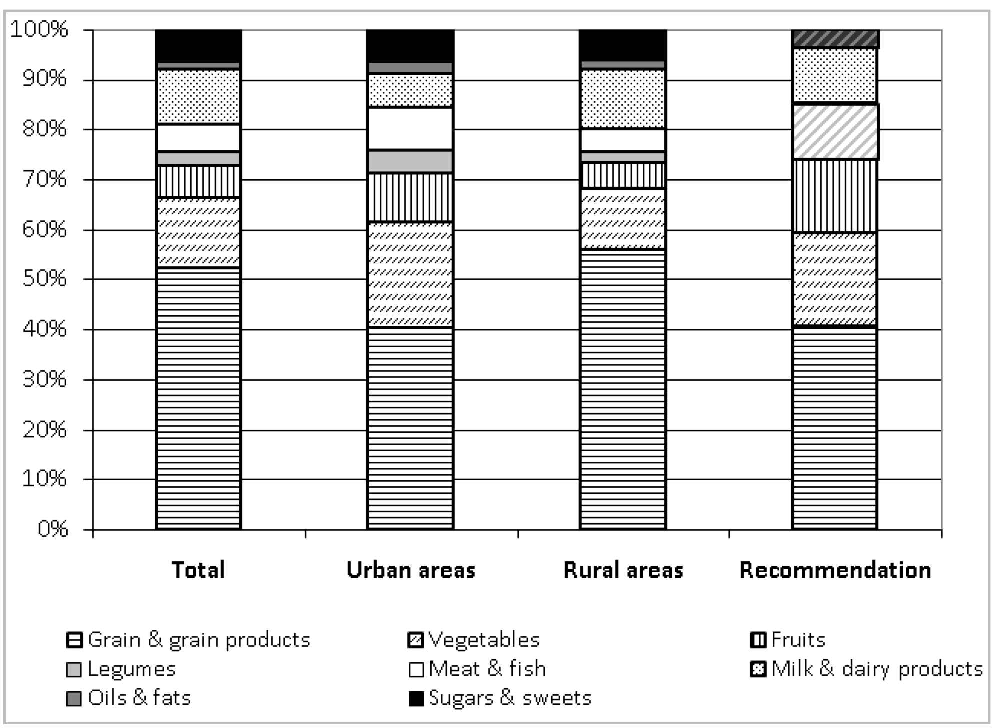
Even if people are food secure in terms of dietary energy, they do not necessarily have access to *nutritious* food. When comparing the ranking of agroecological zones according to the average Food Variety Score (FVS)—a common dietary diversity indicator, typically highly correlated with macro- and micronutrient intakes—versus average per capita calorie consumption in Table 7, it becomes obvious that a diet adequate in terms of energy is not necessarily sufficiently diversified and healthy. This has important implications for interventions aimed at fighting micronutrient deficiencies that critically affect the physical and mental development of children in particular. For instance, it cannot be assumed that the administrative areas showing the highest rate of food insecurity measured on a calorie basis are those areas with the highest rate of micronutrient malnutrition. Or, households identified as food secure in terms of calorie consumption may indeed consume diets lacking in sufficient amounts of essential micronutrients such as iron, iodine, Vitamin A, zinc, and folate.

People living in rural areas consume an undiversified diet and are at higher risk of micronutrient deficiencies than people in urban areas. In addition to lower dietary energy content, diets in rural areas are considerably less diversified than diets in urban areas, exposing consumers to a much higher risk of micronutrient deficiencies. The average diet in rural areas contains almost 25 percent fewer food items than the average urban diet. Figure 6 shows that more than half of the average diet (in quantity terms) in rural areas consists of calorie-dense cereal products. Thus, because of rural people's higher vulnerability to dietary energy shortages, their diet is more aligned with satisfying their calorie needs than diets in urban areas. Rural diets therefore contain more staple products and fewer vitamin- and mineral-rich foods such as vegetables and fruits, and meat, fish, and dairy products. Rural consumers obtain more than 70 percent of their dietary energy from cereal consumption on average, while cereals make up less than 60 percent of the average total calorie consumption in urban areas. Meat products are an important calorie source in urban areas, contributing to about 10 percent of total dietary energy. Sugars and sweets make up about 10 percent of the total calories consumed in the average rural diet (and even more in the urban diet). A main reason for the high percentage is the frequent consumption of sweetened tea.

The average diet in urban areas almost meets the recommendation of a well-balanced diet in relative terms; yet in absolute terms the consumption of vegetables and fruit falls short of the recommendation for a healthy diet. If we use the dietary composition as suggested by the universal food pyramid as a crude reference for a well-balanced diet, the average urban diet in Yemen appears to be almost well balanced across the main food groups, as Figure 6 illustrates. Nonetheless, average vegetable and fruit consumption is far below the minimum recommendations for a healthy diet, as suggested by FAO and WHO (FAO-WHO 2005) The average urban diet contains only 225 grams of vegetables and fruits, which is just more than half of the 400 grams per person per day recommended for the prevention and alleviation of several micronutrient deficiencies (especially in less developed countries).[6]

The average rural diet is poorly balanced across food groups and is lacking in considerable quantities of vegetables and fruit. Figure 6 shows that diets in rural areas are less balanced than diets in urban areas. Taken together, vegetables and fruit, milk and dairy, meat, fish, and legumes account for too small a share of the average rural diet relative to the universal recommendation. Given that animal-source foods are usually too expensive for poor people, sufficient vegetable and fruit consumption is essential to prevent micronutrient deficiencies. Vegetables and fruit make up only 143 grams in the average daily rural diet, however, implying a high prevalence of micronutrient malnutrition. Considering the FVS estimates in Table 7, the risk of micronutrient deficiencies seems to be particularly high for the population living in the Desert Zone.

**Figure 6. Food consumption patterns compared to recommendation**




Source: IFPRI estimation based on 2005–2006 HBS data.

[6] Moreover, potatoes are considered vegetables in Yemen and are included in this number. Although potatoes do not account for a high percentage of the average diet, they bias the estimate upward. The minimum FAO-WHO recommendation of vegetable and fruit consumption excludes potatoes and other starchy tubers (FAO-WHO 2005).

### *3.2.3. Prevalence of Child Malnutrition*

Moderate and severe child malnutrition is highly prevalent, thus hampering the future development of society and the economy. Table 8 suggests that more than 40 percent of the last-born children in Yemeni households are underweight, more than one-third of them severely so. Considerably more than half the children are stunted, and one-third suffers from the severe form of stunting. This suggests that poor nutrition and health have been major problems of child development in the past and still are. In addition, the high prevalence of wasting reveals that more than 15 percent of children are affected by acute starvation from extreme malnutrition and illness. Figure 7 presents the prevalence of underweight children by governorate, and Figures 8 and 9 depict the prevalence of stunting and wasting, respectively.

The incidence of underweight children and stunting is much higher in rural areas than in urban areas. Consistent with the food-security situation, moderately and severely underweight and stunted children are far more likely to live in rural areas than in urban areas. The prevalence of moderate and severe forms of wasting is about the same in rural and urban areas, with a slight tendency toward higher rates of wasting in urban areas. This probably is the case because wasting identifies the extreme cases of severe malnutrition and illness. A higher prevalence of wasting in urban areas might be a result of a combination of extreme poverty and extreme poor health conditions in shanty towns. The findings are largely consistent with estimates from the 2003 Family Health Survey (LOAS and GOY, 2004), although some slight relative differences in prevalence for the moderate forms of the three nutritional impairments are evident.[7]

**Table 8. Prevalence (by percentage) of moderate and severe malnutrition among the youngest children (0–59 months) by residential area and sex**

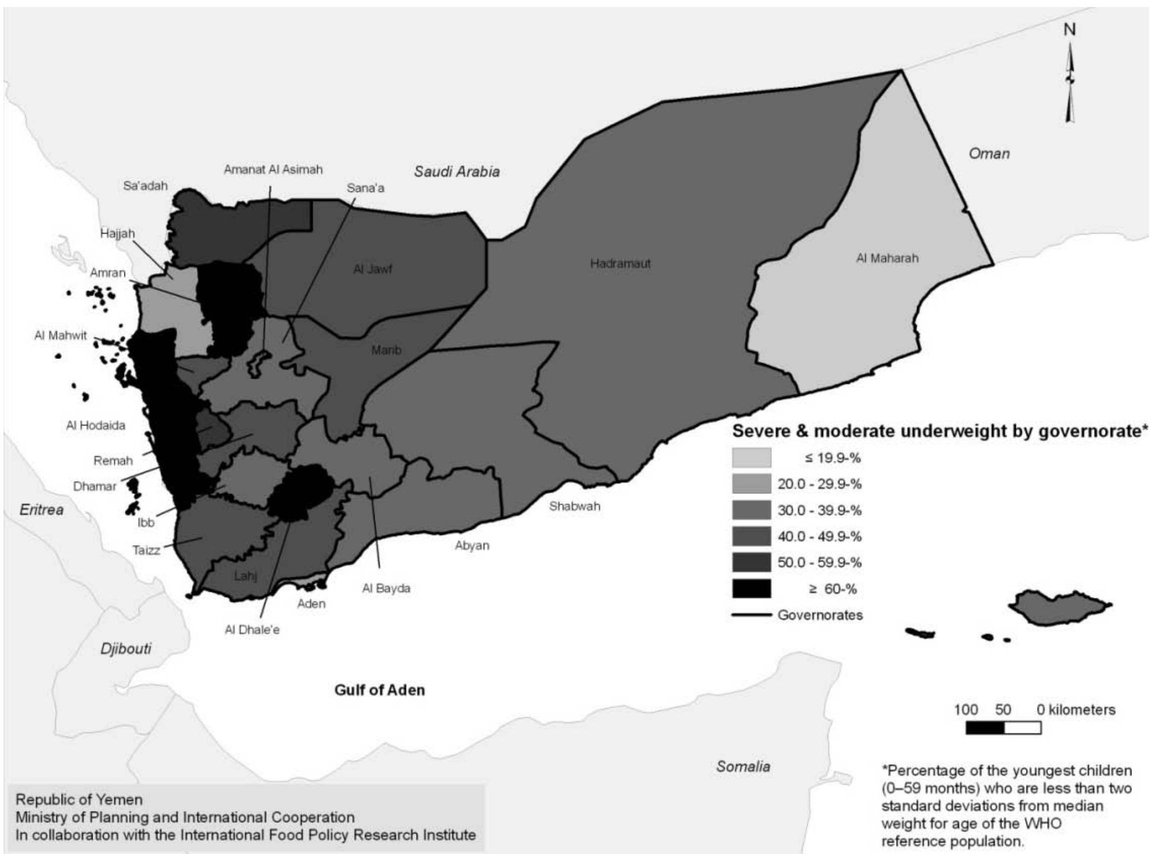
| | Underweight | | Stunting | | Wasting | |
|---|---|---|---|---|---|---|
| | Moderate | Severe | Moderate | Severe | Moderate | Severe |
| ***All children*** | ***42.9*** | ***15.0*** | ***57.9*** | ***35.4*** | ***15.7*** | ***4.4*** |
| *Urban* | *36.2* | *11.6* | *45.4* | *23.7* | *16.2* | *4.6* |
| *Rural* | *45.1* | *16.1* | *62.1* | *39.4* | *15.6* | *4.3* |
| **Male children** | **44.9** | **15.9** | **57.9** | **36.9** | **17.2** | **4.7** |
| Urban | 38.7 | 12.6 | 47.7 | 25.8 | 17.1 | 4.9 |
| Rural | 47.0 | 17.0 | 61.5 | 40.7 | 17.2 | 4.6 |
| **Female children** | **40.7** | **14.0** | **57.8** | **33.9** | **14.2** | **4.1** |
| Urban | 33.4 | 10.5 | 42.8 | 21.4 | 15.2 | 4.2 |
| Rural | 43.1 | 15.2 | 62.8 | 38.1 | 13.9 | 4.1 |

Source: IFPRI estimation based on 2005–2006 HBS data.

[7] Compared to our estimates from the 2005-2006 HBS data, the 2003 Family Health Survey (LOAS and GOY 2004) finds higher prevalence rates of underweight (45.6 percent) among the youngest children (0–59 months) in all households–the rate for children of this age is also higher among rural households (47.9 percent) but similar among urban households (36.7 percent). Our prevalence estimates for stunting and wasting are consistently higher, especially the prevalence of stunting in rural areas and wasting in urban areas. According to the FHS, 53.1 percent of all children are stunted nationwide, 44.2 percent in urban areas and 55.5 percent in rural areas; 12.4 percent of all children nationwide are wasted, representing 10.0 percent of children in urban areas and 13.1 percent in rural areas. Comparisons of data in the 2003 FHS and 2005–2006 HBS child anthropometrics might be inaccurate because the HBS datasets use the revised WHO child growth standards.

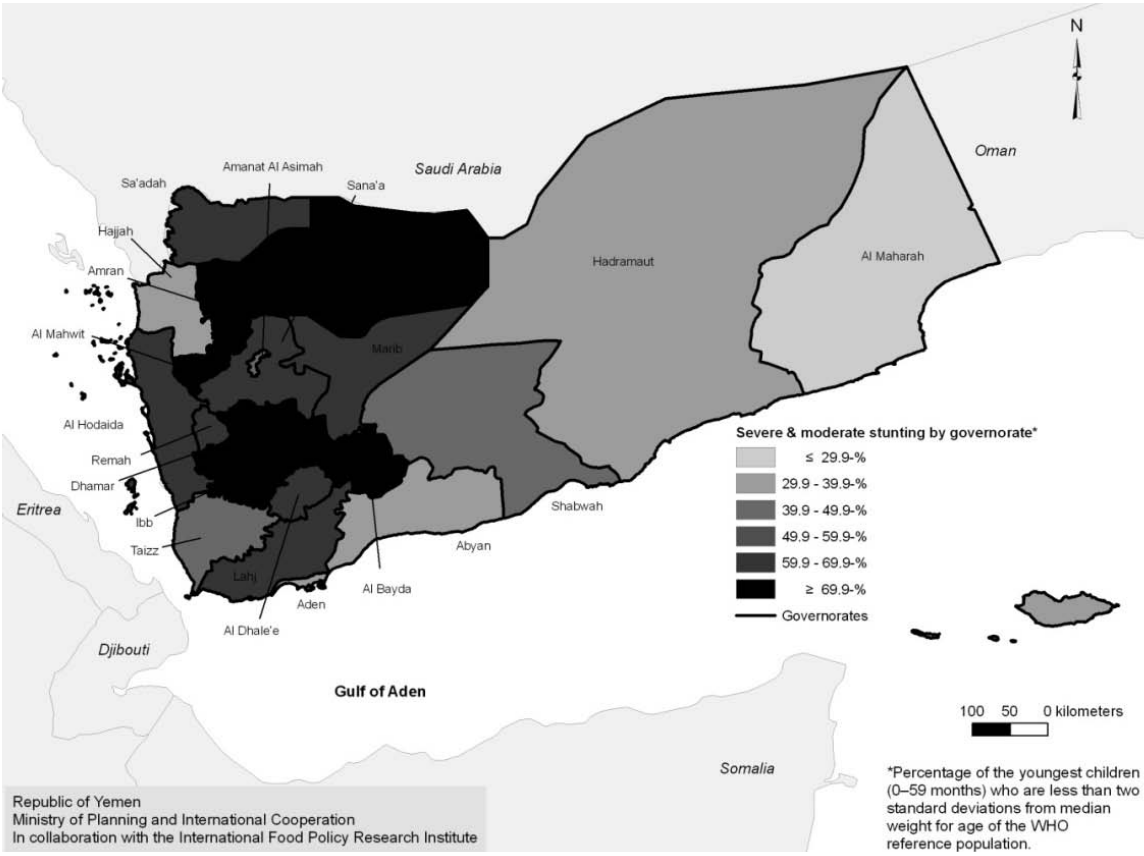
Malnutrition is generally more prevalent among boys than girls. In contrast to the findings in some developing countries, the prevalence of moderate and severe forms of underweight, stunting, and wasting in Yemen is almost consistently higher among male children than female children (Table 8). The usual explanation for why boys in many developing countries are better nourished than girls is that parents give more care to boys. Perhaps this special treatment is also lavished on young Yemeni boys but, paradoxically, in a way that harms them. Perhaps they are given infant formula and other foods in place of the breast milk their bodies need. Certainly, a likely explanation for the phenomenon of malnourished Yemeni boys is the common misconception that these alternatives are more nourishing than breast milk. More research is needed in this area. As Section 4.4 discusses in more detail, breast-feeding practices in Yemen are largely suboptimal.

**Figure 7. Prevalence (by percentage) in Yemen of moderate (and severe) underweight among the youngest children (0–59 months) by governorate**



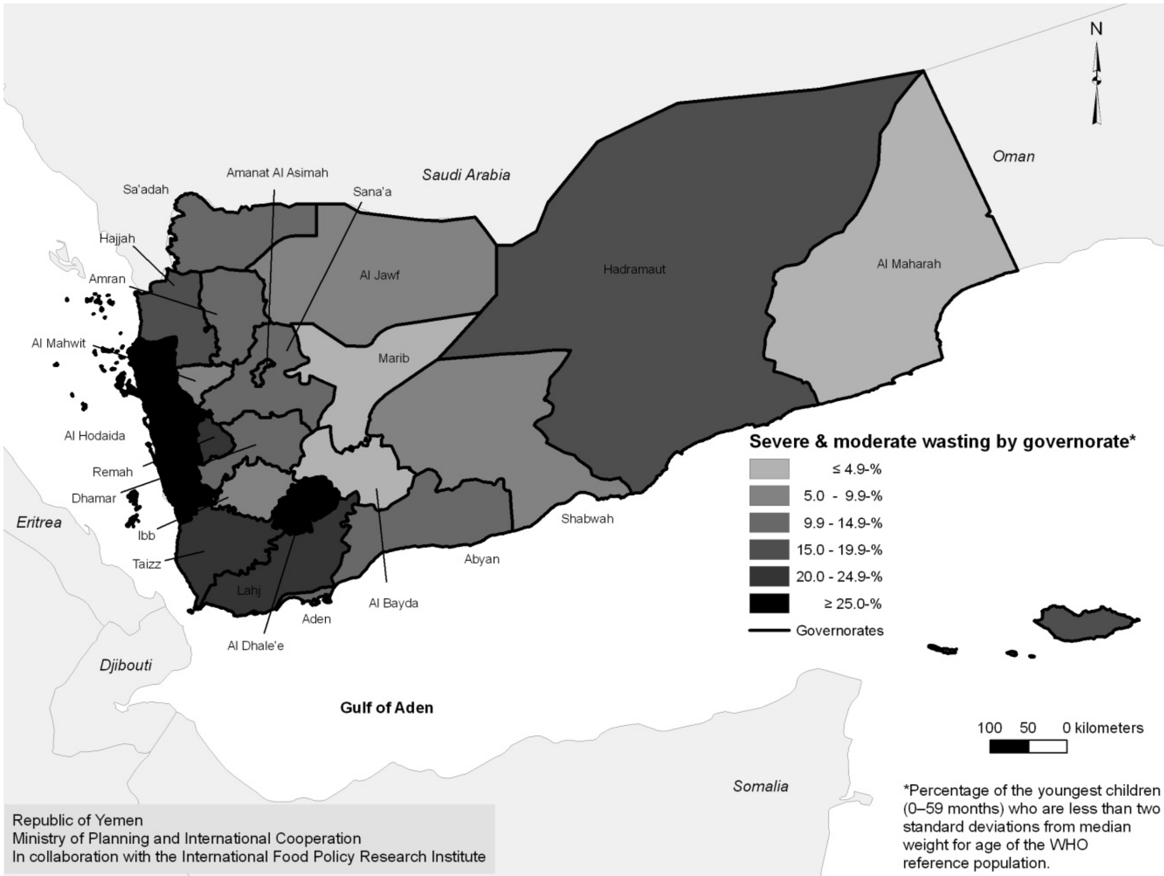

Source: IFPRI estimation based on 2005–2006 HBS data. Note: Map in color is available from the authors upon request.

**Figure 8. Prevalence (by percentage) in Yemen of moderate (and severe) stunting among the youngest children (0–59 months) by governorate**




Source: IFPRI estimation based on 2005–2006 HBS. Note: Map in color is available from the authors upon request.

**Figure 9. Prevalence (by percentage) inYemen of moderate (and severe) wasting among the youngest children (0–59 months) by governorate**




Source: IFPRI estimation based on 2005–2006 HBS. Note: Map in color is available from the authors upon request.

## 3.3. Relationship of Poverty, Household Food Insecurity, and Malnutrition

The food, fuel, and financial crises have hit Yemen hard, and poverty and food insecurity have risen. Because of Yemen's strong economic dependence on oil exports, substantial food imports, and financial inflows (as discussed in Section 4.1), the recent food, fuel, and financial crises have had a serious impact on the country's economy and poverty rate (Breisinger et al. 2010). According to these estimates, 42.8 percent of households nationwide are living in poverty, 47.7 percent in rural areas and 29.9 percent in urban areas. Given the commonly accepted use of poverty as a measure of household welfare and the economic links between poverty and food insecurity, analyzing the relationship between the poor and the food insecure can provide useful information for designing strategies to reduce both problems.

The poor and the food insecure are not the same people in many cases, especially in urban areas. Table 9 shows that the poverty rate is about ten percentage points higher than the food-insecurity rate nationwide as well as in urban and rural areas. More than half the Yemeni population suffers from food insecurity or poverty or both, with a strong tendency toward a higher prevalence in rural areas. Every fifth Yemeni is poor and food insecure, a rate that climbs in rural areas to almost 1 in 4. Every fifth person is poor but not food insecure. These people are at a particularly high risk of falling into food insecurity when the country experiences economic shocks such as price surges for staple foods. Furthermore, in rural areas (as well as in the entire population) more than one-third of the food insecure are not judged to be poor; this group accounts for more than half of the food insecure in urban areas. What seems at first glance like a paradox (that people are classified as nonpoor but do not have enough food) can be explained and has important implications for Yemen. Food security is directly determined by calorie consumption, whereas poverty is an income-based measure based on estimated household expenditures for food and other items. Differences between the two measures can thus occur for several reasons, including differences in the cost of living between regions, the unequal distribution of income within households, and the accounting of qat as expenditure. For example, if food-insecure households spend a lot of money on qat, their qat consumption may mask the households' food insecurity (for more information, see Section 4.1.2).

**Table 9. Proportion (percentage) of food-insecure and poor people among the Yemeni population in 2009**

| | Poor | Food insecure | Either food insecure and/or poor | Food insecure and poor | Poor but food secure | Food insecure but not poor |
|---|---|---|---|---|---|---|
| **All** | **42.8** | **32.1** | **52.5** | **19.9** | **20.4** | **12.2** |
| Urban | 29.9 | 17.7 | 35.3 | 8.1 | 17.6 | 9.6 |
| Rural | 47.6 | 37.3 | 58.8 | 24.2 | 21.5 | 13.1 |

Source: IFPRI estimation based on 2005–2006 HBS data.

Because food security is positively associated with income, raising incomes is an important component in improving food security. The first column of Table 10 shows the coefficients and indicates the statistical significance levels for the correlation of food security (measured as per capita calorie consumption amounts) and income (measured on a per capita expenditure basis), assuming a linear relationship. The high statistical significances suggest that food security both in urban and rural areas (as well as at the national level) is associated with income. As expected, this relationship is positive, suggesting that richer people are also more likely to be food secure and or vice versa, that food insecurity increases with the level of poverty. However, the correlation coefficients indicate that this (linear) relationship is weak. The correlation is lower at the national level than in urban and rural areas, implying the existence of structural differences between urban and rural areas in the calorie consumption–income relationship. On a linear basis calorie consumption is more related to income in rural areas than in urban areas.

**Table 10. Correlation between food-security measures as per capita calorie consumption (kcal/day) and income, dietary diversity, and child nutritional status**

| | Per capita expenditure (riyals/day) | Food Variety Score (foods/week) | Weight-for-age z-score | Height-for-age z-score | Weight-for-age z-score |
|---|---|---|---|---|---|
| **All** | **0.090** *** | **0.128** *** | **0.040** ** | **-0.045** ** | **0.081** *** |
| Urban | 0.140 *** | 0.185 *** | 0.044 * | -0.016 | 0.057 *** |
| Rural | 0.172 *** | 0.201 *** | 0.064 *** | -0.021 | 0.081 *** |

Source: IFPRI estimation based on 2005–2006 HBS data.
Note: *, **, *** Coefficient is statistically significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

Dietary diversity comes along with improved food security, albeit at a low level. The second column of Table 9 shows the coefficients and indicates the significance levels for the correlation between food security in calorie terms and dietary diversity (measured by the Food Variety Score). The statistically significant and positive coefficients reveal that food-secure people tend to consume a more diversified and therefore healthier diet in terms of nutrients. In contrast the risk of micronutrient deficiencies increases with food-insecurity levels (in calorie terms). The magnitudes of the coefficients are similarly high in urban and rural areas and, again, higher than when the analysis is carried out for both populations in combination. Thus the relationship between dietary diversity and food security also takes different forms in urban and rural areas.

Child nutrition generally improves with food security, but other factors seem to matter considerably. In Table 10 the coefficients and statistical significance levels for the correlation between food security (in calorie terms) and the weight-for-age, height-for-age, and weight-for-height z-scores for the last-born children younger than five are reported in the third, fourth, and fifth columns, respectively. The statistically significant coefficients in the third and fifth columns suggest that children's actual nutritional status improves with food security in a weak manner (when assuming a linear relationship). The relationship seems to be stronger in rural areas than in urban areas. The statistically significant negative relationship between actual calorie consumption and height-for-age z-scores, shown in the fourth column, should not be overinterpreted, given that this nutrition indicator also reflects past nutritional and health conditions. That is, stunting might have occurred in the past, and the child has not yet caught up.

# 4. CHALLENGES FOR IMPROVING FOOD SECURITY

This section analyzes the major challenges to food security by sector and the factors driving food insecurity on the macro-, household, and individual levels. Each subsection first outlines the major challenges facing each sector. The discussion in each subsection then uses the HBS data to analyze the main factors influencing food security. The analyses of microlevel food security factors use cross-table summary statistics and correlations of paired variables to identify factors associated with household food security or that may determine it.[8]

## 4.1. Macroeconomics, Growth, and Income

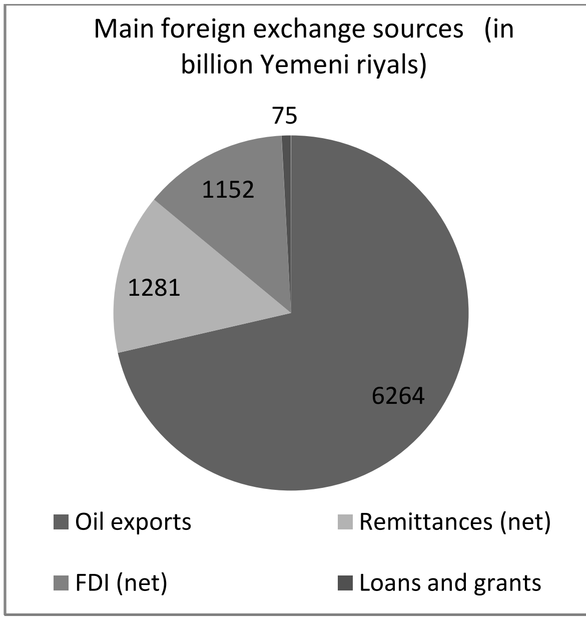
### *4.1.1. Macroeconomic Challenges*

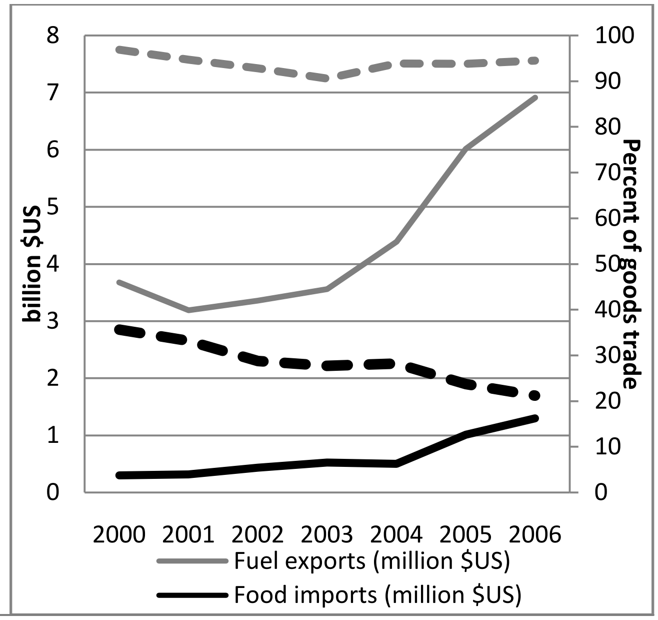
Yemen is highly dependent on oil exports for its balance of payments. Oil is the most important source of foreign exchange earnings, contributing about three-quarters of all foreign exchange inflows in 2007 (Figure 10). The rest of the inflows are primarily remittances by Yemenis working abroad, making this money an important source of income both at the macro- and household levels (IMF 2009). While foreign direct investment (FDI) recently started to increase, the bulk of it is concentrated in the mining sector, traditionally in oil and more recently in the gas sector, to develop liquefied natural gas facilities. Other sectors that have attracted FDI include tourism, real estate, and—to a limited extent—manufacturing, mainly from Gulf countries (World Bank 2009). Seventy-five billion Yemeni riyals, or about 1 percent of the government budget, comes from development assistance in the form of loans and grants.

Accordingly, Yemeni exports are also heavily dominated by oil, and the country depends on food imports. Oil made up 90 percent of the country's total exports from 2000 to 2007 (Figure 10). The remaining exports are mainly agricultural products, including coffee, tobacco, fish, and animal products (Figure 10), and some light manufacturing products. In terms of imports Yemen is one of the most food import–dependent countries in the world. In 2007 value terms about 55 to 65 percent of food products consumed in the country are imported; 70 percent of cereals and 90 percent of wheat (the main staple) and 100 percent of rice are imported. Total food imports account for about 20 to 25 percent of total imports, other consumer goods account for 10 percent, and the remaining imports are about equally split between capital goods and refined fuel.

[8] It is important to note that the correlation analyses applied imply linear relationships, which might not reflect the "true" parametric form of the relationships between the variables and the magnitude of the parameters. Nevertheless they are simple and powerful.

**Figure 10. Foreign exchange earnings and goods trade, 2000–2007**

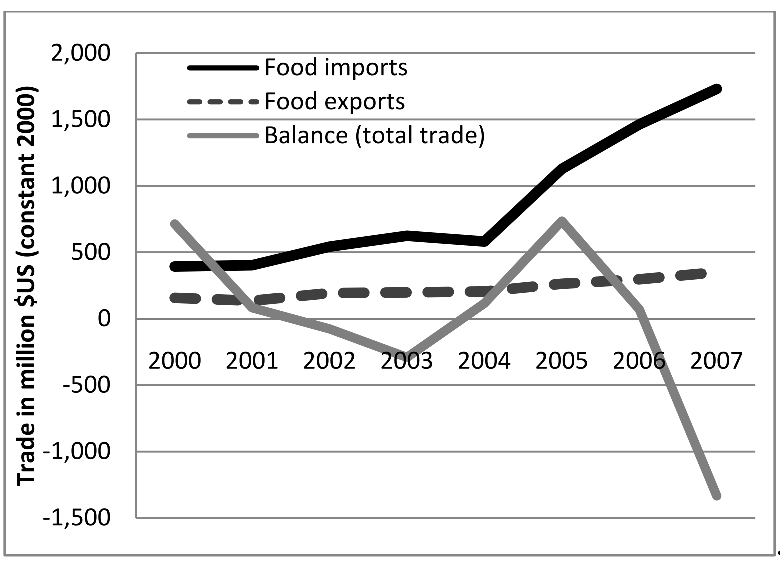



Source: IFPRI estimation based on IMF (2009) and FAO 2009 b.

The food-trade balance is deteriorating because of rapidly increasing food imports. While food exports remained relatively constant in the past, imports of food—especially of wheat and wheat products—have risen sharply since 2004 (Figures 10 and 11). This spike in imports can be explained by a sharp drop in agricultural growth, from about 3 percent in 2001–2004 to less than 1 percent in 2005–2007. In addition, population growth (and thus demand for food) remains high, at 3 percent per year, and changing food consumption patterns further increase import demand. For several types of food for which demand increases, either no local alternatives exist, or natural conditions often do not allow for local production, or both.

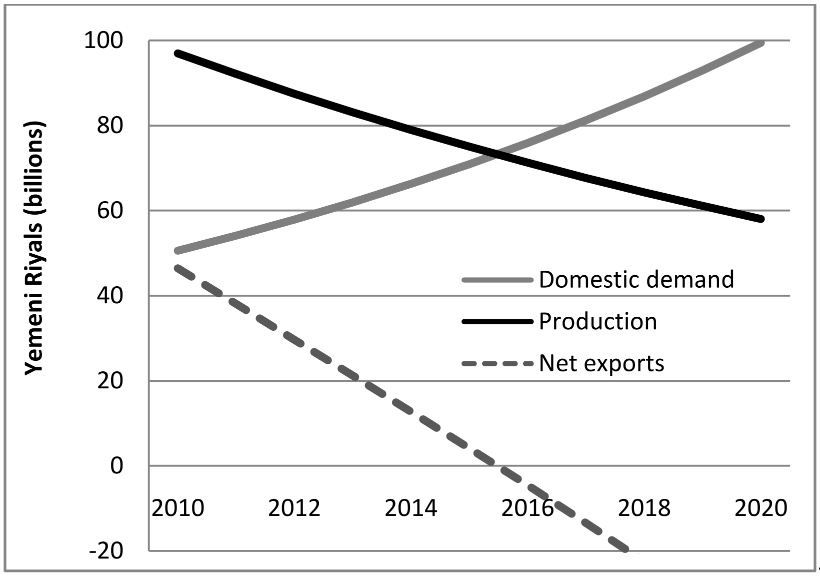
**Figure 11. Food-trade balance**




Source: IFPRI estimation based on FAO (2009) and Yemen, Ministry of Agriculture and Irrigation (2009).

Yemen is expected to become a net oil-importing country by 2015, which further challenges macrolevel food security. Net exports of oil are likely to cease around 2015 because of both rapidly increasing domestic demand and decreasing domestic supply (Figure 12). However, Yemen is bound to become an exporter of gas, which has the potential to partly compensate for declining oil exports but not to solve the macrolevel food-security problem.

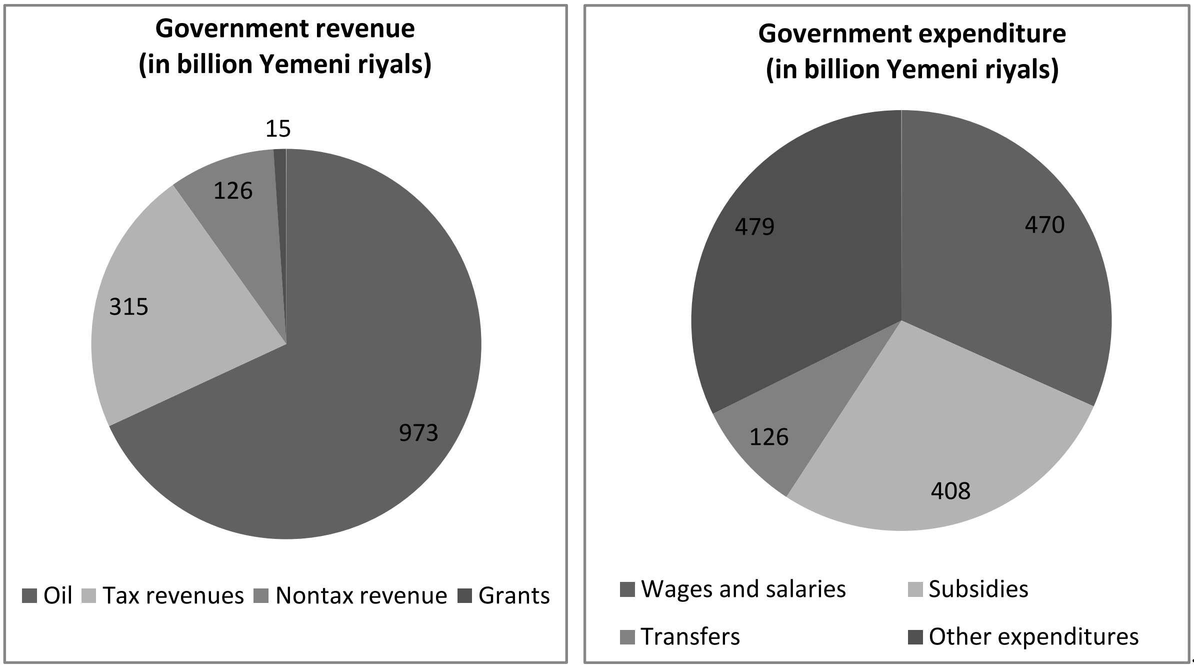
**Figure 12. Mineral resource supply and demand projections (2010–2020)**




Source: IFW/IFPRI estimation based on EIU (2009), IMF (2009), and Yemen, Ministry of Planning and International Cooperation (2009).

Declining oil revenues will also challenge food security because of the resulting reduction in government revenues. Oil plays an important role in government finances, for both revenue and expenditures (Figure 13). Oil money constitutes about 70 percent of government revenues, but with oil exports rapidly dwindling, these revenues have started to decline and are expected to dry up by 2015. While gas exports from 2010 on are expected to partly fill this gap, gas exports will not be able to fully compensate for the loss in oil revenues. On the expenditure side the fuel subsidy for Yemenis constitutes a big burden for the government, particularly when oil prices are high as during the period of 2007-2009. Because Yemen lacks domestic refining capacity, it imports most of the fuel it consumes domestically. In 2007, for example, oil subsidies accounted for about one-quarter of government expenditures, about the same percentage that Yemen spends on public employees' wages and salaries (about 26 percent). Compared with that, social transfer payments (such as pensions, social welfare etc) to households are less than one-third of fuel subsidies. However, removing fuel subsidies might hurt the food insecure and poor if they are not helped in some other way. Evidence from other countries indicates that shifting public spending from fuel subsidies to direct transfer payments is an important tool for improving food security.

**Figure 13. The role of oil in the government budget**



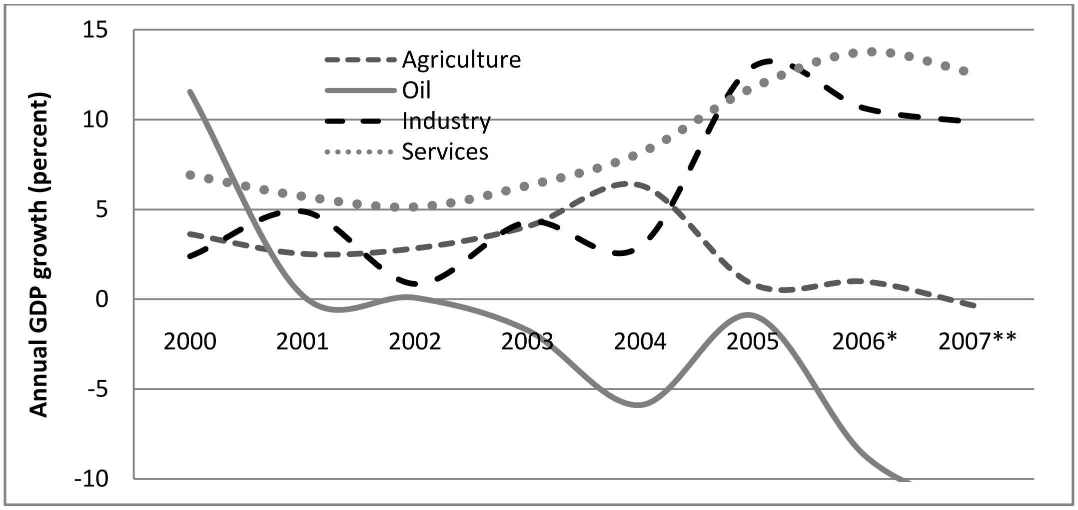

Source: IFPRI estimation based on IMF (2009).

### *4.1.2. Economic Growth and Household Incomes*

Economic growth that raises people's incomes is the single most important driver of food security. People with higher incomes are also less vulnerable to external shocks such as the food crisis and more resilient to future challenges such as climate change. Rapid economic growth and the transformation of rural and urban sectors will be key to future prosperity and food security in Yemen. Therefore food security critically depends on good sector performance, in terms of growth, infrastructure, and service provision. Strong sector performances enable people to access markets, health services, education services, water supply, and the like. These are important conditions for food security and for living a healthy and productive life.

Economic growth in Yemen averaged 3.8 percent from 2000 to 2007, with service and industrial growth (mainly construction) as the main drivers (Figure 14). This service- and construction-led growth is linked to the government's spending of oil revenues on public investments, mostly in urban areas, and recurring expenses. About 30 percent of the workforce is employed by the government, and windfall gains from oil are often associated with rising public sector wages and infrastructure investments, mostly in urban areas. However, this growth model is challenged by declining oil reserves and the lack of new oil finds, as described in the previous section. Unless new oil fields are discovered, it is estimated that Yemen will run out of oil resources in the next 20 to 30 years, indicating that the oil sector will contract at a rate of 2 to 5 percent annually.

**Figure 14. Economic growth by sector in 2000–2007**




Source: IFPRI estimation based on Yemen, Central Statistical Organization (2009).Note. *preliminary **projection

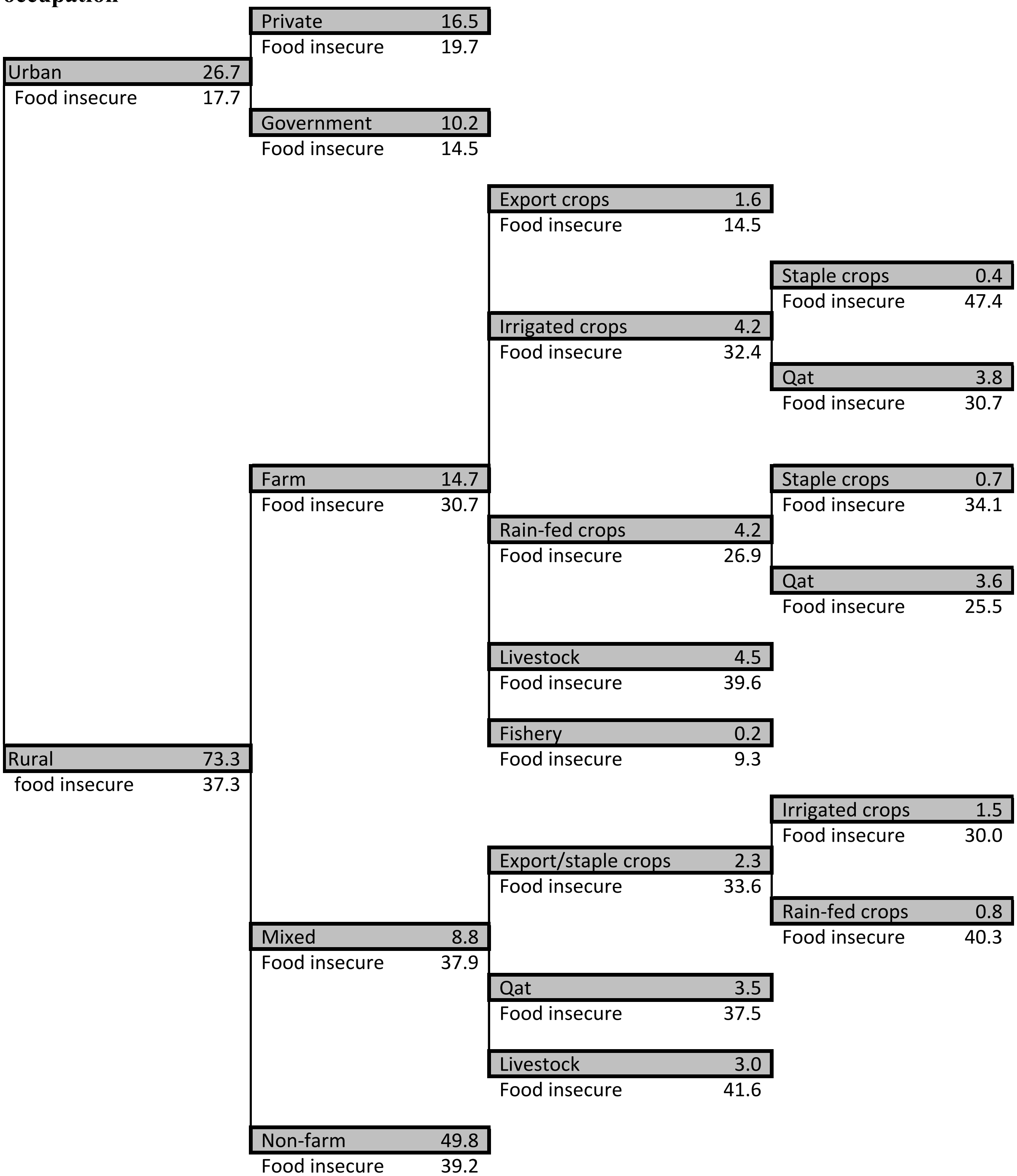
Economic diversification, to lessen Yemen's dependence on oil and bolster the labor-intensive sectors, is slow. Yemen's economy is dominated by the mining sector (oil) and nontradable services, while manufacturing and export-oriented services make up a relatively small share of the economy. In 2007 the oil sector accounted for 22 percent of total GDP, services contributed half of GDP, and the remaining GDP share was generated by construction-dominated industry (15 percent) and agriculture (10 percent). In the agricultural sector qat, fruits, vegetables, and livestock are the most important products in value terms, while cereal production (which saw the steepest world price increase during the food crisis), accounts for only 10 percent of agricultural value added.

Income growth is the single most important factor for household food security; however, household incomes depend on the availability of jobs, and unemployment is high. Also, about 50 percent of Yemen's population is younger than 15. Yemen's unemployment rate increased by five percentage points in five years, to a rate of 16 percent in 2004. More recent estimates vary but consistently put this number much higher. Unemployment is higher in urban areas, affecting 19 percent of the population compared with 10 percent of the rural population (Yemen, World Bank, and United Nations Development Program 2007). In addition, many more are underemployed. The great challenge going forward will be to foster job-creating growth in labor-intensive sectors that can be supplied by the domestic labor market. Given that oil is a limited source of income, another key challenge going forward will be to find the right mix of policies to accelerate job-creating growth and transform rural and urban sectors so that they achieve household food security and higher living standards.

The food-insecure workforce differs from sector to sector, and income growth in different sectors has different potential to improve food security. As outlined, Yemen's economic growth varies considerably between economic sectors, with some sectors having more potential than others for job-creating growth and thus ultimately for reducing hunger and malnutrition. In addition, the food insecure comprise different proportions of the various economic sectors and comprise different proportions of the urban and rural populations. Thus analyzing the sources of income among food-insecure people provides important information about sector investments to the benefit of the food-insecure people.

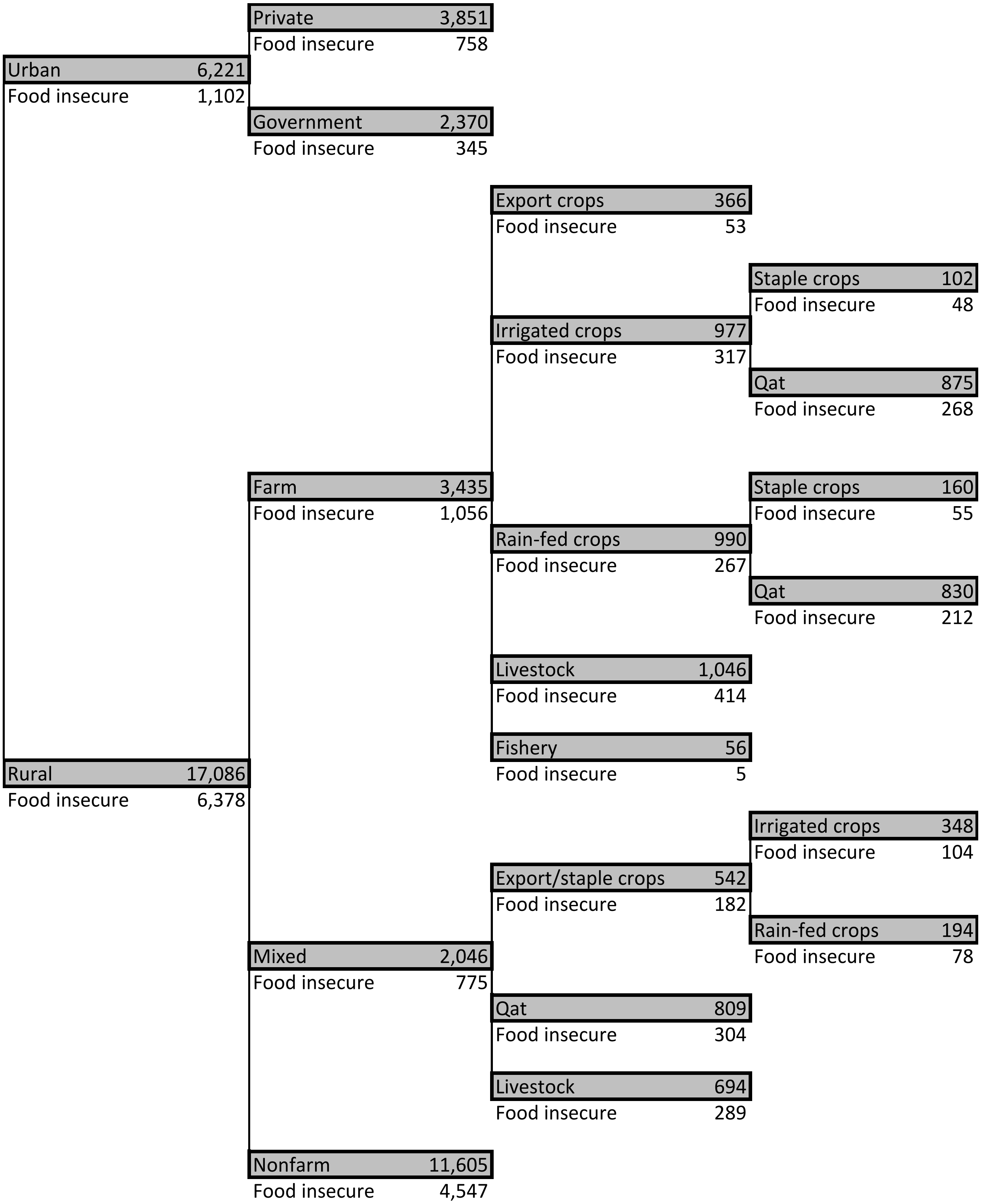
Food insecurity is highest among rural nonfarm households and livestock farmers. Figures 15 and 16 show the disaggregation of Yemeni people according to their location and main occupation. While in urban areas most households draw their income from private business activities or government employment, in rural areas about 15 percent of the population live in households that draw their main livelihood from farming and 9 percent from mixed farming activities; half of all people in rural areas are engaged in nonfarm activities. The proportion of food-insecure people is similarly high among people living in rural nonfarm households (many of whom are landless) and people engaged in mixed-farm activities; 38 to 39 percent of people in each category are food insecure.

**Figure 15. Proportion of food-insecure people (by percentage) according to location and main occupation**




Source: IFPRI estimation based on 2005–2006 HBS data.

**Figure 16. Number of food-insecure people (in thousands) according to location and main occupation**




Source: IFPRI estimation based on 2005–2006 HBS data.

The proportion of food-insecure people is lowest among farmers. Among the three main occupation groups (farmers, part time farmers, nonfarmers), the proportion of food-insecure people is lowest among farm households (30 percent), but it is still 10 percentage points higher than for the urban population. Among both farm and mixed-farm households, the proportion of food insecurity is highest among those who make their living by raising livestock, with levels of food insecurity at about 40 percent.

Most food-insecure people live in rural nonfarm households. In absolute terms people in nonfarm households also account for the largest group, by far, of the food-insecure population; they add up to 4.5 million people. Among the groups of farm and mixed-farm households (taken together), members of livestock-farming households constitute the largest group of food-insecure people, accounting for about 700,000 people.

Income disparities are high; food-insecure people earn only about 60 percent of the per capita income of food-secure people. Table 11 shows that people living in rural areas earn on average about 71,000 Yemeni riyals per year less than their counterparts in urban areas. The average income of the food secure exceeds the average income of the food insecure by about 44,000 riyals, or 64 percentage points, underscoring that low income is a (or the) main determinant of food insecurity. The income gap between the food secure and food insecure is wider in urban than in rural areas because of the generally lower income levels in rural areas. The per capita income gap is about 63,000 riyals in urban areas and 23,000 riyals in rural areas.

Wages are the most important source of income for both the food secure and the food insecure overall. As Table 11 shows, wages contribute the highest share to total income for both the food secure (30.9 percent) and the food insecure (32.8 percent), followed by income from agricultural production (27.0 percent)—which includes the value for (food) products consumed by the household and the fishery production—and income from private business activities (23.6 percent). Despite Yemen's rural structure, agriculture and fishery generate only slightly more than one-fourth of the total per capita income. As expected, income from private business activities, especially in urban areas, makes up a relatively higher total income share among the food secure, while wages, sales from agricultural production, and income transfers contribute a relatively higher share to the income of food-insecure people. In rural areas most income comes from agricultural product sales, both among the food-secure and food-insecure population. However, agricultural production sales is a more important source of income among the food secure than among the food insecure. This supports the findings discussed earlier, that farmers are not the group most vulnerable to food insecurity. Instead, the rural landless workers are.

The private sector contributes the highest share to wage incomes, especially in rural areas, thus playing an important role in the generation of income for food-insecure people. Table 12 shows that half of all per capita wage income is generated by the private sector. Interestingly, the per capita wage income generation of the private sector is relatively higher in rural areas than in urban areas (53.4 percent versus 46.5 percent), because of the large size of the public sector in urban areas. In addition, wages from the private sector make up a greater share of the per capita wage income among the food insecure than among the food secure (53.2 percent versus 49.3 percent). In urban areas the public sector contributes 54.7 percent of the total per capita wage of the food insecure, which is about nine percentage points more than the wage of the food secure in relative terms. In rural areas the share in total wage income is similar (about 53 to 54 percent). These figures clearly point to the central role of the private sector in achieving food security in Yemen.

**Table 11. Total annual income/value of production per capita (in 1,000 riyals) and source of income/ production value (percentage of total)**

| | *Total* (*riyals*) | Wages (percent) | Agricultural production (percent) | Private business (percent) | Transfers (percent) | Other (percent) |
|---|---|---|---|---|---|---|
| **All** | ***98.70*** | **30.9** | **26.7** | **23.6** | **7.9** | **10.8** |
| Residence | | | | | | |
| Urban | ***150.45*** | 36.6 | 8.3 | 33.9 | 7.7 | 13.4 |
| Rural | ***79.86*** | 27.0 | 39.4 | 16.5 | 8.1 | 9.0 |
| Food security status | | | | | | |
| Food secure | ***111.60*** | 30.5 | 25.8 | 25.3 | 7.6 | 10.9 |
| Food insecure | ***67.85*** | 32.8 | 30.5 | 16.9 | 9.3 | 10.6 |
| Residence & food security status | | | | | | |
| Urban food secure | ***156.77*** | 36.1 | 8.3 | 34.7 | 7.6 | 13.2 |
| Urban food insecure | ***93.75*** | 44.3 | 8.2 | 22.6 | 9.1 | 15.8 |
| Rural food secure | ***88.27*** | 25.3 | 41.8 | 16.6 | 7.6 | 8.7 |
| Rural food insecure | ***65.27*** | 31.1 | 33.7 | 16.1 | 9.3 | 9.9 |
| Agroecological zones | | | | | | |
| Lower Highlands | ***134.90*** | 26.3 | 24.7 | 29.6 | 6.5 | 12.9 |
| Upper Highlands | ***74.23*** | 28.4 | 33.4 | 19.2 | 9.3 | 9.7 |
| Red Sea & Tihama | ***102.13*** | 32.3 | 29.1 | 26.3 | 4.6 | 7.8 |
| Arabian Sea | ***132.51*** | 51.5 | 13.8 | 10.9 | 11.5 | 12.2 |
| Internal Plateau | ***81.49*** | 38.5 | 14.6 | 24.9 | 13.0 | 9.0 |
| Desert | ***70.05*** | 29.3 | 33.5 | 19.6 | 5.6 | 12.0 |

Source: IFPRI estimation based on 2005–2006 HBS data.

**Table 12. Total annual wage income per capita (in 1,000 riyals) and source of wage income (percentage of total)**

| | *Total* | Agricultural wage | Nonagricultural wage | | |
|---|---|---|---|---|---|
| | (*riyals*) | (percent) | Private sector (percent) | Public sector (percent) | Other sectors (percent) |
| **All** | ***30.54*** | **8.0** | **50.1** | **39.6** | **2.3** |
| Residence | | | | | |
| Urban | *55.13* | 3.8 | 46.5 | 46.1 | 3.6 |
| Rural | *21.59* | 11.9 | 53.4 | 33.6 | 1.0 |
| Food security status | | | | | |
| Food secure | *34.02* | 6.4 | 49.3 | 41.8 | 2.6 |
| Food insecure | *22.22* | 13.9 | 53.2 | 31.6 | 1.2 |

**Table 12. Continued**

| | *Total* | Agricultural wage | Nonagricultural wage | | |
|---|---|---|---|---|---|
| | | | Private sector | Public sector | Other sectors |
| | *(riyals)* | (percent) | (percent) | (percent) | (percent) |
| Residence & food security status | | | | | |
| Urban food secure | *56.64* | 3.9 | 45.9 | 46.8 | 3.5 |
| Urban food insecure | *41.51* | 2.5 | 54.7 | 37.2 | 5.5 |
| Rural food secure | *22.34* | 9.7 | 53.7 | 35.2 | 1.4 |
| Rural food insecure | *20.30* | 16.3 | 52.9 | 30.5 | 0.3 |
| Agroecological zones | | | | | |
| Lower Highlands | *35.50* | 3.0 | 41.9 | 52.0 | 3.0 |
| Upper Highlands | *21.12* | 9.5 | 51.1 | 39.0 | 0.4 |
| Red Sea & Tihama | *33.03* | 15.4 | 66.3 | 17.9 | 0.4 |
| Arabian Sea | *68.25* | 10.5 | 40.4 | 42.7 | 6.5 |
| Internal Plateau | *31.36* | 1.5 | 69.6 | 26.3 | 2.4 |
| Desert | *20.53* | 8.7 | 43.1 | 48.2 | 0.0 |

Source: IFPRI estimation based on 2005–2006 HBS data.

Wages from the public sector are more important to the urban population and the food-secure population. As Table 12 shows, the public sector contributes about 40 percent to the total per capita wage income nationwide, 46.1 percent in urban areas, and 33.6 percent in rural areas. Among the food secure, 41.8 percent of wage income comes from the public sector, 10 percentage points more than the wage income of the food secure. Looking at the subgroups, the urban food insecure hold the relatively highest share of wage income from the public sector (46.8 percent), and the rural food insecure hold the lowest share (30.5 percent).

Agricultural wage income matters to the rural food insecure. Overall, agricultural wages play a minor role in Yemen's income generation. Nonetheless, agricultural wages account for about 12 percent of the total per capita wage income in rural areas. The share in the wage income of the rural food insecure amounts to about 16 percent on a per capita basis. This group mainly consists of rural, usually land-poor, workers.

Among both the food secure and the food insecure, agricultural production is often consumed at home rather than sold on the market, with the exception of qat. Table 13 reveals no significant differences in the relative patterns of agricultural income generation between food-secure and food-insecure people. Yemen's agriculture is dominated by food production for home consumption. Almost half of the total per capita value generated by agriculture and fishery does not leave the producing household, which demonstrates the low productivity of farmers and reduces the potential for adding value to the agricultural sector by processing and marketing. Qat is the only marketed crop that contributes a significant share of overall income. Sales of the stimulating leaves make up almost one-fourth of the total per capita value generated by agriculture and fishery in Yemen, with a slightly higher contribution to the income of food-insecure people in rural areas compared with their food-secure counterparts (25.7 percent versus 24.1 percent).

Considerable differences in agricultural and fishery income generation exist across regions and between the food secure and the food insecure. In accordance with agricultural production conditions, agricultural and fishery income patterns differ considerably across the agroecological zones and especially with respect to marketed products (Table 13). Per capita income from qat production accounts for about 30 percent of the total agricultural value generated in the Lower Highlands and Upper

Highlands zones, and in the Lower Highlands other cash crops, mainly fruits, generate significant income shares as well. Naturally, in the coastal regions comprising the Red Sea and Tihama zones and the Arabian Sea Zone, fishery makes up the highest share of agricultural income, accounting for about 20 percent and 30 percent, respectively. In the Red Sea and Tihama zones, home consumption of food is relatively low, and agricultural income sources are more diverse. The lowest home consumption of food appears in the Desert Zone, where fruits (grown in oases) and livestock production, in particular, are important income sources within the agricultural sector. In the Internal Plateau Zone livestock production is an important income source, contributing almost one-fourth to the agricultural value generated per capita. Table 13 also shows that a significant share of the agricultural income among the food insecure living in urban areas (located along the coasts) is generated from fishing, which is 10 percentage points higher than the share generated by their food-secure counterparts, and underscores how many urban fisher households are food insecure. In a similar manner, this holds true for livestock-raising households living in rural areas, especially in the Internal Plateau and Desert zones.

Remittances are an important source of income for all groups, especially for rural food-insecure people. Table 11 shows that the average household receives about 8 percent of its annual per capita income from income transfers; the average share among the rural population and among the food-insecure population is slightly higher (9 percent each). Table 14 reveals that most of this income comes from remittances. Remittances account for 80.8 percent of the income transfers to the rural food insecure and 78.8 percent to the rural food secure. Most of these income transfers are coming from family members in the Gulf States. This indicates that higher remittances, for example, through education programs and worker-exchange programs with neighboring countries, can play an important role in improving food security. The biggest share of social transfer payments comes from pensions, which mainly benefit the urban and food-secure population.

**Table 13. Total annual value generated per capita by agricultural production and fishery (in 1,000 riyals) and sources of agricultural production value generated (percentage of total)**

| | *Total* *(riyals)* | Home consumption* (percent) | Cereals (percent) | Qat (percent) | Other cash crops (percent) | Other crops (percent) | Livestock (percent) | Fish (percent) |
|---|---|---|---|---|---|---|---|---|
| **All** | ***26.39*** | **47.3** | **2.3** | **23.3** | **9.4** | **4.4** | **8.5** | **4.7** |
| Residence | | | | | | | | |
| Urban | *12.50* | 51.8 | 1.4 | 15.1 | 8.0 | 5.7 | 5.0 | 13.1 |
| Rural | *31.45* | 46.6 | 2.4 | 24.5 | 9.7 | 4.3 | 9.1 | 3.5 |
| Food security status | | | | | | | | |
| Food secure | *28.78* | 47.4 | 1.9 | 22.8 | 10.5 | 4.5 | 7.2 | 5.6 |
| Food insecure | *20.69* | 46.9 | 3.4 | 24.9 | 5.9 | 4.2 | 12.8 | 1.8 |
| Residence & food security status | | | | | | | | |
| Urban food secure | *13.04* | 51.4 | 1.4 | 15.8 | 8.3 | 5.9 | 4.7 | 12.5 |
| Urban food insecure | *7.64* | 58.3 | 1.6 | 4.0 | 2.4 | 2.9 | 8.3 | 22.5 |
| Rural food secure | *36.90* | 46.6 | 2.0 | 24.1 | 10.9 | 4.2 | 7.7 | 4.4 |
| Rural food insecure | *21.99* | 46.5 | 3.4 | 25.7 | 6.0 | 4.3 | 13.0 | 1.1 |
| Agroecological zones | | | | | | | | |
| Lower Highlands | *33.26* | 44.1 | 1.6 | 31.4 | 17.3 | 1.8 | 3.9 | - |
| Upper Highlands | *24.76* | 55.1 | 1.5 | 29.9 | 2.1 | 2.1 | 9.2 | 0.1 |
| Red Sea & Tihama | *29.68* | 35.6 | 4.8 | 2.0 | 11.0 | 13.3 | 13.3 | 20.1 |
| Arabian Sea | *18.32* | 46.2 | 3.5 | 0.5 | 6.9 | 7.3 | 4.4 | 31.2 |
| Internal Plateau | *11.86* | 53.0 | 3.6 | 0.8 | 3.3 | 15.0 | 24.3 | - |
| Desert | *23.44* | 23.2 | 3.9 | 8.2 | 36.9 | 2.7 | 25.1 | - |

Source: IFPRI estimation based on 2005–2006 HBS data.

Note: * Home consumption includes food and other agricultural in-kind transfers received.

**Table 14. Total annual income transfers per capita (in 1,000 riyals) and source of income transfers (percentage of total)**

| | *Total* (*riyals*) | **Pension** (**percent**) | **National cash assistance*** (**percent**) | **Other support**** (**percent**) | **Remittances** (**percent**) |
|---|---|---|---|---|---|
| **All** | *7.85* | **16.9** | **5.3** | **1.9** | **75.9** |
| Residence | | | | | |
| Urban | *11.62* | 25.2 | 2.9 | 1.5 | 70.4 |
| Rural | *6.47* | 11.5 | 6.9 | 2.1 | 79.5 |
| Food security status | | | | | |
| Food secure | *8.50* | 18.6 | 4.9 | 1.6 | 74.9 |
| Food insecure | *6.29* | 11.4 | 6.7 | 2.7 | 79.2 |
| Residence & food security status | | | | | |
| Urban food secure | *11.97* | 25.2 | 2.7 | 1.5 | 70.6 |
| Urban food insecure | *8.55* | 25.0 | 5.5 | 1.6 | 68.0 |
| Rural food secure | *6.71* | 12.6 | 6.9 | 1.7 | 78.8 |
| Rural food insecure | *6.06* | 9.5 | 6.9 | 2.9 | 80.8 |
| Agroecological zones | | | | | |
| Lower Highlands | *8.80* | 16.9 | 4.1 | 1.0 | 78.0 |
| Upper Highlands | *6.88* | 14.5 | 5.9 | 2.0 | 77.5 |
| Red Sea & Tihama | *4.67* | 5.0 | 8.5 | 2.5 | 84.0 |
| Arabian Sea | *15.30* | 36.8 | 3.4 | 2.4 | 57.5 |
| Internal Plateau | *10.63* | 9.6 | 5.3 | 2.4 | 82.7 |
| Desert | *3.92* | 4.5 | 14.9 | 9.3 | 71.3 |

Source: IFPRI estimation based on 2005–2006 HBS data.
Notes: * National cash assistance includes cash assistance from the Social Security Fund, the Social Welfare Fund, and the Fund for Promotion of Agricultural and Fishery Production and from the general authority for martyr families.
** Other support includes cash assistance and in-kind support from international and local social programs, the Medicine Fund for the Disabled and Chronic Sick, tribal authorities, and charity organizations

Public social income transfers are not well targeted toward the food insecure, particularly in rural areas. According to the HBS data, total public fund assistance amounts to about 8.7 billion Yemeni riyals per year. Almost 80 percent of all public assistance funds go to rural areas; however, the rural food insecure receive less than about 30 percent of the total. On a per capita basis assistance to the rural food secure averages about 460 riyals and only 420 riyals to the rural food insecure annually. The share is particularly low for the Agriculture and Fishery Fund, where more than 80 percent of the fund benefits the food secure.

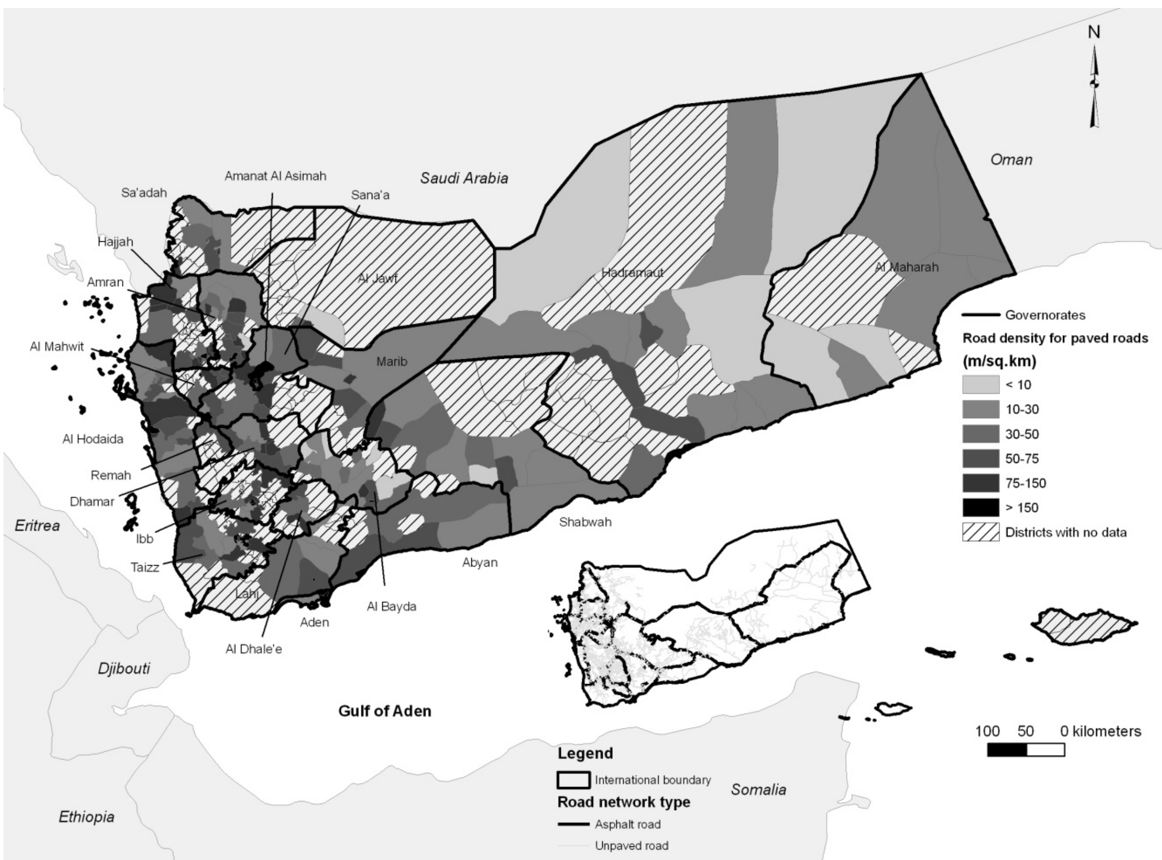
### 4.2. Trade and Transportation

Yemen will increasingly rely on international markets for food imports, so effective and efficient mechanisms have to be found to ensure a steady supply, even in times of global crisis. Managing future food price shocks to ensure sufficient food at affordable prices will become more challenging and require strategic choices about securing access to food through a mix of domestic investments (for physical food stocks) and taking advantage of international markets (through trade agreements and hedging) or innovative mechanisms (such as virtual reserves). The best options are international solutions, such as agreements with the World Trade Organization (WTO) to ensure that food importers are not allowed to limit their exports in times of crisis (such as happened in Vietnam and India during the last food crisis).

Other options include international reserves to cushion future price shocks. However, reviewing options for increasing physical grain stocks at the regional or national level is also important. Information about the physical storage capacity and management of these stocks in Yemen is scarce. Nonetheless, there are concerns that storage capacity is too low. The country has only six silos; these can hold grains for about two months of demand. In addition, there is a feeling that the private sector did not perform well during the last food crisis, when prices skyrocketed in the local market. Improved risk management can also help avoid the large price fluctuations for cereals that are common in Yemen. This in turn will help both producers and consumers of cereals.

The primary transportation method in Yemen is trucking. Paving increased from 961 kilometers in 1978 to more than 6,000 kilometers n 2008, and Yemen has 32,000 kilometers of feeder roads. The expanded road network in the highlands—built first in the 1970s and 1980s with the support of remittances from immigrant workers and later by intense government efforts—transformed local economies. Small commercial centers sprang up along paved roads in secondary towns, turning weekly makeshift barter-based markets into permanent businesses. This contributed to the growth of secondary towns, generating a local economy that was directly tied to nearby villages. The density of the roads, estimated at about 100 meters per square kilometer, is still a low coverage rate (see Figure 17).

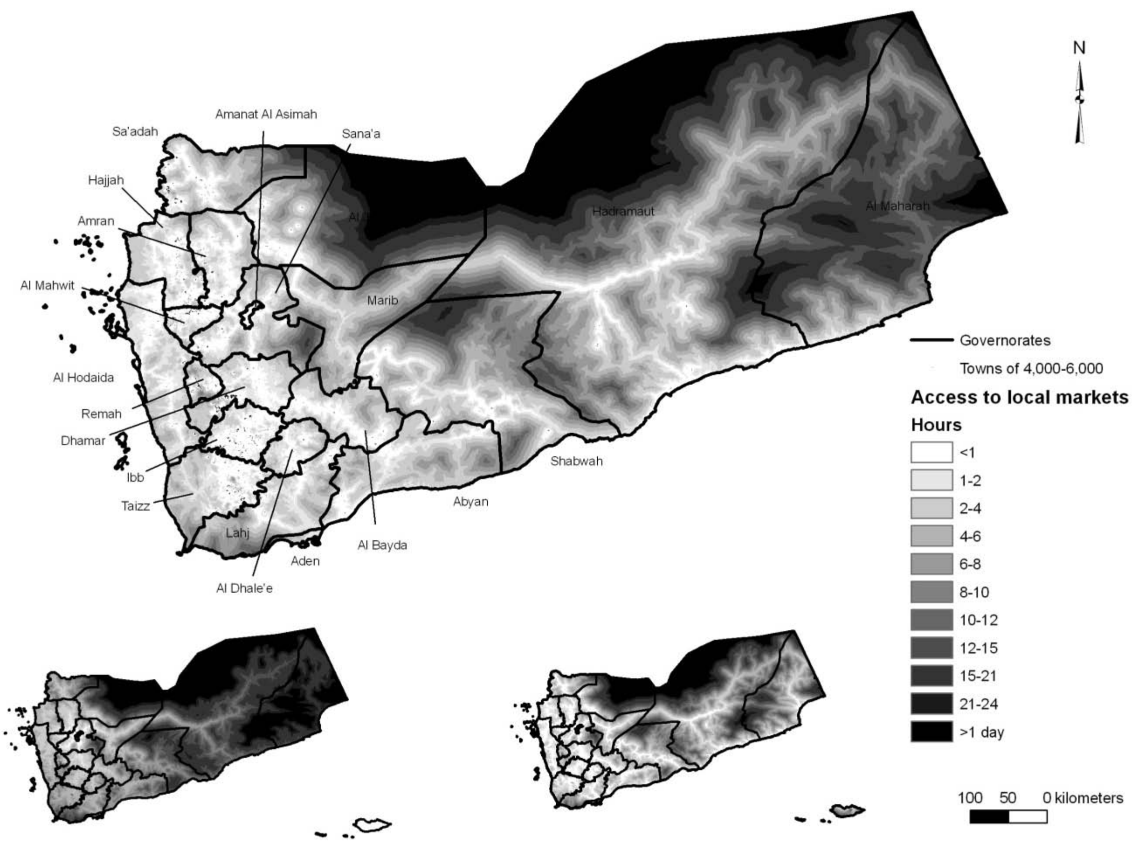
**Figure 17. Road network and road density**




Source: Yemen Food Security Atlas (2010).

Access to markets is important for food security, both for consumers and producers. Figure 18 shows estimated travel times based on a model that considers the average time it takes to travel by motor vehicle on roads of different types, considering steepness of terrain as a modifying factor. Off-road travel is considered to be by foot and is modeled on the basis of dominant land cover type, as well as steepness of local terrain. Travel time from a farm/production location to predefined market hubs/cities of a certain size (viable ports, urban centers, and local markets) is an indicator of access to market opportunities or the economic well-being of a community.[9] In addition, travel time can serve as a measure that effectively links population distribution with transport infrastructure and terrain characteristics.

**Figure 18. Market access measured in travel time (minutes)**




Source: Yemen Food Security Atlas (2010).

Market supply chains are often inefficient, and transaction costs are high. One example of an efficient supply chain is the qat market. The qat chain is a showcase example of a demand-driven, well-coordinated value chain. Lead times are short (usually less than one day), the chain actors are specialized, and the chain features long-term business relations (of about 8 to 12 years). The farmers get most of the added value in the chain, but traders operate with sound gross margins. The chain actors provide credit to one another and coordinate closely on quality grades and production volumes. The quality grading system is consistently applied from farmer to consumer, and all chain actors are well aware of consumer demands. All in all, the experience in the qat chain may provide a culturally embedded model of value chain development for Yemen.[10]

Access to local markets and urban centers is more difficult for rural households and food-insecure households. According to IFPRI estimates, the average travel time to a local market is 96 minutes (Table 15). It takes an average urban household 73 minutes and a rural household 105 minutes to reach a local

[9] See Appendix 7 for more information about the spatial analysis of travel time.

[10] Paragraph is adapted from p. 113 of the draft of May 2009 report by the Small Micro Enterprise Promotion Service and the Royal Tropical Institute for the World Bank's Rural Development Team. The report analyzes five agricultural value chains in Yemen (fish, honey, coffee, wheat, and qat).

market. For rural households travel time to the nearest urban center averages more than two hours. Food-insecure households generally need to travel 10 to 20 minutes more to reach the nearest local market or urban center. Obviously, distances traveled are the greatest in the Desert Zone, where an average trip to a local market or urban center takes more than eight hours. Average travel time is the shortest in the Upper Highlands, where the capital is located, and along the Red Sea and Tihama Plain.

**Table 15. Travel time to local markets and urban centers**

| | Travel time (in minutes) to the nearest | |
|---|---|---|
| | **local market** | **urban center** |
| **All** | **96** | **124** |
| Residence | | |
| Urban | 73 | 60 |
| Rural | 105 | 150 |
| Food security status | | |
| Food secure | 92 | 115 |
| Food insecure | 107 | 149 |
| Residence & food security status | | |
| Urban food secure | 73 | 58 |
| Urban food insecure | 75 | 81 |
| Rural food secure | 103 | 146 |
| Rural food insecure | 111 | 156 |
| Agroecological zones | | |
| Lower Highlands | 59 | 66 |
| Upper Highlands | 76 | 131 |
| Red Sea & Tihama | 105 | 98 |
| Arabian Sea | 163 | 153 |
| Internal Plateau | 167 | 254 |
| Desert | >480 | >480 |

Source: Yemen Food Security Atlas (2010).

## 4.3. Agriculture and Water

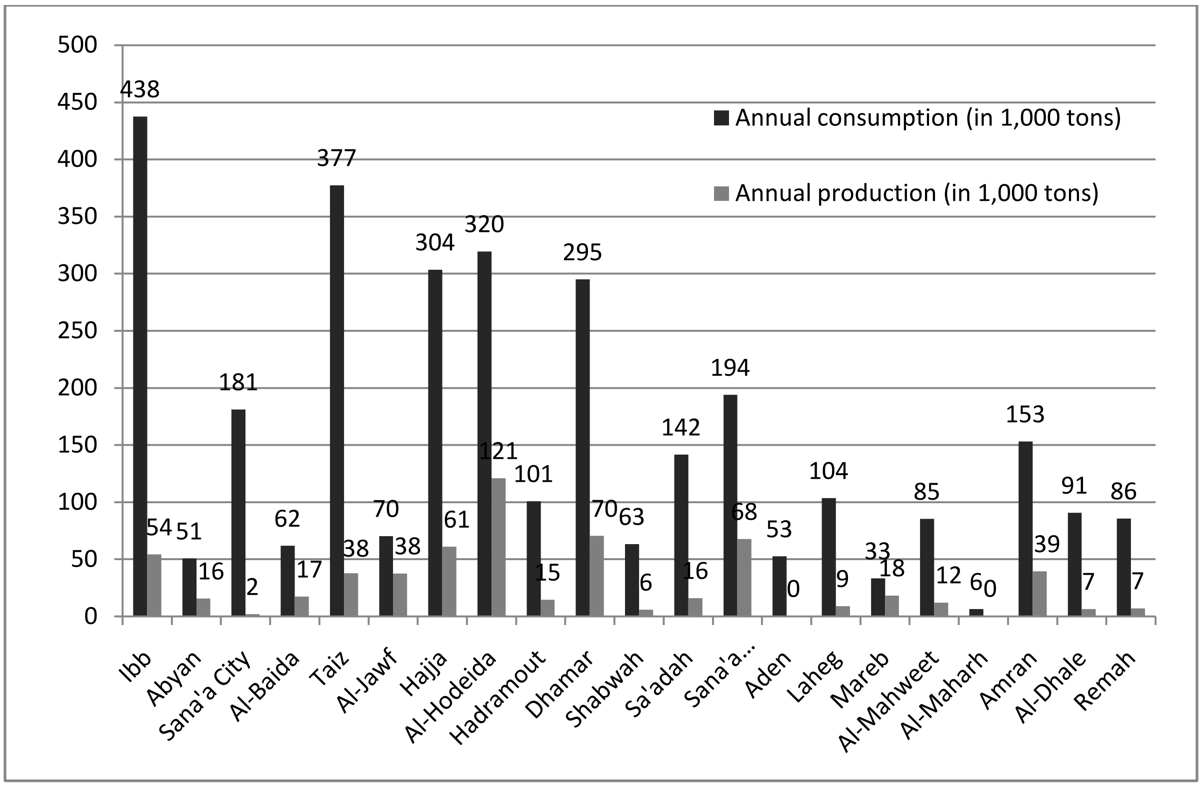
### *4.3.1. Agriculture, Irrigation, and Drinking Water*

The agricultural sector contributes to food security on the macro- and household levels. However, agricultural production is heavily dependent on the availability and efficient use of natural resources—mainly land and water—and therefore constrained by nature, unlike production in other sectors. The agricultural sector competes for limited resources—usually groundwater—with other sectors such as manufacturing, and services (for example, tourism). The sectors also compete for drinking water. Within the agricultural sector food production and nonfood cash crops (mainly qat) compete for water and fertile land.

Yemen imports about 70 percent of all cereals, and its dependence on imports is likely to increase in the future. Figure 19 illustrates Yemen's large negative cereal balance. According to the 2005–2006

HBS, the total annual cereal consumption of the Yemeni population is 3.2 million tons, of which only about 600,000 tons are locally produced.[11] In other words, only about 19 percent of cereal consumption is met by local production. In all governorates cereal consumption is higher than production, so all governorates are net cereal importers. Even the population in the governorate with the highest cereal production, which is Al-Hodeida, consumes more than 2.5 times more cereal than it produces. Moreover, the high food insecurity means the demand for cereals is not met. For example, to supply the current Yemeni population with enough calories from wheat flour to meet its physiological requirements, the country would have to import 4.9 million tons of wheat every year, or about 13 times the total cereal production today.

**Figure 19. Cereal consumption and production by governorate (in thousand tons)**

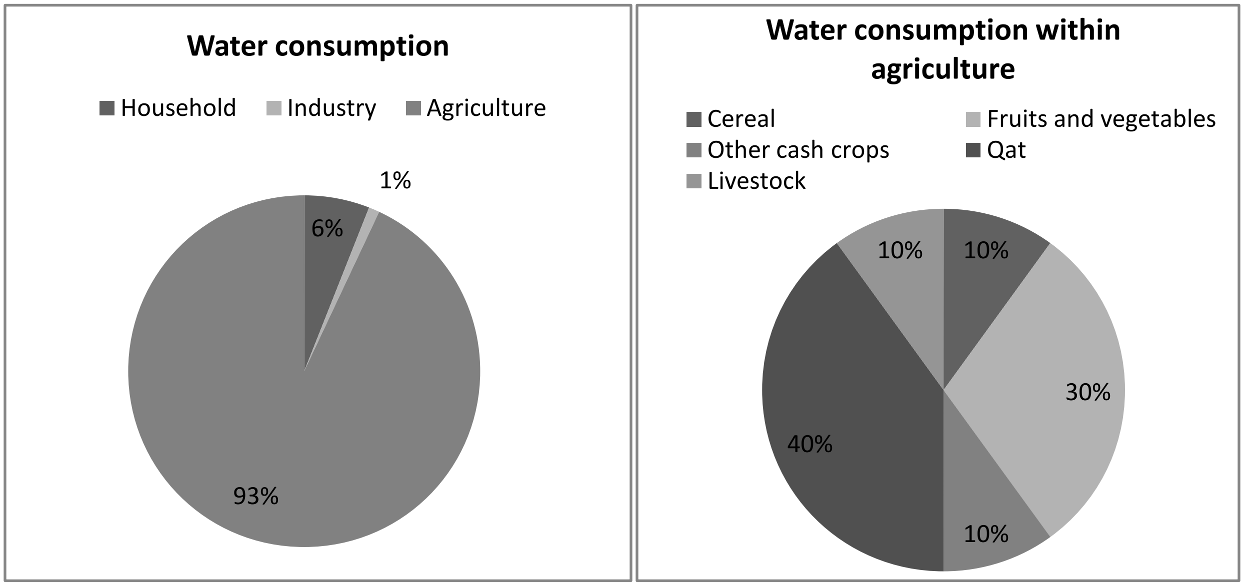



Source: IFPRI estimation based on 2005–2006 HBS data and Yemen, Ministry of Agriculture and Irrigation (2008).

Agricultural production uses 93 percent of all water in Yemen, often in an unsustainable way (Figure 20). The remaining 7 percent of water is used by households (6 percent) and industry (1 percent). About half the agricultural land in Yemen is rain fed and an additional 10 percent of land is directly dependent on rainfall through flood irrigation. The remaining 40 percent of agricultural land is irrigated from different sources, mainly groundwater wells (Figure 20).

[11] The estimate of total annual production is based on a five-year production average from 2003 to 2007, calculated from data in the *Agricultural Statistical Yearbook* (MOAI 2006, 2007).

**Figure 20. Water use by sector and agricultural subsector**




Source: IFPRI, based on Sheba Centre for Strategic Studies (chart at left) and Dr. A. Mukred, Water Sector Support Program (charter at right).

More than 75 percent of irrigated land uses groundwater for irrigation, contributing to rapidly falling water tables. Most land under irrigation is planted with qat, followed by cereals and vegetables (Table 16). Government subsidies for purchasing irrigation pumps and diesel have been a main cause of the overuse of groundwater. In addition, the low-cost fuel has encouraged traders to extract water and transport it to distant regions, often to irrigate qat plantations. Water transported by truck is used on 2.3 percent of all irrigated land, a percentage that likely has increased since the 2001–2002 census (CSO 2004). The second-largest water source for irrigated land is floods, followed by streams.

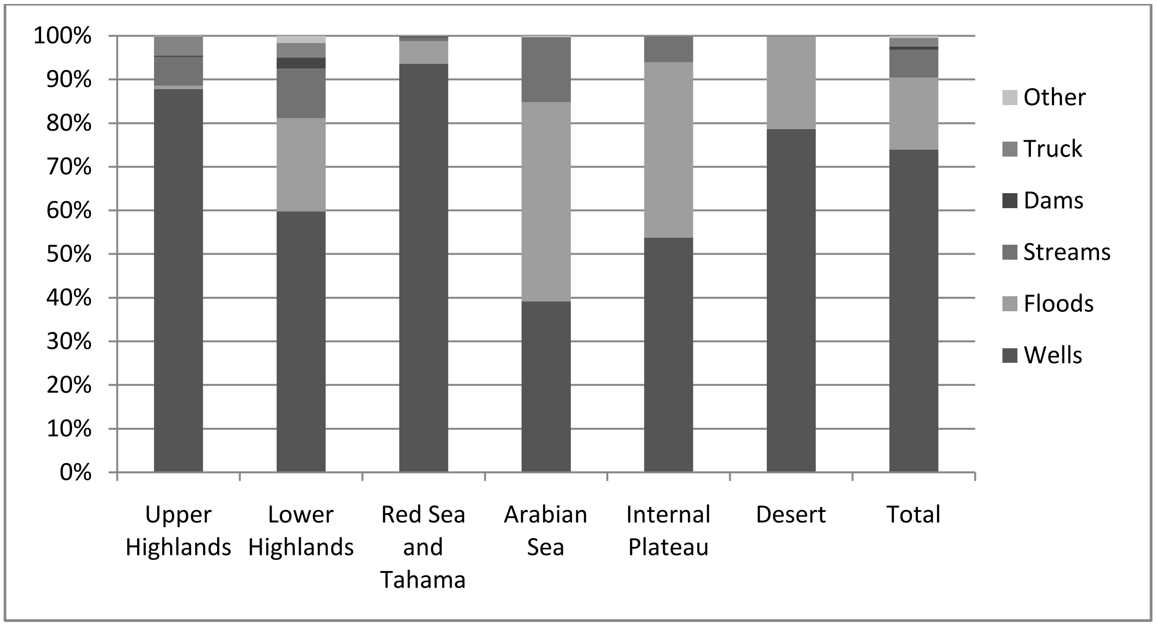
**Table 16. Sources of irrigation by crop and source**

| | Wells | Floods | Streams | Dams | Truck | Others | Total |
|---|---|---|---|---|---|---|---|
| Cereals | 18.4 | 6.8 | 1.7 | 0.2 | 0.0 | 0.0 | **27.2** |
| Qat | 19.3 | 0.2 | 0.6 | 0.5 | 2.1 | 0.4 | **23.1** |
| Vegetables | 16.2 | 0.8 | 0.6 | 0.0 | 0.1 | 0.0 | **17.7** |
| Fodder | 9.3 | 3.7 | 0.4 | 0.0 | 0.0 | 0.0 | **13.4** |
| Trees | 13.1 | 0.5 | 2.1 | 0.0 | 0.1 | 0.0 | **15.8** |
| Other | 1.5 | 1.3 | 0.1 | 0.0 | 0.0 | 0.0 | **2.8** |
| **Total** | **77.7** | **13.3** | **5.5** | **0.8** | **2.3** | **0.5** | **100.0** |

Source: IFPRI estimation based on 2001–2002 agricultural census data.

Groundwater wells dominate irrigated land in most agroecological zones, especially in the Upper Highlands. Almost 90 percent of the irrigated land in the Upper Highlands is irrigated by wells. This is particularly alarming since the region's water tables are falling rapidly, the population is growing rapidly, especially in Sana'a, and qat production and consumption are especially high (Figure 21). Moreover, water is brought to the region by truck for qat irrigation, despite the drinking water scarcity. Flood irrigation is an important method of supplying water to crops in the Lower Highlands, Arabian Sea Zone, and the Internal Plateau Zone, yet in most cases crops are irrigated with groundwater; flood irrigation is used more often than groundwater irrigation only in the Arabian Sea Zone.

**Figure 21. Sources of irrigation by agroecological zones**




Source: IFPRI estimation based on 2001–2002 agricultural census data.

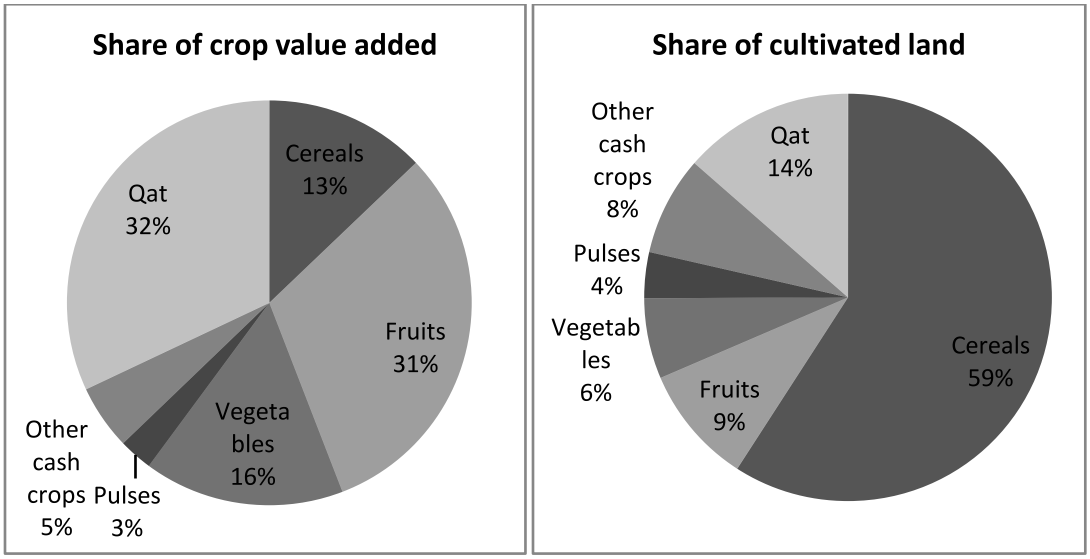
Agricultural growth has been volatile, and food production on a per capita basis has not increased in recent years. While total annual growth in agriculture averaged 3.0 percent in 2000–2006 (Yemen, Ministry of Agriculture and Irrigation 2009), continued rapid population growth has meant no agricultural growth on a per capita basis. Moreover, annual agricultural growth has been less than 1 percent since 2004, which further underlines the big challenges facing agriculture in Yemen. Major challenges include the sector's high dependence on rainfall and the generally harsh natural conditions.

Agricultural growth potential from land expansion is limited, and water is the key constraint, yet relatively low yield levels suggest that the potential exists for productivity-led growth using the most water-efficient crops. Agricultural land area in Yemen is estimated at 1.3 million hectares, or 2.0 percent of the land area. Total cultivated areas have not increased significantly since 1970, ranging from 1.1 to 1.3 million hectares depending on rainfall. Moreover, traditional forms of agriculture are often in decline, including water-harvesting techniques and agricultural terraces. At the same time land productivity is also falling because of salinization and soil erosion. Yemen's yields are significantly lower than those of neighboring countries, which suggests there is potential for productivity-led agricultural growth. For example, yields for cereals are less than half the average of other Middle Eastern countries' (FAO 2009b).

Diversifying agricultural production can also lead to increased incomes and greater food security, especially in rural areas. The differences between certain crops in terms of their share in agricultural value added reflect higher returns for fruit and vegetables (Figure 22). This suggests the potential for export-led growth of the agricultural sector if land devoted to staples and qat is devoted to export crops. However, unsustainable incentives (such as the fuel subsidy) and scarce water resources call for careful analysis of the tradeoffs between export-led and consumption-led agricultural growth. Export of agricultural products, especially of vegetables and fruits, essentially means an export of water. Today fruits consume about 30 percent of the available water, while cereal production uses only 10 percent of it. In addition, while the percentage of land under cereal cultivation declined from 85 percent in 1970 to 61 percent in

1996, it has remained constant since, suggesting that the potential for additional fruit and vegetable production might be limited.

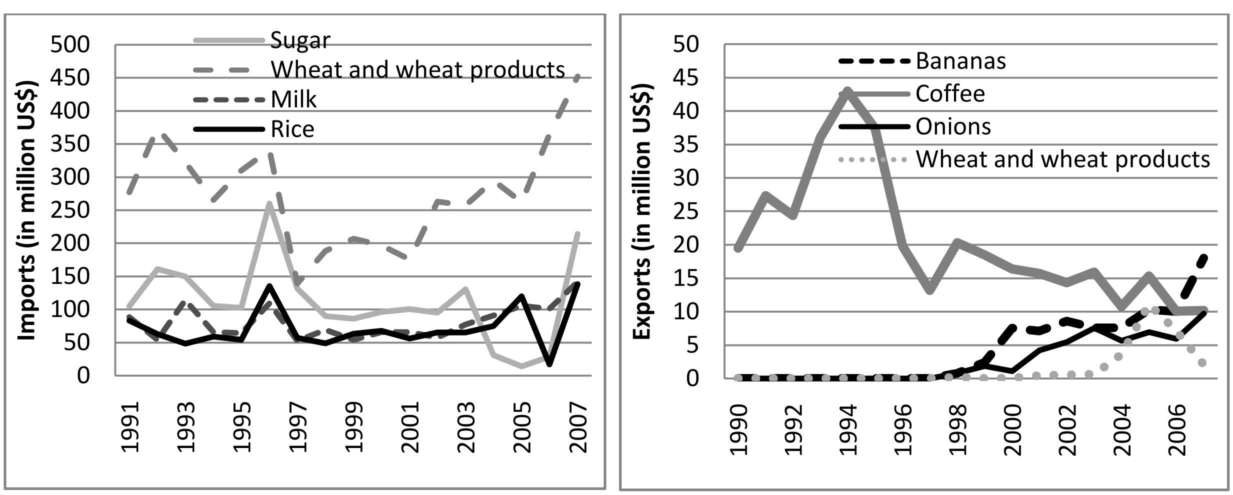
**Figure 22. Agricultural production in 2007**




Source: IFPRI estimation based on Yemen, Ministry of Agriculture and Irrigation (2008).

Water-intensive agricultural exports, especially of bananas and vegetables, have increased since 2000. While traditional exports such as coffee steadily declined in the same period, there is growing concern that Yemen exports its scarce water resources in the form of bananas and other fruits and vegetables (Figure 23). In fact, Table 17 shows that most land where vegetables are grown is irrigated. Moreover, the vast majority of this land is irrigated from groundwater wells, a particularly unsustainable use of water. Therefore banana and vegetable production seems to contribute directly to falling groundwater levels.

**Figure 23. Changes in food export and import composition, 1990–2007**

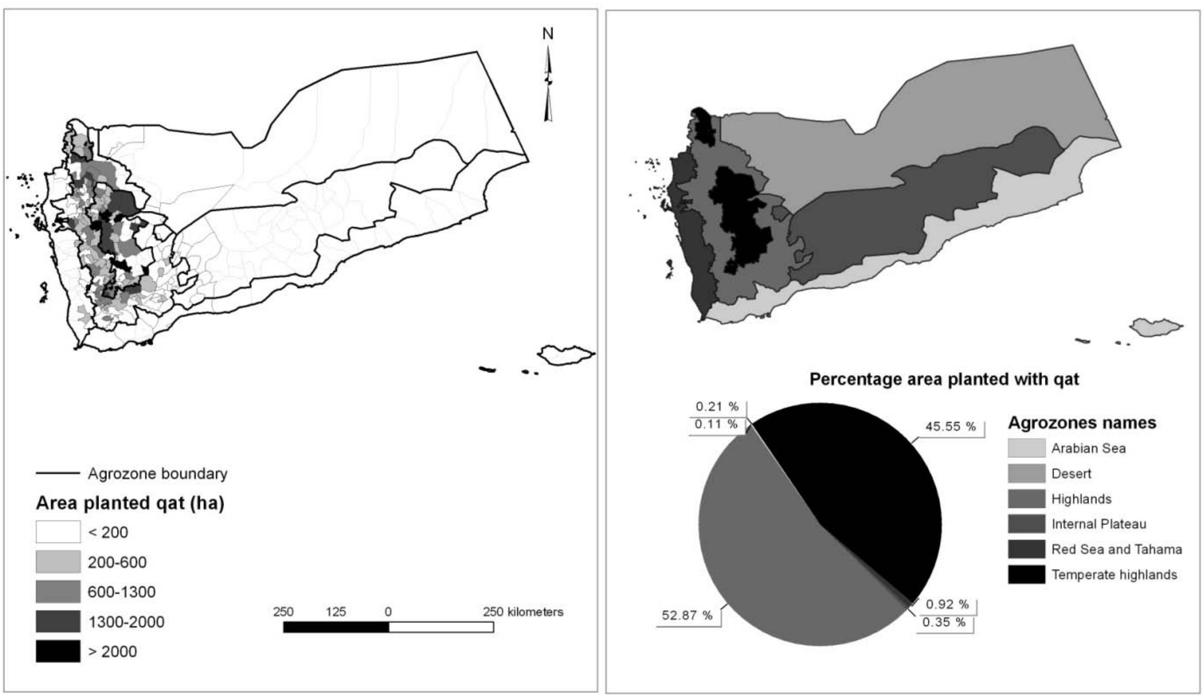



Source: IFPRI estimation based on World Bank (2009), FAO (2009 b), and Yemen, Ministry of Agriculture and Irrigation (2009).

Because current agricultural water use is unsustainable and will have to be reduced, more efficient use of water is a key for improving agricultural production. Historically, water has been managed sustainably, but water use has far outstripped renewable supply in recent years mainly because of the rapid population increase and irrigation expansion. In 1970 only 3 percent of the total arable land was irrigated with wells; by 2003 this had increased to 37 percent (CSO 2004). Annual water consumption is about 3.2 billion cubic meters, which is almost 30 percent more than the renewable water supply. In addition, irrigation likely has to be reduced in the future to satisfy the increasing demand from residential and industrial sectors. Despite these probable reductions, experts agree Yemen could use its water more efficiently and thus maintain or even increase agricultural production with less water.

In addition, reducing qat production has the potential to free up substantial water and land resources for alternative uses. Qat is the most profitable and widespread cash crop in Yemen, especially in the highlands. The crop contributes to almost one-third to agricultural value added. Conservative estimates find that 40 percent of all water is used for qat production; the actual water use might be even much higher. As Figure 24 shows, large qat production areas tend to be close to urban centers because consumers require that their qat be fresh. However, efforts to reduce qat production face substantial challenges, such as resistance from qat farmers, consumers, and the extensive network of traders and other people involved in the qat business.

**Figure 24. Land allocation for qat production**




Source: IFPRI estimation based on 2002 agricultural survey data.

Although about half the farmland in Yemen is irrigated, only 30 percent of households have access to irrigation. This reflects the unequal distribution of land among households and how relatively few households have access to irrigated land. The majority of farmers work on extremely small plots with no irrigation. Seventy percent of all households with land have less than 0.5 hectares. In the temperate highlands zones farmers are most likely to have access to irrigated land, because half of farming households are able to link to a canal or other irrigation infrastructure.

The majority of agricultural households have access to land, a key issue for food security. On average 80 percent of agricultural households in Yemen have access to farmland, and 68.2 percent own some farmland (Table 17). However, this figure disregards the size and quality of the farmland and focuses only on households that receive more than 30 percent of their income from agriculture. About three-quarters of rural households own at least one plot of farmland, and 84.2 percent of rural households have access to land. Food-secure households report slightly higher land accessibility and ownership, by about two percentage points. The proportion of households having access to farmland is highest in the highlands and desert, where more than 80 percent of households have access to land. Land ownership is the highest in the Desert and Lower Highlands zones. More than 75 percent of households in both zones own at least one plot of farmland.

**Table 17. Land access and access to agricultural services among agricultural households**

| | Access to land (percent) | Land ownership (percent) | Access to irrigation (percent) | Access to extension service (percent) |
|---|---|---|---|---|
| All | 79.9 | 68.2 | 30.0 | 3.2 |
| Urban | 29.7 | 23.8 | 23.8 | 2.9 |
| Rural | 84.2 | 72.0 | 30.5 | 3.2 |
| Food secure | 80.5 | 68.8 | 29.8 | 3.5 |
| Food insecure | 78.6 | 66.8 | 30.4 | 2.7 |
| Agroecological zones | | | | |
| Lower Highlands | 84.8 | 75.2 | 47.7 | 3.3 |
| Upper Highlands | 83.0 | 69.1 | 24.3 | 2.9 |
| Red Sea & Tihama | 76.0 | 65.0 | 23.5 | 3.1 |
| Arabian Sea | 33.2 | 31.1 | 12.4 | 4.4 |
| Internal Plateau | 52.7 | 47.0 | 20.2 | 6.6 |
| Desert | 81.3 | 76.0 | 73.2 | 4.2 |

Source: IFPRI estimation based on 2005–2006 HBS data.
Note: Sample includes households with farm income that amounts to 30 percent or more of total household income.

Despite subsidies, fuel is the most expensive item in crop production, as nearly one-third of crop production expenditures are used to purchase fuel. This ratio is the highest in the desert (56 percent) and lowest in the dry highlands (19 percent). Irrigation is also a significant part of cost structure. The percentage spent on irrigation is the highest in the Upper Highlands (27 percent) and lowest in the Internal Plateau (less than 0.1 percent) and the desert (0.4 percent), where irrigation is seldom practiced.

Hired labor in agriculture is common, accounting for 21 to 44 percent of production costs. A close inspection of production costs reveals that hired labor accounts for about one-quarter of crop production costs. The average rural household spends 21 percent of its total production costs on hired labor. The cost share of hired labor is more than 20 percent in all zones except the desert, where only 3.5 percent of crop production cost is associated with hired labor.

Food-insecure farm households use fewer modern inputs such as fertilizer, pesticide, and improved seeds. The HBS shows that fertilizer accounts for about 9 percent of crop production costs. This percentage is lower among food-insecure households, at about 8 percent. Pesticides are also a big item, using more than 10 percent of the crop production budget. Rural households tend to allocate more resources to fight pests and diseases (equivalent to 11 percent in rural areas versus 6 percent in urban areas). Cost of seeds is relatively small in the crop cost structure, accounting for 7 percent. Fertilizer as a percentage of crop production costs is the highest in the Lower Highlands (11 percent), and the percentage allocated to pesticide is highest in the Upper Highlands (15 percent). Households in both coastal zones report high seed costs, more than 10 percent of the production costs. On the other hand, the average farmer in the Desert Zone spends the majority of costs on fuel and little on modern inputs such as fertilizer, pesticide, or improved seed. That reflects the focus on livestock production in that zone.

Irrigation is another important component of the cost structure for crop production. The average Yemeni household spends 16 percent of its crop production budget for irrigation. This percentage does not correlate with access to irrigation. For example, in the Desert Zone, where 45 percent of households have access to irrigation, the cost of water for irrigation represents only 0.4 percent of crop cost. The situation is similar in the Internal Plateau, indicating that the cost of accessing water in these areas is relatively low. In the highlands and Arabian Sea zones, accessing water constitutes a significant part of crop cost. That's because irrigation competes with other uses for water in those zones, where water is generally scarce and becoming scarcer because of falling groundwater tables.

Agricultural extension services are extremely limited in Yemen, with only 3.2 percent of agricultural households reporting access to them. Although agricultural extension is an important service and an important element in raising farm productivity, only 3.2 percent of rural farm households receive any type of extension services (Table 17). Even in the Internal Plateau Zone, where agricultural extension services are most accessible, only 6.6 percent of households receive extension services. Food-insecure farm households are less likely than food-secure households to have access to agricultural extension services.

The link between improved access to clean drinking water and food security is strong. Yemeni settlements are often poorly provided with safe water and sanitation services. Clean and safe drinking water is essential for reducing the transmission of water-borne diseases, and proper sanitation ensures that people avoid contact with feces. This is especially important for children's health. Bad hygienic conditions increase the risk of infection with diseases that can harm people's nutritional status. Modern techniques to provide access to safe water are therefore important. Traditional techniques for storing water can also be an important tool for providing more access to safe water.

Most people have no access to a network water supply. Table 18 shows that only 40.9 percent of the Yemeni population is connected to public, cooperative, or private water networks. Many people do not have water on a regular basis, a result of water scarcity and insufficient functioning of the networks. There is a large gap in water availability between urban and rural areas: 77.0 percent of the population in urban areas and only 25.9 percent in rural areas are connected. The food-insecure people in urban areas are less likely to be connected than their food-secure counterparts; the coverage among the food insecure is lower by 10 percentage points. There is no significant difference in water access for the food secure and the food insecure; the coverage in rural areas is generally low.

**Table 18. Access to water network and sewage system**

| | Percentage of households connected to the water network | Percentage of households connected to the sewage system |
|---|---|---|
| **All** | **40.6** | **15.9** |
| Residence | | |
| Urban | 77.0 | 53.9 |
| Rural | 25.9 | 0.6 |
| Food security status | | |
| Food secure | 44.3 | 19.8 |
| Food insecure | 30.3 | 5.0 |

**Table 18. Continued**

| | Percentage of households connected to the water network | sewage system |
|---|---|---|
| Residence & food security status | | |
| Urban food secure | 77.8 | 54.9 |
| Urban food insecure | 68.0 | 44.0 |
| Rural food secure | 25.7 | 0.4 |
| Rural food insecure | 26.4 | 1.0 |
| Agroecological zones | | |
| Lower Highlands | 54.6 | 26.6 |
| Upper Highlands | 20.9 | 7.3 |
| Red Sea & Tihama | 42.1 | 5.3 |
| Arabian Sea | 84.3 | 57.9 |
| Internal Plateau | 69.6 | 9.6 |
| Desert | 24.5 | 0.1 |

Source: IFPRI estimation based on 2005–2006 HBS data.

More than one-third of the population and about half the food insecure suffer from water scarcity. According to the HBS, 37.0 percent of the Yemeni population suffers from water scarcity. Supplying the population is more of a problem in urban areas than in rural areas. In urban areas 38.6 percent of the population is short of water, and 36.4 percent is short in rural areas. The urban food insecure suffer especially from water shortages; almost half (46.9 percent) are short of water. There is no significant difference in water scarcity for the food secure and food insecure in rural areas.

Treating water to make it potable is not common. The HBS data show that 13.4 percent of the population treats its own drinking water. Water treatment is more common in cities, where 38.3 percent of the population, treats its water, but only 3.4 percent of the population treats water in rural areas. Because of a high risk of contamination, water treatment is particularly important in cities, especially when water is not coming through a safe network.

The sewage system is poorly developed and virtually nonexistent in rural areas. As Table 18 shows, only 15.9 percent of the Yemeni population is connected to the public wastewater system, and almost all are urban residents. The coverage rate amounts to 53.9 percent in urban areas and less than 1 percent in rural areas. Again, the coverage rate among the food secure is considerably higher than among the food insecure, who typically live in quarters with poor infrastructure.

### *4.3.2. Fishery*

The fishery sector contributes only about 1 percent to GDP; however, it plays an important role in local economies and personal incomes.[12] In 2008 about 73,400 people were directly employed in the sector, living in 129 fishing communities (Table 19). Fish processing and marketing employs additional people, creates value added, and is one of the promising sectors for future growth and prosperity. It is estimated that the fishery sector provides a livelihood for 642,000 people, or about 3 percent of the Yemeni population (GOPA Worldwide Consultants 2006).

[12] The average share of the fishery sector in GDP for 2006 and 2007 is reported, based on CSO (2008).

**Table 19. Fish production and trade**

| | Sea fishing in 2008 | Change from 2006 to 2008 (percent) | Average share (percent) |
|---|---|---|---|
| **Structure of fishing sector (numbers)** | | | |
| Fishermen | 73,444 | 2.7 | |
| Boats | 21,492 | 10.4 | |
| Fishing communities | 129 | 0.8 | |
| **Production (tons)** | **132,062** | **-24.2** | **100.0** |
| ***Industrial fishing*** | ***1,471*** | ***-47.5*** | ***2.3*** |
| Red Sea | 1,103 | -45.9 | 1.2 |
| Arabian Sea/Gulf of Aden | 368 | -51.6 | 1.0 |
| ***Small-scale fishing*** | ***41,850*** | ***-12.0*** | ***97.7*** |
| Al-Maharah | 28,986 | -46.2 | 37.0 |
| Hadramout | 34,642 | -15.0 | 22.1 |
| Al-Hodeidah | 25,113 | 6.0 | 13.2 |
| Abyan | 18,243 | 15.7 | 8.4 |
| Aden | 6,569 | -31.0 | 6.1 |
| Shabwah | 8,545 | -5.8 | 3.9 |
| Laheg | 1,872 | -54.8 | 3.1 |
| Taiz | 2,626 | -18.5 | 1.9 |
| Socotra lsland | 1,568 | -20.6 | 1.1 |
| Hajja | 2,427 | 30.5 | 0.9 |
| **Exports (tons)** | **97,957** | **-6.6** | **100.0** |
| Frozen fish | 44,293 | 43.7 | 32.7 |
| Fresh fish | 40,207 | 78.1 | 28.1 |
| Tuna | 2,262 | -32.2 | 7.8 |
| Other fish and fish products | 11,195 | -60.9 | 31.4 |

Source: Structure and production data from Yemen, Ministry of Fish Wealth (2009); export data from Yemen, Central Statistical Organization (2010).

Fish and fish products are the second-largest export product after oil and oil products; about half of all fish production is exported. However, total fish exports have decreased by about 7 percent since 2006, especially tuna and items in the "other fish and fish products" categories (Table 19). Exports of fresh and frozen fish have increased by about 30 percent each. Yet, it is widely acknowledged that, given Yemen's long coastline, fish exports and fish manufacturing have growth potential through more effective control of large-scale fishing activities, especially by foreign vessels. The Ministry of Fish Wealth estimates that Yemen could reach a fish production level of as much as one million tons annually, or about seven times its current levels.

Productivity in the fishery sector decreased sharply between 2006 and 2008, because of reduced production and an increase in the number of fishers and boats. Owner-operators of vessels account for 83 percent of fishers in Hadramout and Al-Maharh regions, 62 percent in Socotra, and 45 percent in Al-Hodeida. The average catch per boat per trip varies from 1,930 kg in Aden to 493 kg in Socotra. The number of trips per boat per year—a measure of fishing effort—ranges from 205 to 236; almost all are of one day's duration for a period of nine to 14 hours.

Small-scale fishing accounts for about 97 percent of total production; large-scale fishing fleets bring in only about 3 percent of the catch. Thus small-scale dominate the fishery sector in Yemen (Table 20). Tradition plays an important part in many fishing communities; more than 60 percent of the population in Socotra and Taiz works in the sector, either because fishers inherited the work from a family member or it is their preferred means of earning a living. In addition, a significant number of those interviewed who fish say they do so because they cannot find alternative employment. The industry is therefore an opportunity of last resort that may be perpetuated in future generations (GOPA Worldwide Consultants 2006).

Most fish caught by Yemenis come from the Arabian Sea. Only three governorates produce more than 70 percent of all fish in Yemen. Most fish are caught by people in Al-Maharh, followed by those in Hadramout and Al-Hodeida (Table 20). Other governorates with fishing activities are Abyan, Aden, Shabwah, Laheg, Taiz, and Hajjah.

More than half the fish eaten in Yemen is consumed in the Hadramout and Al-Hodeida governorates. On a per capita basis fish consumption is highest in the governorates with fish production. Al-Maharh tops the list, with an average per capita fish consumption of 33.5 kg per year (Table 20). Compared with this, the average consumer eats only 2.6 kg per year in Sana'a City, 1.4 kg in Dhamar, and 0.3 kg in Amran.

**Table 20. Fish production and consumption in Yemen**

| | **Per capita consumption** (kg/year) | **Total consumption** (tons/year) | **Total production** (tons/year) | **Balance** (percent) |
|---|---|---|---|---|
| **Total** | **5.2** | **107,915** | **176,429** | **38.8** |
| Al-Maharh | 33.5 | 2,812 | 66,775 | 95.8 |
| Hadramout | 17.8 | 18,321 | 41,885 | 56.3 |
| Al-Hodeida | 15.0 | 35,200 | 23,829 | -47.7 |
| Abyan | 10.5 | 4,867 | 15,211 | 68.0 |
| Aden | 11.0 | 6,116 | 11,014 | 44.5 |
| Shabwah | 10.3 | 5,504 | 7,098 | 22.5 |
| Laheg | 7.8 | 6,055 | 5,606 | -8.0 |
| Taiz | 3.3 | 8,156 | 3,350 | -143.5 |
| Hajja | 5.4 | 8,443 | 1,661 | -408.4 |
| Sana'a City | 2.6 | 4,173 | - | -100.0 |
| Dhamar | 1.4 | 2,070 | - | -100.0 |
| Ibb | 0.8 | 2,036 | - | -100.0 |
| Al-Mahweet | 2.1 | 1,047 | - | -100.0 |
| Al-Baida | 1.7 | 998 | - | -100.0 |
| Sa'adah | 0.8 | 636 | - | -100.0 |
| Al-Dhale | 1.1 | 566 | - | -100.0 |
| Amran | 0.3 | 273 | - | -100.0 |
| Remah | 0.5 | 218 | - | -100.0 |
| Mareb | 0.8 | 179 | - | -100.0 |
| Sana'a Region | 0.1 | 128 | - | -100.0 |
| Al-Jawf | 0.3 | 118 | - | -100.0 |

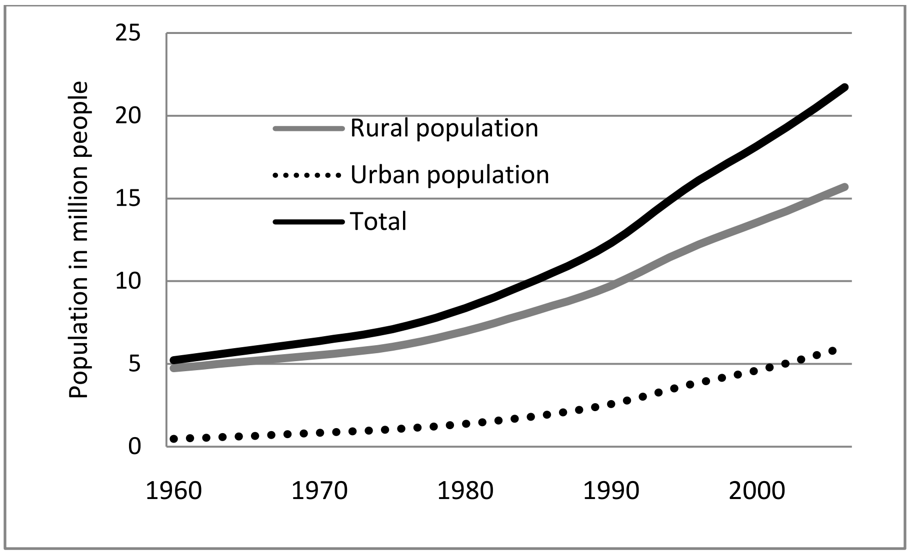
Source: Consumption data from 2005–2006 HBS; production data from Ministry of Fish Wealth (2009)
Note: We calculate fish imports as fish production minus fish consumption minus fish exports. This residual is close to the officially reported imports of about 18,000 tons, or about 17 percent of domestic consumption.

## 4.4. Public Health and Education

### *4.4.1. Public Health and Population*

Population growth in Yemen is among the highest in the world, with an average annual rate of about 3 percent in recent years. Figure 25 shows that the Yemeni population has increased from five million in 1960 to almost 23 million today. That is an increase of 460 percent within half a century, although it has dropped slightly since 2000. Given the limited natural resources for food production and the exacerbated macrolevel food-security situation for the near future, efforts to reduce population growth are critical if the fight against hunger and malnutrition is to succeed.

**Figure 25. Population growth in Yemen**



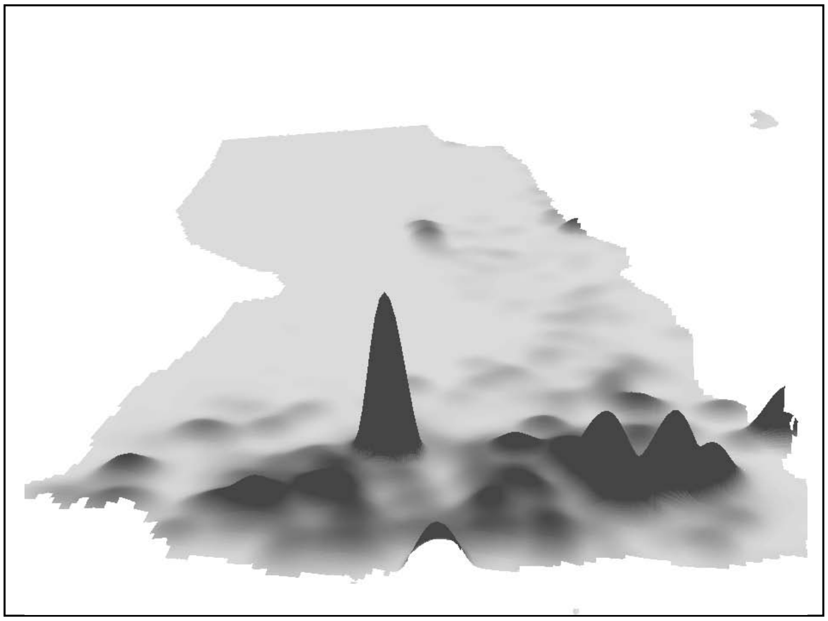

Source: IFPRI estimation based on UN (2009).

Fertility is alarmingly high, especially in rural areas. The 2003 FHS reveals a nationwide fertility rate (TFR) of 6.2 percent[13] Rural women on average have two more children than their urban counterparts; the TFR is 6.7 percent in rural areas and 4.5 percent in urban areas. The median age of women at first birth was 20.0 years, with no appreciable differences between women living in rural and urban areas. Almost half the population is younger than 15. Yemen's population is extremely young. According to the 2003 FHS, 46 percent of the population is 14 or younger; 47 percent in rural areas and 42 percent in urban areas are in that age group.

Yemen is still a predominantly rural society, yet urbanization is progressing rapidly. Almost three-quarters (73 percent) of the Yemeni population still live in rural areas. Nonetheless, Figure 26 shows that people are mostly concentrated in and around the metropolitan city of Sana'a, followed by the cities of Taiz and Ibb in the highlands. Because of a large influx of rural migrants and natural population growth, urban areas have been growing rapidly. In 1975, 10 percent of the population lived in urban areas, 13 percentage points less than today. Sana'a's population was 135,000 in 1975 compared with 1.83 million today

[13] The TFR is defined as the average number of children a woman bears during her reproductive life (assumed to be from 15 to 49 years of age). The TFR is measured for the period of five years before the survey (LOAS and Yemen 2004).

**Figure 26. Distribution of the Yemeni population**



Source: IFPRI estimation based on 2005–2006 HBS data.

### *4.4.2. Household Composition, Nutrition, and Education:*

A variety of food and nonfood factors also affect an individual's nutritional status. For instance, family members may not have equal access to food because of unequal food distribution within the household, especially in periods of shortages. Nonfood factors include the care mothers give to children; decisions about household expenditures (for example, food versus qat); awareness and knowledge of healthy food and its preparation; cultural practices and common beliefs; and life habits. Other factors that influence individual health are sanitation and hygiene conditions, access to clean and safe drinking water, and infectious diseases.

Larger households with many children are more likely to be food insecure, especially in rural areas. The average Yemeni household has 7.5 members and 3.5 children younger than 15; on average, more than one child (1.1) is younger than five. Households also tend to be larger in rural areas (7.6 people) than in urban areas (7.2) and host more children (3.6 versus 2.8) and more young children (1.1 versus 0.9). Per capita calorie consumption decreases with household size and especially with the number of children, implying that larger households are at a higher risk of food insecurity (21). The reason might be that, in larger households, the available income from the (adult) income earners must be shared among more people so that relatively fewer calories are available for each individual. This problem is more evident in rural areas than in urban areas. This hypothesis is supported by the strong negative correlaton of per capita expenditure (the proxy for per capita real income) and household size and the number of children. Statistically significant correlation coefficients amount to 0.155 and -0.157 for urban areas and -0.200 and -0.217 for rural areas, respectively. Hence, reducing population growth is critical for improving microlevel food security, particularly in rural areas.

Young children living in larger households with many older siblings are more likely to be malnourished. Correlation coefficients for the nutritional status of the youngest ones in the surveyed households (Table 21) suggest that young children are generally at a higher risk of malnutrition when they have many (older) siblings and relatives living in the same household, especially in rural areas. This indicates that no special attention is devoted to the youngest child—the most vulnerable person—by other household members or that special circumstances, such as suboptimal breast-feeding practices, are influencing the nutritional status of younger children more than that of older children.

Young children are thinner when their caregivers are young. Correlation estimates indicate that children's weight-for-age z-scores (WAZ) consistently increase with the age of their caregivers/mothers, a finding that is valid for the entire population as well as in urban and rural areas. This phenomenon may have a biological explanation, namely, that young mothers tend to have lighter children. Because of insufficient observations, we could not verify whether a child is less well nourished if cared for by a person other than his mother (such as by a sibling because of the absence of the mother in the household).

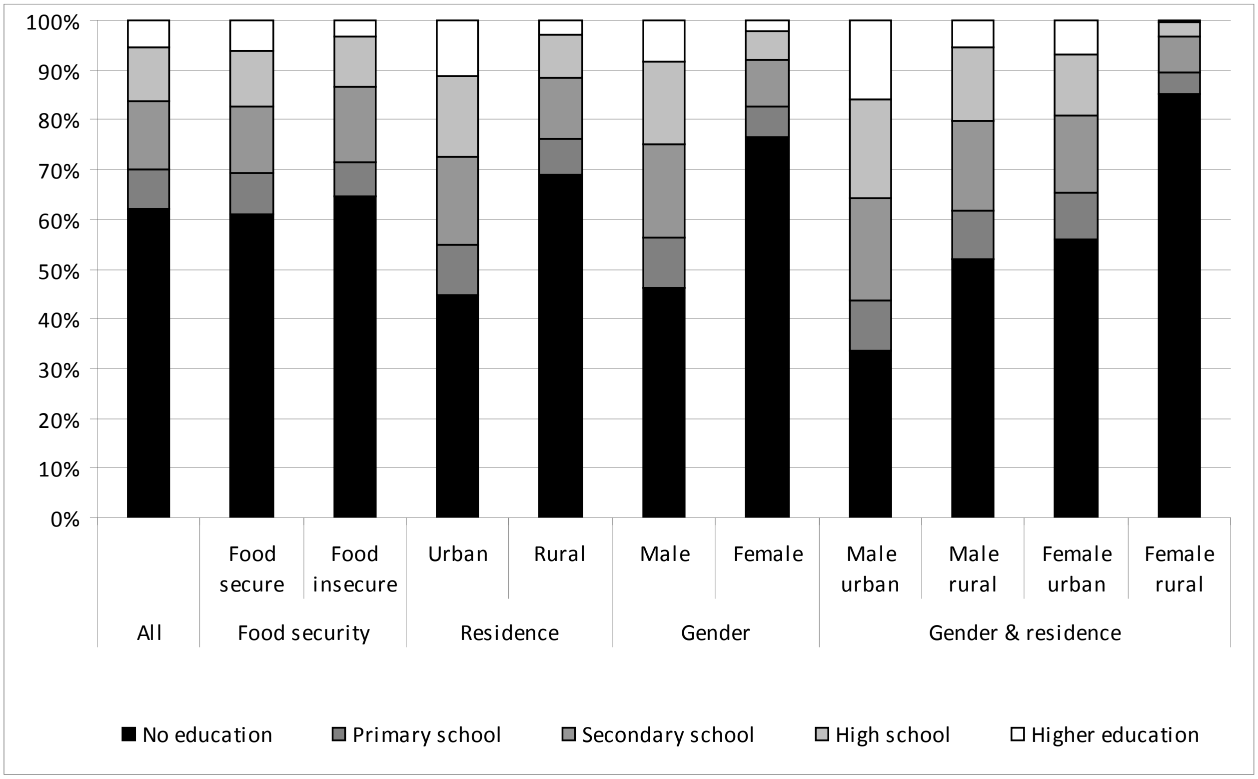
Education levels are generally very low, especially among women. Figure 27 shows that more than 60 percent of the total adult population has had little or no education. The urban-rural divide is considerable, and the gender gap is alarming. Forty-five percent of the urban population and almost 70 percent of the rural population aged 18 and older did not attend school or failed to complete primary school. While"only" 46 percent of male adults are uneducated, more than three-quarters (77 percent) of the female adults are uneducated. In rural areas 85 percent of the adult females did not attend or complete primary school. From a food security perspective, the tremendous lack of education among women is especially worrisome, because women are almost exclusively responsible for food preparation, child care, and other key components of family nutrition. Considering the generally low education of many Yemenis, the difference in the education levels between food-secure and food-insecure (male and female) adults is not large, but a clear tendency toward higher education in food-secure households is still evident. The direct link between education and nutrition is obvious: better-educated people have better access to information about food and nutrition and tend to be more aware and knowledgeable about nutrition problems and their solutions.

**Table 21. Correlation coefficients for calorie consumption and child anthropometrics and household size (head count) and number of children younger than five years**

| | **Household size** | **Number of children** |
|---|---|---|
| ***Per capita calorie consumption (kcal/day)*** | | |
| **All** | **-0.138** *** | **-0.209** *** |
| Urban | -0.132 *** | -0.221 *** |
| Rural | -0.221 *** | -0.245 *** |
| ***Weight-for-age z-score*** | | |
| **All** | **-0.048** *** | **-0.075** *** |
| Urban | -0.010 | -0.031 *** |
| Rural | -0.059 *** | -0.079 *** |
| ***Height-for-age z-score*** | | |
| **All** | **-0.029** *** | **-0.044** *** |
| Urban | -0.045 *** | -0.085 *** |
| Rural | -0.022 | -0.017 |
| ***Weight-for-height z-score*** | | |
| **All** | **-0.018** * | **-0.033** *** |
| Urban | 0.025 ** | 0.036 ** |
| Rural | -0.032 ** | -0.057 *** |

Source: IFPRI estimation based on HBS 2005–2006 data.
Note: *, **, *** Coefficient is statistically significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

**Figure 27. Adult (18 and older) education levels and food security status, residence, and gender**




Source: IFPRI estimation based on 2005–2006 HBS data.

Better educated people consume fewer calories because they require less energy. On average households' per capita calorie consumption decreases with the years the household head and the caregiver/mother of the youngest child (often the meal preparer) attended school and enjoyed further education (Table 22). However, this does not imply that food insecurity is more likely in better educated households. In this correlation two empirical relationships overlap—that is, the relationship between food security and education on the one hand and the biological association between calorie expenditures and dietary energy demand on the other. Thus the negative relationship is a result of the activities and the dietary energy required to carry them out. So uneducated people are usually forced to generate their livelihood by physical work that eats up more calories than mental work, which is more common among educated people. This relationship might also explain why the correlation between calorie consumption and a household head's years of education is negative in rural areas. And the generally extremely low education level among rural women may explain the negative relationship between calorie consumption and a child caregiver's education years that we found in rural areas

**Table 22. Correlation coefficients for calorie consumption, dietary diversity, child anthropometrics, and years in education for household head and child caregiver.**

| | Household head | Caregiver |
|---|---|---|
| ***Per capita calorie consumption (kcal/day)*** | | |
| **All** | **-0.071** *** | **-0.099** *** |
| Urban | 0.041 *** | 0.010 |
| Rural | -0.065 *** | -0.053 *** |
| ***Food Variety Score*** | | |
| **All** | **0.161** *** | **0.260** *** |
| Urban | 0.083 *** | 0.126 *** |
| Rural | 0.067 *** | 0.133 *** |
| ***Weight-for-age z-score*** | | |
| **All** | **0.094** *** | **0.105** *** |
| Urban | 0.074 *** | 0.122 *** |
| Rural | 0.074 *** | 0.043 *** |
| ***Height-for-age z-score*** | | |
| **All** | **0.080** *** | **0.141** *** |
| Urban | 0.081 *** | 0.165 *** |
| Rural | 0.044 *** | 0.068 *** |
| ***Weight-for-height z-score*** | | |
| **All** | **0.019** ** | **-0.013** |
| Urban | 0.031 ** | 0.014 |
| Rural | 0.021 | -0.019 |

Source: IFPRI estimation based on 2005–2006 HBS data.
Note: *, **, *** Coefficient is statistically significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

Education is associated with healthier nutrition. All correlation coefficients for the relationships between dietary diversity (measured by the Food Variety Score) and education of the household head and the caregiver of the youngest child are highly statistically significant and positive. They strongly indicate that higher dietary quality and thus higher nutrient consumption is associated with education. This also holds true when controlling for income, which is an important determinant for achieving a healthy diet and typically is higher among better educated people. The finding implies that nutritional awareness and knowledge go along with general education.

Child malnutrition is significantly lower in educated households. Table 22 shows that higher WAZ and HAZ are consistently correlated with higher education in both urban and rural areas, with a stronger association in urban areas. Furthermore, the HBS data reveal that, independent of income, underweight and stunted children are more prevalent among uneducated households.

Female education and knowledge matter for the healthy nutrition of all household members and for children in particular. The statistically significant correlation coefficients for the relationships between dietary diversity and child nutrition and the education years are consistently higher for the female caregiver (with the exception for the WAZ of children living in rural areas) than for the household head, who is male in almost all cases. This confirms findings from other studies, that the education of girls and women is especially important for the nutritional well-being of the entire household and of children in particular.

Maternal nutrition is also important for child nutritional health. Using available data on body mass index (BMI) for the children's mothers, estimates for the correlation between mothers' and children's nutritional health status reveal highly statistically significant and positive relationships for all three anthropometric indicators (WAZ: 0.108; HAZ: 0.108; WHZ: 0.118).[14] This also holds when taking into account the overall food security status of households. Thus mothers with good nutritional health are more likely to give birth to and raise healthy and well-nourished children, because of the lower transmission of diseases, higher quality of breast milk, and ability to give more care to children.

Children of women who received medical care during delivery have higher weights and are taller. HBS-based estimation results indicate that the WAZ and HAZ of children are significantly higher when their mothers received medical care during childbirth than the when the mothers did not. According to the HBS, less than half of all mothers and less than one-third of those living in rural areas received medical care when they gave birth. Clearly, medical treatment during childbirth and better access to health services in general improve the well-being of the next generation.

Inadequate breast-feeding practices are a major cause of malnutrition among young children in particular. While breast-feeding among young children is almost universal in Yemen, exclusive breast-feeding is not common, and breast-feeding practices vary considerably. Breast-feeding data from the 2005–2006 HBS are limited, but a recent UNICEF-WFP survey provides reliable and detailed data. The Yemen Nutrition Baseline Survey (YNBS) finds that almost all children from birth to six months are breastfed, but about half the mothers reported feeding some other liquids to their babies, even before initiating breast-feeding (UNICEF-WFP 2006). Common liquid and solid foods fed to infants younger than six months include water; sugared or salted water; fresh (animal) milk and milk powder; tea; fruit juices; commercial infant formula; ghee, butter, and yogurt; and food from the family pot and prepared porridge. Almost half the infants receive food other than breast milk on a regular basis before they are three months old, and about 30 percent of children are breastfed until they are two or older (Yemen, Ministry of Public Health and Population and JICA 2009; UNICEF-WFP 2006). In addition, delayed breast-feeding is common. UNICEF and the World Food Programme (2006) find that a large proportion (40 percent) of mothers reported delaying initiation of breast-feeding for 30 minutes after giving birth, and about one-fourth of mothers reported starting breast-feeding after more than 24 hours.

Lack of knowledge seems to be the main reason for inadequate breast-feeding practices. Consultations with experts reveal a common misconception that breast milk is not good for child health or, at least, not the optimal nutrient source for infants, that commercial infant formula, for instance, is better. Since boys are generally more valued in a male-dominated society, and thus receive more highly regarded food than girls, a paradoxical outcome of this misbelief might be that boys receive less breast milk than girls and accordingly are less well nourished. Indeed, more research is needed to test this hypothesis. Other reasons for inadequate breast-feeding practices might include the frequent absence and insufficient time of women.

Qat consumption and smoking by both males and females harm the development of children. Nationwide, 56 percent of the male population aged ten and older and 27 percent of the female population of the same age chew qat, and 27 percent of males and 10 percent of females smoke tobacco (LOAS and Yemen 2004). The HBS provides strong evidence that, in both rural and urban areas, children are less well nourished if they live in a household headed by a person who chews qat regularly (that is, at least once a week) and smokes or does one or the other. The situation for the children is even worse when their caregivers consume either qat or tobacco, or both, on a regular basis. These children consistently

[14] Unfortunately, the original anthropometrics of the 2005–2006 HBS provide no reliable BMI data for women. The indicator is heavily biased by outliers. Therefore we applied the rule that the Yemen Central Statistical Organization proposes for dropping outliers. Given the inconsistency in data, this report does not present average BMI estimates or prevalence estimates for women with low BMI. After adjusting the sample for outliers, only 914 observations remained that reported the BMI for the caregivers/mothers of children included in this study although this sample is small, it suggests clear and consistent patterns concerning the relationship between maternal and child health.

have significantly lower WAZ and HAZ, no matter where they live. The reason might be that parents under the influence of qat give less care to children. Or the explanation could be biological or a combination of the two factors. Qat consumption has been shown to have negative nutritional effects, including loss of appetite and reduced absorption of nutrients, both of which contribute to malnourishment in children. This could occur directly, because their mothers were unhealthy when the children were in utero. Or it could occur indirectly, because the children receive fewer servings of food in households where the influential members experience reduced hunger. Thus reducing qat and tobacco consumption is also mandatory from the perspective of microlevel food security.

Children with diarrhea are thinner and lighter in general. HBS data consistently show that children in both urban and rural areas who suffering from diarrhea in the month before the interview have statistically significant lower WAZ and WHZ. Thus children with diarrhea are more often underweight and wasted than their healthy counterparts. A main reason is that diarrhea prevents the body from digesting food and causes it to immediately lose large amounts of ingested energy and nutrients. In addition, the YNBS reveals that more than 90 percent of mothers reported reducing the amount of food offered to children during episodes of diarrhea. The survey finds that more than 40 percent of the children younger than five who were examined suffered from diarrhea and about 30 percent had blood in the stool. What is worrisome is that more than one-third of the children with diarrhea were not treated specifically for it. Consequently, reducing the spread of infectious diseases such as diarrhea through better access to health services, access to clean and safe drinking water, treatment of drinking water, improvement of sanitation conditions, and promotion of hygiene in general are essential for allowing children to develop a healthy life.

Malaria too is associated with thinness in children. Children who showed symptoms of malaria infection during the month before the HBS interview also showed significantly lower WHZ than their malaria-free peers. Thus malaria hampers the physical development of children by limiting their potential to gain sufficient weight and can cause continuing severe weight loss. In addition, we found strong statistical evidence that malarial children usually are affected by diarrhea.

Finally, the HBS provides information about vaccinations among children, including tuberculosis (TB), polio, diphtheria-pertussis-tetanus (DPT), measles, and hepatitis vaccination. In urban areas 7 percent of the children aged 24 to 59 months and 8 percent in that age range in rural areas did not receive immunization. While polio vaccination seems to be common in both urban and rural areas, one-fourth of the children in rural areas did not receive DPT vaccination, and even more were not immunized against TB. Moreover, the HBS data suggest a clear tendency toward higher WAZ and WHZ of immunized children. The positive relationship between polio vaccination and child health is the most distinct (and obvious). Children who received immunization, especially against polio, are better off.

# 5. SUMMARY AND CONCLUSION

The lack of recent information about food security is of concern to many countries, especially during and after crises, such as economic crises, natural disasters, and conflicts. In this paper we present an analytical framework that allows for the assessment of effects of such crises on food security; this framework also links food security on the macro- and microlevels. This methodology can compensate for missing data and thus provide important information to policymakers. We apply this methodology to Yemen, a country where the recent food price crisis and global economic recession have been especially damaging. The paper provides an in-depth analysis of the current food security situation in Yemen, including the major challenges to food security and factors driving food insecurity.

Our findings suggest an alarming situation of food insecurity at both macro- and household levels. Yemen's food security has dramatically deteriorated in recent years and is far below international levels, mainly because of its declining oil exports and increasing food imports. If no action is taken, food security is projected to remain at extremely low levels through 2020, and Yemen will remain highly vulnerable to external shocks and disasters. We have found that at the household level 32.1 percent of the population in Yemen is food insecure. In other words, almost one-third of Yemenis, or 7.5 million people, do not have enough food to satisfy their needs. Results also show that 57.9 percent of all children are stunted as consequence of undernourishment and poor health. Such a high prevalence of child malnutrition has serious consequences for the future development of Yemen's society and economy. In an international context these results put Yemen among the 10 most food insecure countries in the world.

Rural-urban inequalities are high in Yemen. The number of food insecure people living in rural areas is more than five times higher than in urban areas. In rural areas, 37.3 percent of the population is food insecure, while food insecurity affects "only" 17.7 percent of the urban population. Child underweight and stunting is also much more pronounced in rural areas than in urban areas. For instance, while 45.4 percent of urban children are stunted, 62.1 percent of their rural peers are. The average rural diet is poorly balanced, and the risk of micronutrient deficiencies is especially high. Food insecurity is highest among rural, nonfarm households, and livestock farmers.

Economic growth that improves people's income is the single most important driver of food security. Rapid economic growth in promising sectors and the transformation of rural and urban economies will thus be essential to sustainable food security in Yemen. However, several challenges exist for accelerating growth in Yemen. Decreasing oil exports are hindering macroeconomic stability—Yemen is expected to become a net oil-importing country by 2015. This will have a severe impact on the government budget, as oil constitutes about 70 percent of government revenues. In addition, the fuel subsidy continues to be a big burden for the government. However, economic diversification into labor-intensive sectors is slow, unemployment is high, and existing social transfers are not well targeted to the food insecure.

Accelerating growth that benefits the poor and food insecure is necessary but not sufficient. Yemen will need additional policies and investments. The country will increasingly rely on the international market for food imports and must find effective and efficient mechanisms to ensure a steady supply of imports, especially in times of global crisis. In the domestic market Yemen needs to address inefficient supply chains and high transaction costs. Results also show that access to local markets, urban centers, and credit is more difficult for rural and food insecure households.

Agricultural production uses 93 percent of all water in Yemen, and more than 75 percent of irrigated land uses groundwater, contributing to rapidly falling water tables. This unsustainable use of water, with increasing demand from urban areas, means agricultural growth has to come from increased water productivity and a structural change. More than one-third of the population and about half the food insecure suffer from water scarcity. The food-insecure population has less access to factors of agricultural production, including land, credit, natural resources, and advice from extension services. Fishery plays an important role for local coastal economies, and fish is the second most important export good. Yet productivity in the fishery sector decreased sharply between 2006 and 2008, and fish marketing and processing are often inefficient.

Population growth in Yemen is among the highest in the world, with an average annual growth rate of 3 percent in recent years. Total fertility is higher in rural areas, where women on average have more than two more children than their urban counterparts; the average rural Yemeni woman will bear almost seven children (6.7), whereas the total fertility rate in urban areas is 4.5.

Econometric analyses did not show clear statistical evidence for the important role of education for food security and child nutrition, as found in other countries. This might be mainly explained by the general low level of education, especially in rural areas, so that the necessary variability in the education variables for statistical significances are lacking. However, descriptive results reveal that there a considerable urban-rural divide and an alarming gender gap in formal education. Three-fifths of the total adult population did not attain any level of formal education. Forty-five percent of the urban population and almost 70 percent of the rural population aged 18 and older either did not attend school or failed to complete primary school. In addition, Qat consumption and smoking divert household resources from food, health, and schooling and thus harm the development of children.

More economic analysis is needed to prioritize policies and investments to improve food security in Yemen. Under the National Food Security Strategy (NFSS) Development Project, IFPRI will conduct this analysis and present the findings to the Yemeni Government and its partners.

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2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

**IFPRI ADDIS ABABA**

P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6172500
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

**IFPRI NEW DELHI**

CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
Fax: 91 11 2584-8008 / 2584-6572
Email: ifpri-newdelhi@cgiar.org