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The Agriculture-Nutrition Disconnect in India

What Do We Know?

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ABSTRACT

India is home to one-third of the world's malnourished children. This figure that remains stubbornly high, despite the country having the second-fastest growing economy in the world, with agriculture accounting for a significant part of that growth. Agriculture continues to be the primary source of livelihood for the majority of nutritionally vulnerable households in India. In order to maximize the *nutrition-sensitivity* of agriculture, we need to first map existing evidence of the various links, pathways and disconnects between agriculture and nutrition. We start with a narrative review of the background literature for India, including an assessment of trends in nutrition and agriculture indicators. A conceptual framework is then put forward to aid in the systematic search for links and disconnects, delineating seven key *pathways* between agriculture and nutrition. Evidence is then mapped to these pathways through a summary of the literature for each pathway as well as a fully annotated bibliography. A data audit assesses gaps and overlaps in survey data containing information on agriculture and nutrition indicators, on which future analyses could be built. Overall, the authors find that the conceptual framework is useful in this process, and conclude that there are some significant gaps in the literature and in the data currently available to analyze linkages between agriculture and nutrition. Data and policy disconnects need to be bridged to enhance the nutrition sensitivity of agriculture in India.

Keywords: malnutrition, agriculture, economic growth, India

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1. UNDERNUTRITION TRENDS IN INDIA

India is home to one-third of the world's undernourished children. According to the third National Family Health Survey (NFHS-3), one-third of Indian children are born with low birth weight, 45 percent of children below three years of age are stunted, 23 percent are wasted, and 40 percent are underweight. Not only are the absolute numbers high, but the prevalence of young child undernutrition—and the fact that it has changed so little through the last two decades, in spite of India's rapid economic progress—is especially disturbing (see Table 1.1). Undernutrition among adults is substantial too: Around one-third of all Indian women have body mass index (BMI) below 18.5. Micronutrient deficiencies are rampant among children and adults, with 79 percent of children, 56 percent of women, and 24 percent of men being anemic. One young child in three continues to be at risk for iodine deficiency.

Table 1.1—Undernutrition in India

Nutrition indicator	NFHS-2 (1998/99)	NFHS-3 (2005/06)
	(percent)	
Stunting (children < 3)	51	45
Wasting (children < 3)	20	23
Underweight (children < 3)	43	40
Anemia (< 11.0 g/dl) (children 6–35 months)	74	79
Vitamin A deficiency (children < 5)	n.a.	57
Women with BMI < 18.5	36	33
Men with BMI < 18.5	n.a.	28
Women with anemia	52	56
Men with anemia	n.a.	24

Source: National Family Health Survey-3 (2005/06).

Note: n.a.: information is not available.

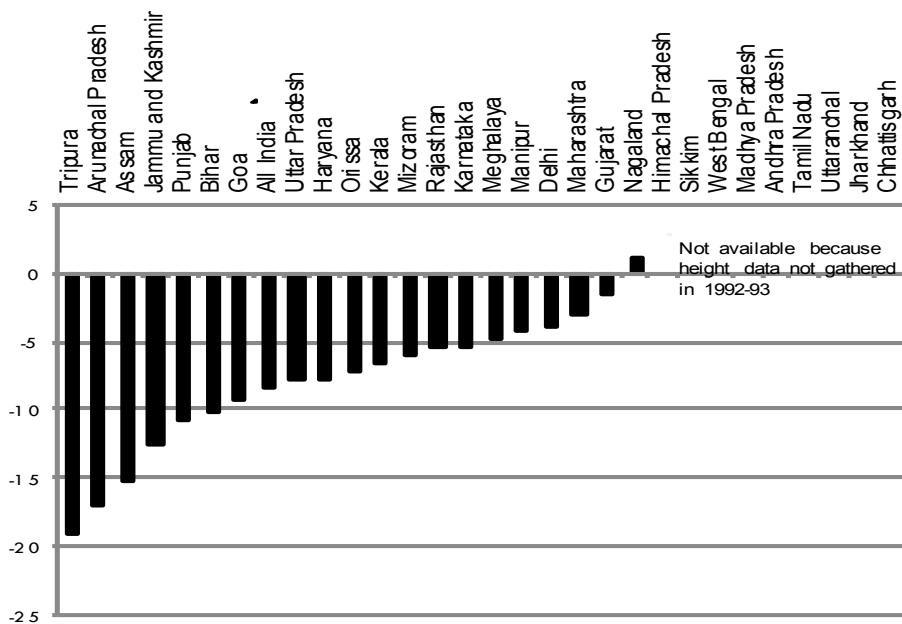
While national trends paint a bleak picture, the mosaic of child undernutrition in India reveals five key patterns. *First*, we find a substantial geographic variability in changes in the prevalence of various nutrition indicators. Between 1992/93 and 2005/06, the prevalence of stunting (an indicator of chronic undernutrition) fell, on average, by about 8 percentage points, but reductions in stunting ranged from 19 percentage points in Tripura to about 2 percentage points in Gujarat, with Nagaland showing an increase in stunting of 1 percentage point (Figure 1.1). Trends in wasting over the same time period have been more variable—wasting decreased substantially in many states but also increased in some states, with increases above 10 percentage points in Meghalaya and Haryana (Menon and Aguayo 2011).

Second, trends in stunting by age and gender over the three rounds of the NFHS survey reflect normal global patterns. The greatest declines in height-for-age occur during the first two years of life, with little change thereafter. Trends in mean weight-for-age scores by child age, over the three rounds of the NFHS, are similar to those for height-for-age. All three rounds of the NFHS data show mean height-for-age for girls to be similar to or better than that for boys during the first two years. Among older children, the mean height-for-age for boys was similar to that of girls during NFHS-1 but was increasingly greater than that of girls during NFHS-2 and 3 (Menon and Aguayo 2011).

Third, the data on nutrition indicators reveal significant socioeconomic inequalities. The poorest, the scheduled tribes and castes, and those residing in rural areas, bear the highest burden of undernutrition. While undernutrition is higher in children from lower income quintiles, it is substantial in middle income quintiles as well. Approximately half the children in the middle quintile and a quarter in the highest quintile are stunted. Several recent studies show the persistence of economic inequities with

respect to nutrition improvements over the last two decades (Pathak and Singh 2011; Sen et al. 2011; Subramanyam et al. 2011). These findings, in light of India’s economic growth, suggest that India’s undernutrition problem has its roots in systemic factors affecting virtually the entire population.

Figure 1.1—Interstate variability in changes in stunting rates (percentage points) between 1992/93 and 2005/06



Source: Menon and Aguayo (2011).

Fourth, the level and trends in anemia among both children and adults paint an alarming picture throughout India. Anemia among children 6–35 months of age is as high as 80 percent, and its prevalence increased by about 5 percentage points between NFHS-2 and NFHS-3 at an all-India level. Anemia has increased among women who have ever been married from 52 percent in NFHS-2 to 56 percent in NFHS-3. There is less variability across states and over time, indicating a uniform and static picture of crisis levels in anemia.

Fifth, while more than a third of Indian men and more than half of Indian women are too thin, the prevalence of overweight and obesity, currently at 15 percent (NFHS-3), is rising, increasing the public health importance of associated chronic diseases. The International Diabetes Federation estimates that the number of diabetic patients in India more than doubled from 19 million in 1995 to 40.9 million in 2007 and is now the highest in the world. This double burden (of under- and overnutrition) raises important challenges with regard to dealing simultaneously with issues of nutritional deficit and excess.

2. AGRICULTURE TRENDS IN INDIA

The track record of the Indian agriculture sector in augmenting the availability of food is noteworthy. The two most prominent examples are the cases of rice and wheat (the Green Revolution) in the 1960s through 1980s, and of milk from Operation Flood (the White Revolution) during the 1970s through 1990s. The history of the Indian agriculture sector can be categorized broadly into three phases (Table 2.1). In the pre–Green Revolution phase, persistent droughts and rapid population growth in the 1960s led to successive food crises, which prompted the government to invest heavily in agricultural technologies, supportive policies, and rural infrastructure. In its heyday (1965–1985), the Green Revolution transformed Indian agriculture: cereal production nearly doubled (with yields in some high-potential areas quadrupling), allowing the government to build a buffer stock that could be used to smooth inter-temporal and interregional variations in foodgrain consumption. Famine has essentially been eliminated in India and rural poverty fell from 64 percent in 1967 to 50 percent in 1977 and down to 34 percent in 1986.

Table 2.1—Key phases in Indian agriculture

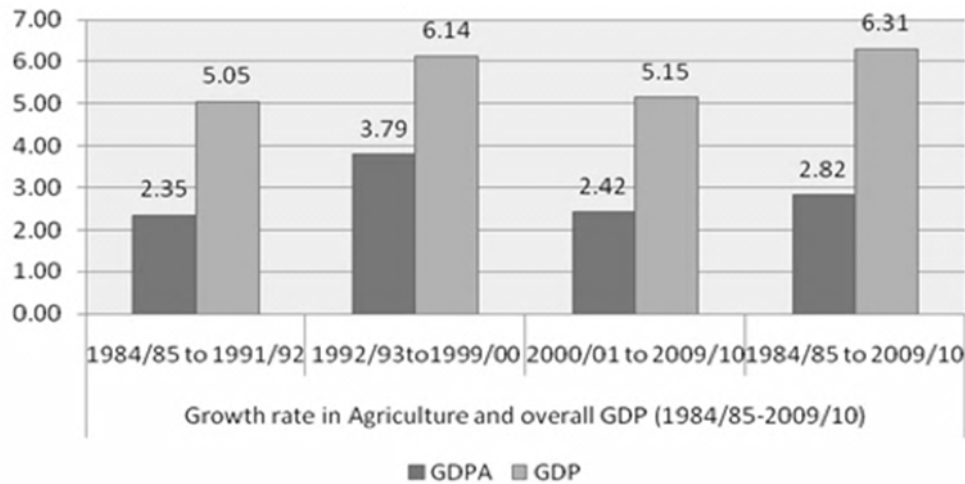
Pre-reform (until 1990s)		Post-reform (1992 onward)
Pre–Green Revolution (until mid-1960s)	Green Revolution	Postliberalization
<ul style="list-style-type: none"> • Imbalances between demand for food and domestic supply • 1950s: Institutional reforms: Abolition of <i>zamindari</i> system; enactment of tenancy laws and ceilings on landholdings 	<ul style="list-style-type: none"> • Near self-sufficiency achieved for food • <i>Mid-1960s</i>: Shift in policy emphasis from institutional to technological factors • 1970s: intra- and interregional and intercrop imbalances in crop yields • Operation Flood • 1980s: Regional spread of agricultural growth and crop diversification • Shift from cereal to other food crops • Shift from food to nonfood crop production (such as cotton) 	<ul style="list-style-type: none"> • Decline in growth of the agriculture sector • Shift in policy emphasis to liberalizing trade in agriculture • 1990s: Decline in annual growth rate of agriculture to 3.6 percent • 1990s onward: Rise in relative cereal prices amid rising buffer stocks • Rapid growth in nonfood crop cultivation (Bt cotton) and contract farming • <i>March 2001</i>: End of all quantitative restrictions

Source: Bhalla and Singh (2009); Radhakrishna (2002).

Since the economic reforms in the 1990s, the following five key trends in the agriculture sector are discernible. *First*, although India has seen unprecedented economic growth rates, the trend in agricultural growth has been broadly the same and far below the target growth rates of 4 percent in the last three decades (Figure 2.1). This should not come as a surprise, given the steady decline in the share of public investment in agriculture (from 20.5 percent in 2004/05 to 17.6 percent in 2008/09) and the low public investment in agricultural research and development—0.5 percent of agricultural gross domestic product (GDP) as against the norm of 1 percent recommended by the Indian Council of Agricultural Research (ICAR)—affecting technological progress. The Indian agriculture sector remains one of the least productive in the world (Binswanger-Mkhize and Parikh 2012).

Second, the share of agricultural growth in GDP is declining much faster than the share of agricultural labor. Although a falling share of agriculture in GDP—from 28 percent in 1996/97 to 19 percent in 2004/05 to 15.7 percent in 2008/09 to 14.2 percent in 2010/11—is indicative of structural transformation of the economy, the sector continues to be the predominant source of livelihood for more than half the nation’s total labor force and more than two-thirds of the rural labor force (India, Ministry of Finance 2011). Far from converging, in a recent analysis, Binswanger-Mkhize and Parikh (2012) show that the two shares are on a divergent path.

Figure 2.1—Growth rate in agricultural GDP (GDPA) and overall GDP

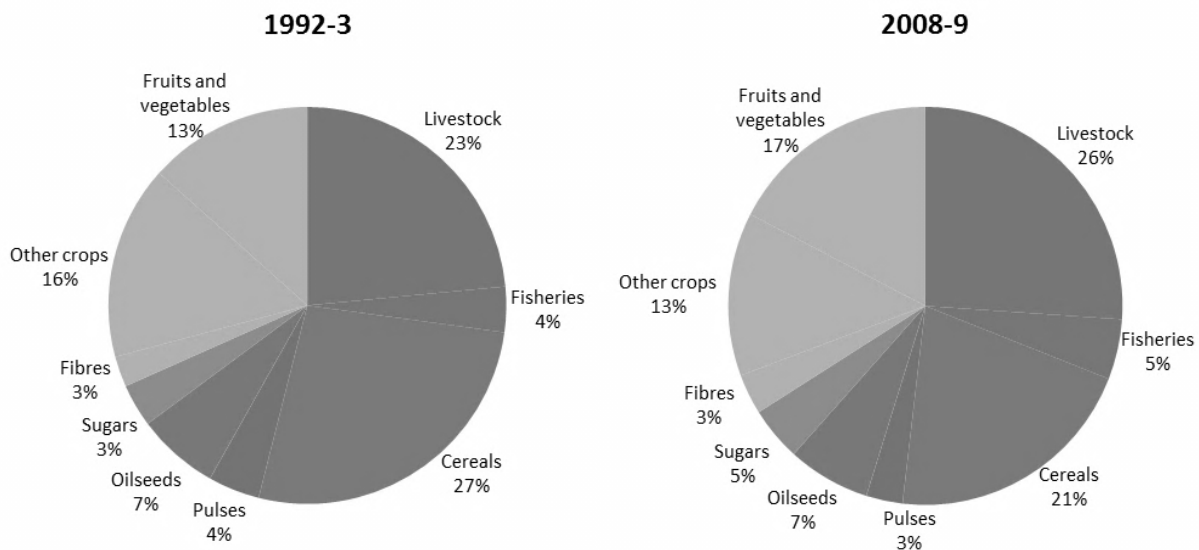


Source: Reserve Bank of India (2009, 2010).

Third, as in the case of nutrition trends, agricultural growth as well as its volatility at the state level is heterogeneous (Gulati, Ganguly, and Shreedhar 2011). Gujarat’s agriculture sector grew at a rate of 10.2 percent between 2000/01 and 2008/09, compared, for example, with Uttar Pradesh and West Bengal at 2.2 percent and 2.4 percent, respectively. This volatility in the performance of the agriculture sector is largely driven by the predominance of rainfed agriculture.

Fourth, India’s agriculture production is diversifying toward food commodities with higher nutritional and monetary value (fruits, vegetables, dairy, poultry, fish, small ruminants, and livestock), a trend driven primarily by smallholder farmers. India is the world’s largest producer of milk and second-largest producer of fruits and vegetables. But production of pulses in the last two decades has remained stubbornly low. In aggregate, horticulture, livestock, and fisheries account for about 48 percent of the total value of agricultural output, while cereals account for about 21 percent (Figure 2.2). Yet cereals continue to dominate the policy debates, as is evident in the recently passed National Food Security Bill.

Figure 2.2—Share of value of output of agriculture, livestock, and fisheries in India



Source: Gulati, Ganguly, and Shreedhar (2011).

Note: Livestock includes all animal products, including dairy, poultry, fish, and small ruminants.

Fifth, food price inflation remains high in India and is driven by high-value commodities. Increasing per capita incomes, urbanization, and globalization are changing the dietary patterns in both urban and rural households. But supply has not kept pace with the increasing domestic demand: High production uncertainty and price volatility, weak infrastructure, huge postharvest losses, lack of risk management instruments, and inefficient supply chains continue to plague the sector. This demand–supply mismatch in high-value foods is one of the key driving forces behind the high food price inflation (22.9 percent in June 2010, and hovering around 9 percent since March 2011), driven by a 23 percent increase in the price of fruit and a 13.6 percent rise in the price of eggs, meat, and fish. Food price inflation threatens the hard-earned gains in poverty reduction; a 10 percent increase in food prices could push 30 million Indians into poverty (Asian Development Bank 2011).

India now needs to manage its economic transformation to ensure that its agriculture sector realizes its potential to reduce poverty and increase access to optimal quality and quantity of foods to nourish its population on the one hand, and simultaneously address overnutrition and associated chronic diseases on the other.

Tackling the Agriculture-Nutrition Disconnect in India: The TANDI Initiative

Agricultural initiatives alone cannot solve the nutrition crisis in India, but they can make a much bigger contribution than they have managed to date. This basic belief gave rise in January 2010 to the TANDI initiative, facilitated by the International Food Policy Research Institute (IFPRI) with funding from the Bill & Melinda Gates Foundation. The goal of TANDI is to better understand and address the failure of economic and agricultural growth to make significant inroads into reducing malnutrition in India. TANDI has promoted the establishment of a multistakeholder platform to bring together economists, nutritionists, and other stakeholders to address key knowledge gaps and drive a change in India’s nutrition policy and program processes.

3. A SYSTEMATIC REVIEW OF AGRICULTURE AND NUTRITION PATHWAYS IN INDIA

The pioneering United Nations Children’s Fund (UNICEF) conceptual framework for nutrition (UNICEF 1990) has proved extremely useful in showing the relevance of the food, health, and care triad of preconditions that underpin nutritional well-being. The framework’s simplicity aids communication between multiple stakeholders, but it is not necessarily optimal for highlighting specific pathways and generating testable hypotheses. Figure 3.1 shows a framework, developed and modified through an extensive consultative process with multiple stakeholders, that details the seven key pathways between agriculture and nutrition, which are as follows:

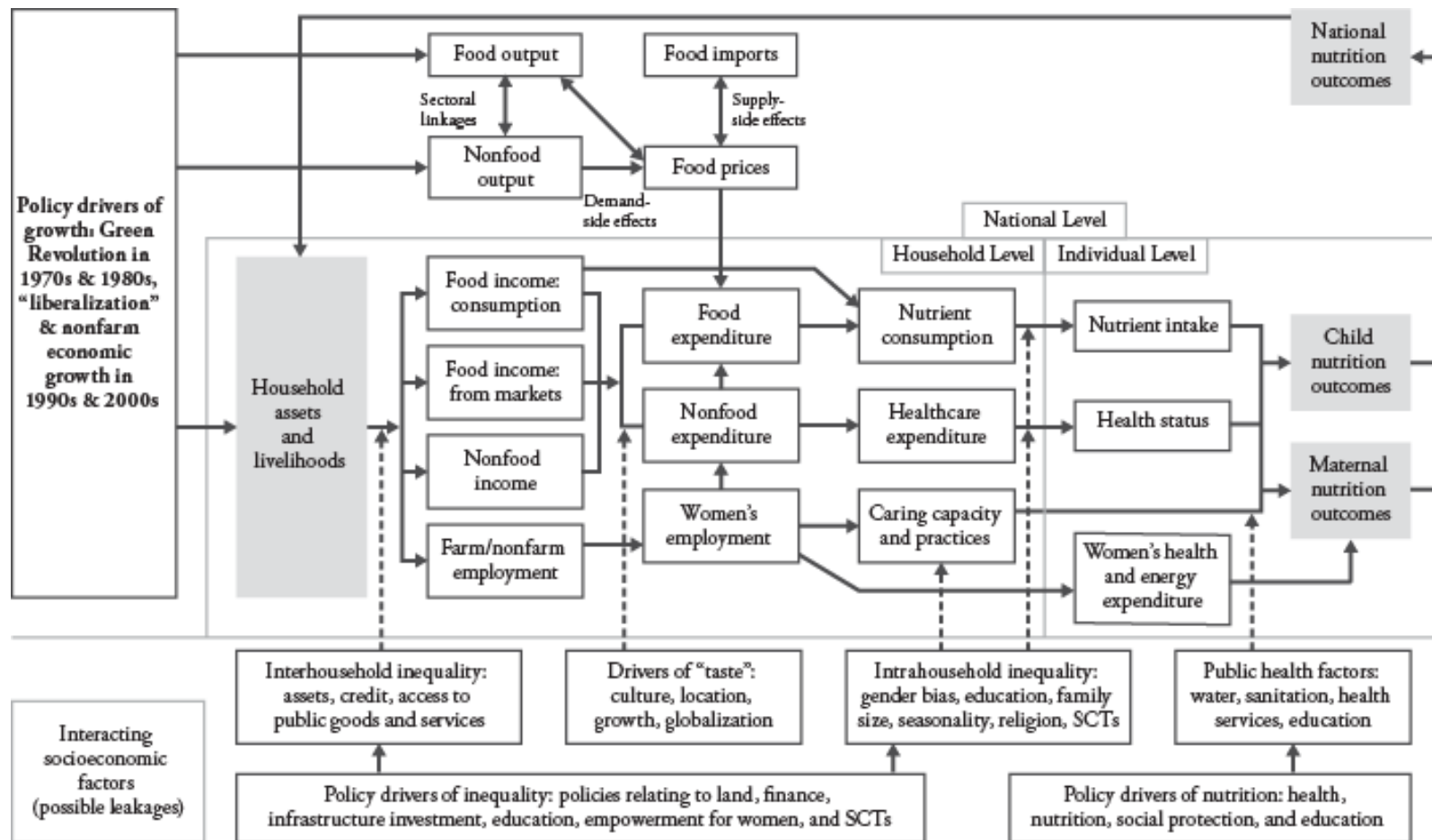
1. Agriculture as a *source of food*, the most direct pathway by which household agricultural production translates into consumption (via crops cultivated by the household)
2. Agriculture as a *source of income*, either through wages earned by agricultural workers or through the marketed sales of food produced
3. The link between agricultural policy and *food prices*, involving a range of supply-and-demand factors that affect the prices of various marketed food and nonfood crops, which, in turn, affect the incomes of net sellers and the ability to ensure household food security (including diet quality) of net buyers
4. Income derived from agriculture and *how it is actually spent*, especially the degree to which nonfood expenditures are allocated to nutrition-relevant activities (for example, expenditures for health, education, and social welfare)
5. Women’s *socioeconomic status* and their ability to influence household decisionmaking and intrahousehold allocations of food, health, and care
6. Women’s *ability to manage* the care, feeding, and health of young children
7. Women’s *own nutritional status*, when their work-related energy expenditure exceeds their intakes, their dietary diversity is compromised, or their agricultural practices are hazardous to their health (which, in turn, may affect their nutritional status)

To support the TANDI initiative, a systematic literature search was undertaken between March 2010 and May 2011 aimed at populating this seven-pathway framework with current or recent evidence. More than 15 databases and websites were searched for published and gray literature, yielding 4,545 citations, which were then screened for their relevance to the pathways. Only 71 of these articles were found to be relevant and included in the bibliography, and these were of varying scale, scope, methodology, and rigor; while all addressed the pathways, most did so only partially. Studies completed under the TANDI initiative are excluded from this count, but we draw on some of these findings in the review below. Full details of the search are provided in Appendix Figure A.1.

The literature on agriculture and nutrition in India has focused predominantly on analysis of existing policies (Pathway 3), with little rigorous or generalizable research on the underlying linkages or mechanisms on which to base conclusions or future policy. Nutrition outcomes were absent from most studies (in particular, research covering Pathways 3–6 did not get as far as nutrition outcomes along the proposed impact pathways), and a need for a concept of malnutrition that goes beyond calories and hunger is evident.

These shortcomings are in part due to an observed *data disconnect*, whereby nutrition surveys in India omit agricultural information (and often food consumption information), and agricultural and economic surveys typically omit anthropometric outcomes. Under TANDI, a comprehensive audit of existing datasets was undertaken to assess the possibility of combining datasets containing information on agriculture and nutrition variables (Appendix Table A.1). One finding, the paucity of data for units below the state level that combine information on both nutrition and agriculture, is itself a form of data disconnect between agriculture and nutrition.

Figure 3.1—Mapping the agriculture-nutrition disconnect



Source: Adapted by the authors from Headey, Chiu, and Kadiyala (2011).

The evidence base for TANDI is summarized below, following the pathways and the logic described above. The entire annotated bibliography of reviewed studies is provided in Appendix Table A.2.

Pathway 1: Agriculture for Food

Agriculture—own production—household calories/micronutrients—individual intake—nutrition outcome

Sixteen papers addressed the contribution of some form of subsistence agriculture or home food production to food security and nutrition (Ahmed and Lorica 2002; Alderman 1987; Babu, Thirumaran, and Mohanam 1993; Berti, Krasevec, and FitzGerald 2003; De Walt 1993; Dewey 1990; FAO 2007; Jones et al. 2005; Kataki 2002; Kumar 1977; Lokesh and Hanstad 2004; Murthy, Lakshmi, and Bamji 1999; Rais, Pazderka, and Vanloon 2009; Rao et al. 1993; Salam, Babu, and Mohanakumaran 1995; von Braun and Kennedy 1994). Broad themes covered were the impacts of subsistence and commercial farming, diversification of crops, and the effects of landlessness. Most were cross-sectional studies or surveys, assessments of interventions, or reviews of these.

At the macro level, the correlation between agricultural growth and growth in grain production across Indian states is negative (and significant, at -0.45). Headey, Chiu, and Kadiyala (2011) found that across Indian states, growth in grain production is much more strongly associated with nutritional improvements than are agriculture growth rates.

Many farmers were seen to preserve an element of subsistence farming even while embracing cash crops or other agricultural developments (De Walt 1993), and this has been viewed as a kind of insurance by many agricultural communities (von Braun and Kennedy 1994). Subsistence farming provides minimal risk in that nutritional value of foods grown is static and stable, whereas monetary value of crops is often volatile (Dewey 1990). Subsistence farmers have therefore been seen to recover better nutritionally from shocks to production than do entirely market-oriented farmers (Babu, Thirumaran, and Mohanam 1993), and farm income has been seen to have the most consistently positive effect on child nutrition indicators, suggesting that growing at least some food within the household has a protective effect on nutrition (Kumar 1977). Conversely, commercialization can have a negative impact on household nutrition, one example being the case of dairy cooperatives, where milk that would once have been consumed by the household became more valuable and was therefore sold, although the increased income did result in an increase in nutrients overall (Alderman 1987).

There are potentially negative aspects to the production of food for household consumption in the absence of alternative food sources; one study found subsistence farmers to be more vulnerable to food insecurity than their commercial counterparts, in contrast to other studies (FAO 2007). Seasonality in particular was seen to affect the nutritional status of household members in several contexts (Babu, Thirumaran, and Mohanam 1993; Lokesh and Hanstad 2004), and in the hungry season this was also seen to worsen gender bias and inequities in intrahousehold allocation of food (Babu, Thirumaran, and Mohanam 1993).

A combination of household food production with some income-generating activity to provide other food sources is therefore likely to be the most stable arrangement: generally, there is some consensus that it is important to diversify both food sources (Rao et al. 1993) and foods grown, including more vegetables and pulses (Kataki 2002), to provide adequate nutrition. It has been argued that reducing the dependency of households on agriculture would reduce malnutrition and associated gender bias (Babu, Thirumaran, and Mohanam 1993). In one study, those households sourcing food and income from both agriculture and local forests fared better in terms of child anthropometry than those limited to either one alone (Rao et al. 1993), and in another the practice of aquaculture was found to be beneficial for both income and consumption (Ahmed and Lorica 2002). Specifically, the practice of horticulture or home gardening can provide additional dietary diversity (Lokesh and Hanstad 2004) and improved nutrition security (Salam, Babu, and Mohanakumaran 1995); horticulture interventions have been seen to improve

the nutritional value of complementary foods (Jones et al. 2005), but not vitamin A deficiency in particular (Murthy, Lakshmi, and Bamji 1999).

It is, of course, essential to have access to land in order to produce food for household consumption, and the practice prescribed in the Tenth Five-Year Plan of providing smaller plots to more households has been shown to provide significant supplemental food and income (Lokesh and Hanstad 2004). Interventions aimed at improving nutrition through agriculture have been seen to work best where investments are made in capital, and, in particular, human capital (Berti, Krasevec, and FitzGerald 2003), rather than simply in providing inputs. Diversification of foods, food sources, and income streams appears to be the most protective approach, although more research is needed in specific social and agroecological contexts.

Pathway 2: Agriculture for Income

Agriculture—income (poverty)—food expenditure—household calories/micronutrients—individual intake—nutrition outcomes

Twenty-six papers assessed the links between agriculture-derived income and household food expenditure or individual nutrition status (Ahmed and Lorica 2002; Alderman 1987; Babu, Thirumaran, and Mohanam 1993; Deaton and Drèze 2009; Deshpande, Mishra, and Mishra 2001; De Walt 1993; Dewey 1990; FAO 2007; Gaiha 2002; Gaiha, Jha, and Kulkarni 2010; George 1984; Jha, Gaiha, and Sharma 2006; Joshi 2004; Kennedy 1994; Khullar, Sekhon, and Kaur 2007; Krishna 2006; Kumar and Dey 2006; Kumar 1977; Lokesh and Hanstad 2004; Rais, Pazderka, and Vanloon 2009; Rajuladevi 2001; Rao et al. 1993; Sable, Goswami, and Singh 2004; Sharma 2005; von Braun and Kennedy 1986, 1994). Broad themes covered were household income and expenditure patterns, the effects of landlessness, and the impacts of agricultural commercialization and diversification of incomes. Studies ranged from economic analyses of income and expenditure patterns to analyses of national-level statistics or household-level surveys to case studies to reviews of these.

Analyses under the TANDI initiative showed that agricultural growth rates are significantly associated with improvements in women's BMI and weakly associated with child stunting at the national level (Headey, Chiu, and Kadiyala 2011). But when one looks at heterogeneity across Indian states, it is clear that in some states agricultural growth does seem to be associated with improvements in stunting (for example, Kerala, Bihar, Himachal Pradesh, Tamil Nadu, Assam, and Tripura), while in others there is a total disconnect (for instance, Gujarat and Madhya Pradesh).

Many subsistence households cannot provide for the entire household's food needs from production alone, often due to small landholdings and low productivity, and so will need to create income to purchase additional food (Rais, Pazderka, and Vanloon 2009), and this pattern is repeated throughout India. Landless agricultural laborers, unable to grow any food at all, have consistently been found to be more food insecure and to spend a larger proportion of household income on food than other agricultural or nonagricultural households in studies across India (FAO 2007; Rajuladevi 2001; Sable, Goswami, and Singh 2004). This often leads to a lower consumption of energy and protein in these households (Babu, Thirumaran, and Mohanam 1993; Kumar and Dey 2006), although this is not always the case (Sharma 2005). It has been recognized that access to adequate land is a vital step in addressing food security, and the government policy of providing small plots to landless families was assessed as generating significant income in one small study in Karnataka (Lokesh and Hanstad 2004).

A qualitative study in Andhra Pradesh found that food was seen as the single most important expenditure for all agricultural households, over and above servicing debt and improving shelter, although enforced health spending took precedence and often drove households into poverty (Krishna 2006). In the only study to assess the switching of expenditures in response to external shocks such as economic crises, no switching was seen between food and nonfood items, with expenditures rising or falling proportionally with income (Gaiha 2002).

Numerous studies looked at household expenditure on food as a proportion of household income, and several assessed the impact of expenditure on measures of nutrition. Two studies in Punjab found that expenditure on food fell from around 60 percent of income in the 1980s to below 40 percent in the new millennium (Joshi 2004; Khullar, Sekhon, and Kaur 2007), although it is not known whether other states saw similar declines. Calorie consumption per capita at a given income has, however, been seen to have fallen over the past 25 years in India. Possible explanations include a downward drift of the Engel curves plotting calorie consumption against income due to better health and lower activity levels (Deaton and Drèze 2009), and the changing prices and relative elasticities of different food commodities (Gaiha, Jha, and Kulkarni 2010).

Using balance sheets from the Food and Agriculture Organization of the United Nations (FAO), analyses under the TANDI initiative confirmed that coarse grains are chiefly responsible for the decline in cereal consumption and calorie availability as a whole. Wheat consumption has increased, and there have been modest contributions from vegetable oils as well as fruits and tree nuts. In terms of protein availability, coarse grains and rice are again responsible for the largest declines, while increased wheat and milk consumption have counterbalanced this somewhat. However, over the longer run (1960–2007), the 50 percent decline in pulse consumption is the largest driver of decreased protein availability, closely followed by the decline in coarse grains (Headey, Chiu, and Kadiyala 2011). If pulse and coarse grain consumption had remained at 1960 levels, then daily intake of protein would be more than 10 grams (or 17 percent) higher than current intakes. Increased fat consumption is chiefly driven by increased consumption of vegetable oils and animal fats (butter and ghee). The authors also showed that these patterns have resulted in moderate increases in dietary diversity, as measured by the declining share of cereals in total energy and protein intake, and the rising share of animal fats in total fats.

In terms of demand, most nutrients have been found to be relatively elastic, suggesting that increased income would increase intake of macro- and micronutrients (Gaiha, Jha, and Kulkarni 2010; Headey, Chiu, and Kadiyala 2011; Jha, Gaiha, and Sharma 2006). However, increased income is not consistently found to improve child nutrition (Kumar 1977); several studies noted that the effects of income on food consumption and child nutrition are mediated by control of income within the household, with maternal control seen to be preferable (De Walt 1993; Kumar 1977; von Braun and Kennedy 1986) (see Pathway 5).

Three separate reviews of the effects of commercialization on food consumption, taking evidence from developing countries with relevance to India, found that increased income had no effect (De Walt 1993) or a very small effect (von Braun and Kennedy 1986, 1994) on food consumption and nutrition outcomes, depending on context. Some very specific effects resulting from specific commercialization schemes should be noted; in particular, two separate studies noted a fall in milk consumption in nonproducing households on introduction of local dairy cooperatives, likely due to increased prices and the disappearance of small quantities of milk available for purchase (Alderman 1987; George 1984), although nutrient intake in milk-producing households was seen to rise with the increased income from milk sales (Alderman 1987). Overall, international reviews dealing with commercialization of agriculture noted that the most positive effects on nutrition were seen where improvements in income were concentrated among the undernourished poor (Jha, Gaiha, and Sharma 2006; von Braun and Kennedy 1994) and combined with public health action to reduce malnutrition and morbidity (Kennedy 1994). As noted in Pathway 1, diversification of income streams within agriculture and between agriculture and other sources has been seen as one solution to the problem of food and nutrition insecurity.

Overall, there is a need to look at actual causes of poverty and food insecurity in context to inform policy (Krishna 2006) and certainly a need for better nutrition monitoring in India to reduce reliance on available calories as a primary indicator, a particularly poor measure of nutrition that is often used (Deaton and Drèze 2009). Improving aquaculture (Ahmed and Lorica 2002) and reducing the complete dependency of rural households on agriculture (Babu, Thirumaran, and Mohanam 1993) have been suggested to reduce undernutrition rates through agricultural income.

Pathway 3: Agriculture and Food Prices

Supply and demand factors (policies, taste, incomes)—relative prices of various food items—household calories/micronutrients—individual intake—nutrition outcomes

Twenty-nine papers assessed the impacts of supply and demand factors on household food security, and some went on to assess likely impact on nutrition (Abdulai, Jain, and Sharma 1999; Chand 2004; Datt and Ravallion 1998; De Walt 1993; Dewey 1990; Dixit 2011; Gaiha 1999; George 1984; Gupta 2009; Haddad and Zeitlyn 2009; Islam and von Braun 2008; Jha 2007; Jha, Imai, and Gaiha 2009; Kataki 2002; Khullar, Sekhon, and Kaur 2007; Kumar, Mruthyunjaya, and Dey 2007; Patnaik 2003, 2008, 2009; Pica-Ciamarra and Otte 2010; Rao 1998; Ravallion 1998, 2000; Saxena 2001, 2004; Swaminathan 2008; Tarozzi 2005; von Braun and Kennedy 1994; von Braun et al. 2005). Broad themes covered were the impact of food prices on producers and consumers, liberalization policies and the public distribution system (PDS), and the impact of changing tastes and diets on agricultural diversification and nutrition. Studies included economic analyses of food price data and elasticities of expenditure, analyses of local and national household surveys, policy reviews, paper critiques, and literature reviews.

Food demand in large part depends on food cost, so increasing supply will reduce prices and increase demand (Abdulai, Jain, and Sharma 1999). However, there is some uncertainty from available data about whether India's rural poor are predominantly net producers or consumers of food (many rural households are both producers and consumers) (Datt and Ravallion 1998; Patnaik 2008; Ravallion 2000) and therefore whether high or low food prices would benefit the majority. A persistent voice in the literature comes from Ravallion and colleagues at the World Bank, with seemingly contradictory articles noting, on the one hand, that the poor, as net consumers of food, would benefit in absolute if not relative terms from lower food prices (Datt and Ravallion 1998), but on the other, that higher food prices are not detrimental to the rural poor and may contribute to reducing rural poverty as part of the process of reform (Ravallion 2000). Ravallion's 1998 article questioning interpretations of the links between food prices and poverty concluded that these links are due not to income distribution effects but rather to fluctuations in production and supply (Ravallion 1998), although the methods used in this paper have been questioned (Rao 1998). An analysis of national survey data did not show an adverse effect on child anthropometry (weight-for-age) of a sudden rise in the price of rice supplied by the PDS (Tarozzi 2005), but more work is certainly needed to establish the differential effects of rises in food prices for the producer-consumer rural poor.

Commercialization of agriculture in developing countries can affect not only food prices but also local availability of foods, and can shift the locus of control away from the household and toward larger enterprises, with wide-ranging impacts on communities and their diets (Dewey 1990). Gains from commercialization for producers generally depend on the maintenance of high prices for crops, with potential impacts on nonproducers (De Walt 1993), although the promotion of small-scale but market-oriented poultry farms was assessed in one study as having the ability to increase the availability and affordability of quality protein sources, such as eggs and meat, in rural areas (Pica-Ciamarra and Otte 2010). The example of dairy cooperatives illustrates the complex effects of commercialization, with increased incomes and nutrient intakes in producer households balanced against significant reductions in milk consumption in nonproducer households due to reduced availability of small quantities for sale locally on introduction of the cooperative (George 1984).

Commercialization is not the only force driving agricultural change in India; changing tastes are also having an impact. Micronutrient malnutrition is very common in India, deriving from diets that rely predominantly on staple grains. What is necessary for optimal nutrition outcomes is diversification of agricultural systems and diets of the poor (Kataki 2002), and particularly a focus on pulse production for protein (Chand 2004). Changing tastes of the population (Atkin 2010) and changing demand, particularly from urban areas (Kumar, Mruthyunjaya, and Dey 2007), are also increasing demand for a more diverse range of foods, and several papers call for policy and infrastructure to encourage or accelerate this

diversification process in order to improve rural nutrition security (Gupta 2009; Headey, Chiu, and Kadiyala 2011; Kataki 2002; Kumar, Mruthyunjaya, and Dey 2007; von Braun et al. 2005).

Analyses by Headey, Chiu, and Kadiyala (2011) illustrated the interlinkages between changing tastes, demand, and prices driving consumption patterns. They reported that a key factor in the relatively steep rise in coarse grain prices was the greater use of coarse grains in the production of livestock, also seen in other studies (Patnaik 2009). This in itself stems from rising incomes and the increased demand for higher-value foods, such as meat and dairy products. The authors reported that while coarse grain consumption by humans decreased by 50 percent from 1970 to 2001, coarse grain use as feed increased by 500 percent, largely as a result of increased consumption of meat (which increased tenfold) and, to a lesser extent, dairy (which increased by 240 percent). In conjunction with inferior taste, the steeper rise in coarse grain prices relative to rice and wheat prices must have rendered coarse grains increasingly unattractive to the average Indian consumer.

The PDS is the current mainstay of policy to reduce hunger in India, and while the PDS has been found to reduce the vulnerability of households to poverty (Jha, Imai, and Gaiha 2009), there are many more papers criticizing the inefficiency of the system, whereby food consumption falls and hunger persists while grain stocks mount (Jha 2007; Saxena 2001). In essence, critics claim that the government has interpreted a lack of purchasing power among the poor as overproduction (Patnaik 2008; Saxena 2001), whereas, in fact, the problem is distributional (Gaiha 1999). Consequent deflationary policies then hit producers; as prices are pushed down, incomes and agricultural wages fall (Patnaik 2008; Saxena 2004), and undernutrition rates increase (Patnaik 2003). Occasional sharp rises in PDS grain prices have also contributed to malnutrition rates (Chand 2004). In particular, targeting (Haddad and Zeitlyn 2009; Swaminathan 2008), monitoring (Saxena 2004), and governance (Haddad and Zeitlyn 2009; Saxena 2004) have been cited as in urgent need of reform, and studies have recommended reduction of food stocks by using them in food-for-work or other programs to reduce malnutrition (Saxena 2001).

Although liberalization has had some positive effects on food consumption, these were attributed in one study to social forces as much as to income increases (Khullar, Sekhon, and Kaur 2007). High growth in Gujarat, for instance, which has followed the market-oriented trickle-down pattern advocated by neoliberal economic policies, has not led to significant reductions in rural poverty and undernutrition (Dixit 2011). Policies that seek to increase food production without increasing wages or purchasing power are seen as likely to fail in their objective of overcoming hunger and malnutrition (Abdulai, Jain, and Sharma 1999). Overall, there is certainly a need to understand the complex processes linking food prices and rural poverty for the formulation of effective policy (Patnaik 2008), and there is a need for a concept of malnutrition that goes beyond calories and hunger (Islam and von Braun 2008).

Pathway 4: Expenditure of Income Derived from Agriculture

Agriculture—income (poverty)—nonfood expenditure—healthcare expenditure (cost)—health status—nutrition outcomes

Three studies addressed the links between agricultural income and health expenditure (Gaiha 2002; Kennedy 1994; Rajuladevi 2001). No study went as far as to assess the impact of health spending on nutritional status; studies ranged from national- or regional-level reviews with secondary analysis of aggregate data to small household studies at village level.

Landless agricultural workers were found to be worst off, with a lack of funds to spend on all basic needs, including healthcare (Rajuladevi 2001). In another study, while the switching of income sources (between crop, other agricultural, and nonagricultural sources) occurred in response to shocks resulting from structural adjustment, proportional expenditure on food, nonfood, and health items remained the same (Gaiha 2002). Commercialization of agriculture was found not to decrease child morbidity in one review; it was noted that health gains would depend on the type of health expenditure seen with increased incomes, whether to improve short-term health (for example, purchase of medicines) or long-term health (for example, improved sanitation) (Kennedy 1994).

Studies suggesting policy recommendations noted that improved public health action was necessary alongside improved incomes to make real health gains (Gaiha 2002; Kennedy 1994). More research into the impact of increased agricultural or other incomes on health spending and on nutrition and health outcomes, and more research into the impact of policies and programs to improve the access of agricultural workers to health services, is certainly needed in India.

Pathway 5: Female Agricultural Labor and Power

Agriculture—female employment—female socioeconomic power—household expenditure (food/health)—intra-household allocation—nutrition outcomes

Eleven studies looked at factors linking female employment and increased socioeconomic power with household expenditure and equality as proxy indicators of nutrition and health (Agarwal 2001; Bennett 1992; Berman et al. 1997; De Walt 1993; Dewey 1990; Kaur 2005; Kennedy 1994; Kumar 1977; Misra 2000; Rao 2006; Sharma 2005). Only one study went as far as to measure actual nutrition outcomes (Sharma 2005); studies ranged from national- or regional-level reviews with secondary analysis of aggregate data to small household studies at village level.

There is a generally understood or imposed division of labor in rural Indian households, whereby household tasks fall to women, whether or not they are also working outside of the home. Such household labor is classically not captured in economic statistics and is often not valued equally with nonhousehold tasks (Kaur 2005). Where women do contribute financially to the household, however, several studies have found that female control of these earnings can significantly increase expenditure on food and basic needs (Agarwal 2001; Bennett 1992; De Walt 1993; Kennedy 1994; Kumar 1977) and reduce gender bias and dowry payments (Agarwal 2001).

However, sociocultural factors and the attributes of the work will mediate this relationship; one study found that the additional female wages were not sufficient to alter the overall spending pattern and in fact reduced spending on health (Berman et al. 1997) (possibly due to women's having insufficient time to devote to child health—see Pathway 6), although mothers who exercise autonomy in household decisionmaking have been seen to enhance the nutritional status of their young children (Sharma 2005). In particular, more commercial forms of agriculture tended to reduce the burden of jobs traditionally performed by men while replacing those performed by women, thereby reducing female empowerment, reducing spending on food, and altering intra-household distribution of food toward the working men (Dewey 1990).

In order to improve the status of women in work and move toward their greater empowerment within the household, the role of women in agriculture should be explicitly recognized in policy (Dewey 1990). Specifically, recommendations include ensuring land rights for women (Rao 2006), investing in female human capital (Rao 2006), and providing more off-farm opportunities for women (Misra 2000). Further research is needed into the links between income earned and income controlled by different actors in the household, and its relationship with nutrition outcomes.

Pathway 6: Female Agricultural Labor and Childcare and Feeding

Agriculture—(female) employment—caring capacity/practice—nutrition outcomes

Ten studies identified the links between female employment, reduced caring capacity or health seeking, and nutrition and health outcomes (Agarwal 2001; Bennett 1992; Berman et al. 1997; Bhalotra 2010; De Walt 1993; Duvvury 1998; Kaur 2005; Rani and Rao 1995; von Braun and Kennedy 1986, 1994). Papers looked at the effect of agricultural work and the need for income on maternal nutrition, health knowledge, and health seeking behavior, and the effects of commercialization, structural adjustment, and development on these linkages.

It has been noted for several decades at least that the successful commercialization of agriculture should be gender sensitive and not adversely affect the capacity of women or the household to care for

children (von Braun and Kennedy 1986). In particular, decreases in the time working mothers have to address child morbidity (especially diarrhea) may offset any nutritional gains from increased income through commercialization (De Walt 1993); and spending on healthcare has been seen to decrease rather than increase with maternal employment, possibly due to these time constraints (Berman et al. 1997). Women's role in agriculture was found to be grossly underestimated in national figures in India (Kaur 2005), and structural adjustment has been seen to increase further still the time women are expected to spend on income-generating activities, particularly in agriculture, making it difficult to maintain household activities (Duvvury 1998). Economic recession has also been found to increase female participation in the labor force, particularly agriculture, with detrimental effects on child health and well-being (Bhalotra 2010). Maternal nutrition and health knowledge appear to be compromised with the need to work, with female farmworkers or agricultural laborers having reduced exposure to health information even compared with other working women (Rani and Rao 1995).

However, other studies have found a withdrawal of women from the labor force with commercialization, mechanization, and development (Kaur 2005; von Braun and Kennedy 1994); mechanization has disproportionately displaced women from the workforce (Agarwal 2001), potentially freeing more time for the household. Sociocultural factors play a large role in determining the exact effects of development on female time allocation and therefore on caring capacity and on nutrition and health outcomes (von Braun and Kennedy 1994). Local interventions such as health communication and education programs for women in agriculture (Rani and Rao 1995), and national interventions such as social safety net programs (Duvvury 1998), have been put forward as potential solutions to the problem of maternal time allocation, but little research is available on the impact of either female labor or these interventions on child nutrition and health in agricultural households in India. Bennett (1992) suggests that the positive impacts seen on food expenditure from maternal employment could be improved with concurrent access to childcare.

Under the TANDI initiative, Headey, Chiu, and Kadiyala (2011) shed further light on this issue. Using the NFHS data to plot breakdowns by mother's occupation and caregiver category, the authors found no prima facie evidence that women employed in agriculture spent less time on childcare. If anything, other relatively unskilled occupations—such as household, domestic, or service employee—tended to show even higher rates of preschoolers being cared for by other children or other adults (with the exception of unskilled manual workers). The authors then tested for the impact of different caregiver categories on child stunting and wasting in a multivariate context. They found no difference between the care of mothers and that of other adults on mean height-for-age or stunting. Care provided by other children, however, had an adverse impact on height-for-age, although no significant effects were found for wasting or weight-for-age. Moreover, the impact of caregiving categories on height-for-age were only moderate and not particularly robust to different samples. Given that mothers employed in agriculture are no more likely to have other children taking care of their children than mothers in other unskilled occupations, the authors tentatively concluded that there is not much evidence that poor childcare practices are more prevalent or more important in agricultural households than in nonagricultural households. More accurate time use data might give rather different results, and it is still likely that the labor burden of mothers in all unskilled occupations (agriculture, domestic work, unskilled manual labor, and other services) detracts from appropriate childcare practices.

Pathway 7: Female Agricultural Labor and Women's Nutritional Status

Agriculture—female employment—energy expenditure—female adult BMI

Eight studies were found relating female employment in agriculture to energy expenditure and to nutrition and health outcomes (Bains, Kaur, and Mann 2002; Barker et al. 2006; Durnin, Drummond, and Satyanarayana 1990; Ghosh 2007; Griffiths and Bentley 2001; Panwar and Punia 1998; Rao et al. 2003; Rao, Gokhale, and Kanade 2007; Rao et al. 2009). Papers attempted to classify the energy costs of daily household and farming activities, to assess adaptations to seasonality, to assess the impact of activity and

food intake on neonatal size, and to look at differences in thinness according to work behavior and gender. All were small studies conducted at state or village level within India.

Energy expenditure by rural women was estimated in two studies using FAO physical activity ratios (PARs) (Bains, Kaur, and Mann 2002; Rao, Gokhale, and Kanade 2007). In both studies, activity levels for most women in most tasks were found to be light to moderate, while it is often assumed that the work of rural women is heavy. Thinness could not be attributed to working behavior in a third study, although women were thinner in farming families than in nonfarming families, and women were found to be more likely to work full-time in farming as well as carrying the burden of household chores (Barker et al. 2006).

Seasonality is hypothesized to affect both energy expenditure and food intake, and therefore to affect female nutrition and health outcomes, particularly among rural women employed in agriculture. Seasonality was found to affect both energy expenditure and food intake in two studies, with small adaptations resulting in reduced basic metabolic rate (BMR) and exercise capacity in the hungry season in one (Durnin, Drummond, and Satyanarayana 1990) and in increased neonatal size with late gestation over harvest season in the other (Rao et al. 2009). One other study assessed maternal activity (such as farmwork) and neonatal size, finding that excessive maternal activity was associated with smaller fetal size (Rao et al. 2003).

Livelihood characteristics do seem to have a sizable effect on adult BMI (Headey, Chiu, and Kadiyala 2011). Using NFHS-3 data, the authors showed that moving a woman from agriculture to unskilled manual labor activities improved her BMI by just 0.08, while moving her to services yields a BMI increase of 0.27 and moving her to sales yielded an increase of 0.29. These effects were fairly moderate but comparable in size to many other effects in their regression analysis. For example, moving from the lowest wealth quintile to the next highest improved BMI by just 0.24. And raising a mother's education from none to having completed a primary education improved her BMI by 0.31. Mother's BMI, mediated through her occupation, did not have a significant impact on child anthropometric outcomes. Griffiths and Bentley (2001) found that women working in agriculture were 1.52 times more likely to be underweight than those who are not, and Panwar and Punia (1998) found that farming women have significantly lower protein intake. Recent land reforms favoring women have been found to have a positive impact on women's height (Ghosh 2007).

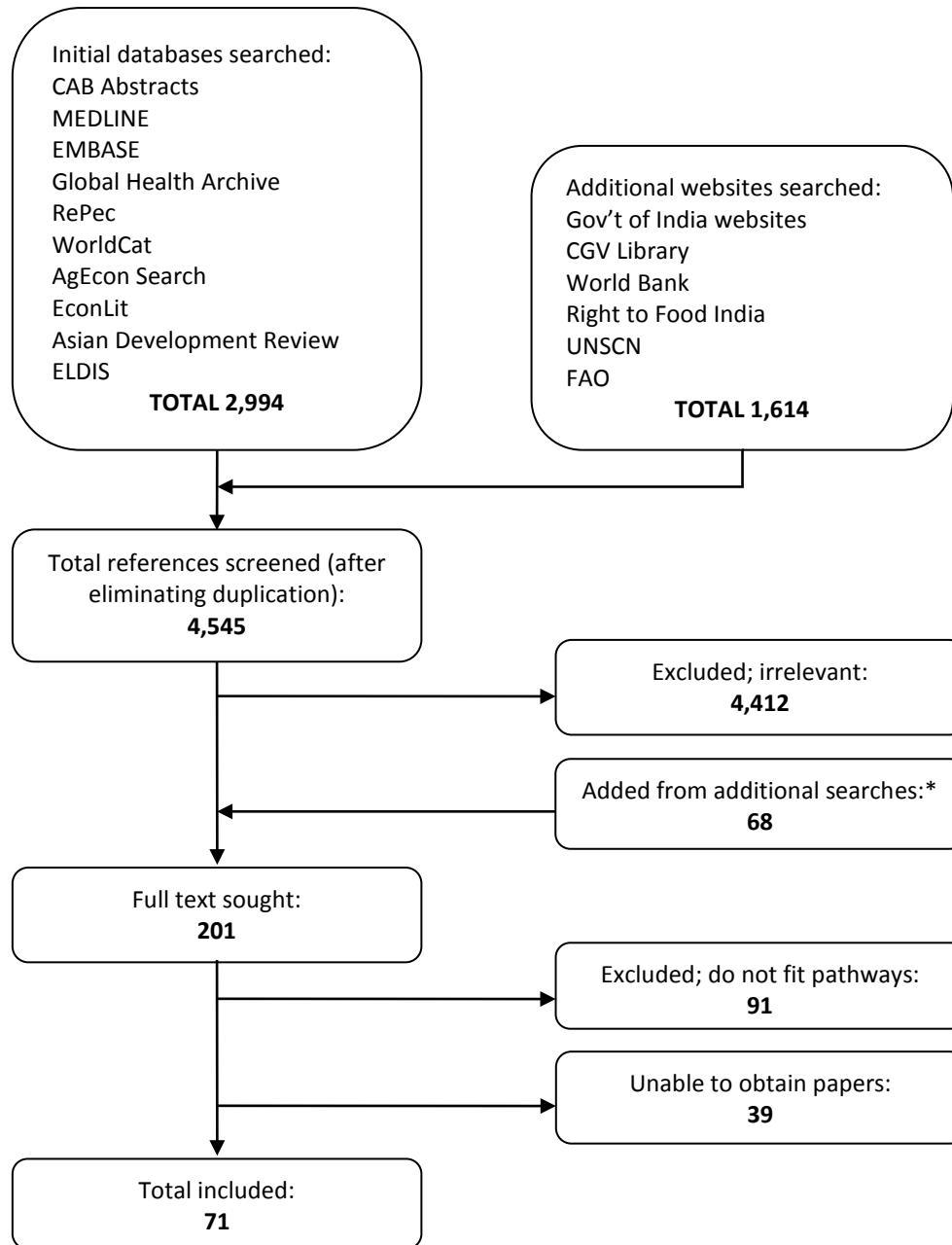
When Pathways 5–7 are taken together, it would appear that general rural livelihood characteristics matter for optimal maternal and child nutrition outcomes more than occupations per se.

4. CONCLUSION

Although there is a substantial body of literature focusing on Indian agricultural development, there is an extraordinarily thin evidence base for the links between major agriculture-related institutional, technological, and policy shifts in the past two decades and the nutritional status of women and children. It is urgent that this gap be addressed so that the nature of agriculture–nutrition links or disconnects, and their variations across socioeconomic groups and regions, can be clarified. The need for building nationally representative panel datasets that enable this inquiry in the short and long runs is crucial. Without progress in closing empirical and information disconnects, policy gaps will remain. A commitment to evaluating the impact of agriculture on nutrition outcomes and understanding its pathways is critical if India is to realize the agriculture sector’s potential to reduce undernutrition.

APPENDIX: SUPPLEMENTARY FIGURE AND TABLES

Figure A.1—Literature search strategy



Source: Author's creation.

Note: Additional searches (November 24, 2010) included the Scopus database, which became available later and yielded 93 potentially eligible papers, of which 5 were included. Also included were additional searches of CAB Abstracts, MEDLINE, and EMBASE using search terms [overweight OR obes* OR (food policy) AND agriculture AND India], yielding 6 potentially eligible papers, 1 of which was relevant but had already been included. Also added were several potentially eligible papers already held by the authors that had not been found through previous searches.

Table A.1—Data disconnect between agriculture and nutrition

Survey name	Years	Panel	Sample	National coverage	Representative at state level (and district)	Anthropometrics, nutrition indicators		Access to health services	Access to water and sanitation	Feeding and health practices	Expenditure, consumption (including food)	Agriculture: Income production, (farm, inputs, etc. nonfarm)	
						< 5 years	Adults						
NFHS-1	1992/93		Ever-married women of age 13–49 ^a	Yes	Yes	Yes (< 4 years)	Women only ^b	Limited ^c	Yes	Yes	Very limited ^d		No ^e
NFHS-2	1998/99		Ever-married women of age 15–49 ^f	Yes	Yes	Yes (< 3 years)	Women only	Yes ^g	Yes	Yes	Yes ^h		No ^e
NFHS-3	2005/06		All women of age 15–49; all men of age 15–54 ⁱ	Yes	Yes	Yes (< 5 years)	Yes	Yes ^g	Yes	Yes	Yes ^j		No ^e
ARIS	1970/71		Rural households ^{k, l}	Yes ^m	Yes						Yes ⁿ	Yes ^o	Yes ^p
REDS (HH schedule)	1981/82	Yes	Rural households ^{q, r}	Yes ^s	Yes						Yes ^t	Yes ^t	Yes ^u
REDS (HH schedule)	1998/99	Yes	Rural households ^v	Yes	Yes	Yes			Yes		Yes	Yes	Yes ^w
REDS (village schedule)	1981/82	Yes	Rural villages ^{x, y}	Yes ^z	Yes			Yes ^{aa}	Yes ^{bb}			Yes ^{cc}	Yes ^{dd}
REDS (village schedule)	1998/99	Yes	Rural villages ^{ee, ff}	Yes	Yes			Yes	Yes			Yes	Yes
ICRISAT (VLS)	1975–1985; 1989; 2001–2006	Yes	Villages ^{gg}						Yes		Yes	Yes	Yes
ICRISAT (VDS)	2010/11		Villages			Yes			Limited ^{hh}		Yes	Yes ⁱⁱ	Yes
Young lives	2002, 2006	Yes		No, only Andhra Pradesh		Yes ^{jj}		Yes	Yes		Yes ^{kk}	Yes	
DLHS I (RCH)	1998/99		Currently married women of age 15–44; men of age 20–54 ^{ll}	Yes	Yes (and district)	Yes ^{mm}		Yes	Yes	Yes			No ⁿⁿ

Table A.1—Continued

Survey name	Years	Panel	Sample	National coverage	Representative at state level (and district)	Anthropometrics, nutrition indicators		Access to health services	Access to water and sanitation	Feeding and health practices	Expenditure, consumption (including food)	Agriculture: Income production, inputs, etc. (farm, nonfarm)
						< 5 years	Adults					
DLHS II (RCH)	2002–04		Currently married women of age 15–44 and their husbands ^{oo}	Yes	Yes (and district)	Yes (< 6 years) ^{pp}		Yes	Yes	Yes		
DLHS III (RCH)	2007/08		Ever-married women of age 15–49 and never-married women of age 15–24 ^{qq}	Yes	Yes (and district)			Yes ^{rr}	Yes	Yes		No ^{ss}
NNMB	1975–79; 1988–90; 1996/97	Yes	Rural and urban households in 9–10 states ^{tt, uu}			Yes ^{vv}	Yes ^{ww}				Yes ^{xx}	Yes
NSS	1950–		All India ^{yy}	Yes	Yes (and substate)			Yes ^{zz}	Yes	Yes	Yes ^{aaa}	Limited ^{bbb}
IDD	1961; 1971; 1981; 1991	Yes ^{ccc}	Districts ^{ddd, eee}	Yes	Yes (and district)							Yes ^{fff}
Agricultural Census	1995/96 ^{ggg} ; 2000/01 ^{hhh}		All India ^{iii, jii}	Yes	Yes (and district)							Yes ^{kkk}
IHDS-I	1994/95	Cross-section	Rural household/village level ^{lll}	Yes	Yes (and district)	Yes (< 4 years & 5–12 years) ^{mmm}	Yes	Yes ⁿⁿⁿ	Yes ^{ooo}	Yes ^{ppp}	Yes ^{qqq}	Yes
IHDS-II	2004/05	Cross-section	Rural/urban, village/ block level ^{rrr}	Yes	Yes (and district)	Yes	Yes ^{sss}	Yes ^{ttt}		Yes ^{uuu}		Yes

Source: Assembled by Ananya Ghosh-Dastidar, Priya Bhagowalia, and Derek Headey, and the authors.

Notes: NFHS (National Family Health Survey); ARIS (Additional Rural Incomes Survey); REDS (Rural Economic and Demographic Survey); ICRISAT (International Crops Research Institute for the Semi-Arid Tropics); DLHS (District Level Household & Facility Survey); NNMB (National Nutrition Monitoring Bureau); NSS (National Sample Survey); IDD (Iodine Deficiency Disorder); IDHS (India Demographic and Health Survey).

Table A.1—Continued

Notes:

- ^a Sample size: 89,777 women; 88,562 households
- ^b BMI
- ^c Sources of maternal care
- ^d Food consumption by children
- ^e Wealth index only
- ^f Sample size: 89,199 women; 91,196 households
- ^g Source of healthcare for households
- ^h Food consumption by women (yes or no indicator for food category); very limited on food consumption by children
- ⁱ Sample size: 124,385 women, 74,369 men, and 109,041 households
- ^j Food consumption by men and women (yes or no indicator for food category); very limited on food consumption by children
- ^k 4,527 households
- ^l Gender of household members only
- ^m 17 major states in India
- ⁿ Value of consumption only
- ^o Some information on crop production and cropping pattern
- ^p Salary, agricultural wages, and nonagricultural wages
- ^q 4,979 households
- ^r Both 1982 and 1999 rounds: caste, religion, and gender of household members
- ^s 16 largest states of India
- ^t Both 1982 and 1999 rounds: detailed categories, both quantity and value
- ^u Household level: income from nonfarm self-employment, wages from farm and nonfarm employment, and salaries
- ^v 7,474 households
- ^w Individual level: income from nonfarm self-employment, wages from farm and nonfarm employment, and salaries
- ^x 250 villages
- ^y Religious composition only
- ^z Both 1982 and 1999 rounds: 16 largest states of India
- ^{aa} Both 1982 and 1999 rounds: distance to and availability of health facilities
- ^{bb} Both 1982 and 1999 rounds: distance to and availability of water and sanitation facilities
- ^{cc} Both 1982 and 1999 rounds: inputs, cropping practices, and yield rates
- ^{dd} Both 1982 and 1999 rounds: wage rate of various agricultural activities
- ^{ee} 253 villages
- ^{ff} Caste and ethnicity
- ^{gg} Household is primary sample unit. Six villages were originally selected from different agroclimatic zones: two from Andhra Pradesh and four from Maharashtra. In 1980 and 1981, four more villages were added from Gujarat and Madhya Pradesh.
- ^{hh} Source of water for irrigation, drinking water, toilet (yes/no)
- ⁱⁱ Income from farm and nonfarm; inventory of farm implements and livestock, plot area, irrigated area, rainfall
- ^{jj} 2,011 (1-yr-olds), 1,008 (8-yr-olds) (2002), reassessed in 2006 1,950 (5-yr-olds), 994 (12-yr-olds)
- ^{kk} Round 2 (2006) includes food and nonfood consumption expenditure
- ^{ll} 504 districts, 474,463 women, 198,566 men (one male from each household), and 529,817 households
- ^{mmm} Birth weight
- ⁿⁿ Type of house as a proxy
- ^{oo} 593 districts, 507,622 women, 330,820 men, and 620,107 households
- ^{pp} Child weight and anemia status
- ^{qq} 611 districts
- ^{rr} Where to go for treatment (household level), childcare and maternal care for women, and distance to healthcare facility (village level)
- ^{ss} Ownership of agricultural land only
- ^{tt} Four districts from each of the socioeconomic category were covered in each state
- ^{uu} Sex composition only
- ^{vv} Also on nutritional deficiency
- ^{ww} Men and women: BMI
- ^{xx} Very detailed information on food and nutrient intake (quantity)
- ^{yy} Almost all of India, except for a few inaccessible regions
- ^{zz} In the Health module: maternal and childcare
- ^{aaa} Consumer expenditure and food consumption (quantity and value)
- ^{bbb} Crop yield only from the Agricultural Survey
- ^{ccc} District boundaries are adjusted to create comparable units; cross sections are also available for years 1981 and 1991
- ^{ddd} 339 districts in 31 states and territories
- ^{eee} Sex composition; limited on caste and ethnicity
- ^{fff} Number of cultivators, agricultural laborers, and farmers; crop area and production
- ^{ggg} Only all India and state-level data available
- ^{hhh} All India, state, district, and tehsil levels (data obtained by aggregating up from tehsil level.)
- ⁱⁱⁱ 33 states in 1995–1996 and 35 states in 2000–2001
- ^{jjj} Caste group only; gender decomposition in 1995–1996
- ^{kkk} Number and area of operational holdings; characteristics of holdings (tenancy, cropping pattern, irrigation, land use, etc.); a separate Input Survey is available at district, state, and all India level for 1996–1997, 2001–2002, and 2006–2007.
- ^{lll} Sample size: 33,230 rural households from 16 states, during 1994
- ^{mmm} Height-for-age, weight-for-age, and body mass index, immunization
- ⁿⁿⁿ Distance to and availability of health facilities; sources of maternal care and immunization
- ^{ooo} Availability of drinking water facilities
- ^{ppp} Demographic data on reproductive healthcare services; mother/baby immunization
- ^{qqq} Estimates of expenditure on food and nonfood items (value), health expenditures, education expenditures; utilization of PDS (quantity of cereals purchased)
- ^{rrr} 41,554 households in 1,503 villages and 971 urban areas
- ^{sss} Healthcare, morbidity, self-reported health, immunization; morbidity (men and women)
- ^{ttt} Availability of healthcare services: government versus private quality-wise
- ^{uuu} Child health, immunization, survival rate

Table A.2—TANDI bibliography

Study	Geographic area and aims	Study design	Key findings
<p>Abdulai, Jain, and Sharma 1999 Pathway: 3</p>	<p><i>Haryana, Karnataka</i> To provide estimates of own-price, cross-price, and expenditure elasticities, and estimates of the effects of demographic characteristics on food items, for rural and urban areas of India.</p>	<p>Linear approximate almost ideal demand system (LA-AIDS) was used to determine elasticity of consumer expenditure allocation between food and nonfood goods, then between food types, from survey data taken from 1,100 households in 1995/96.</p>	<ul style="list-style-type: none"> • The estimated parameters showed that only milk and milk products were income elastic in both rural and urban areas. Meat, fish, and eggs also appeared to be income elastic in urban areas. All other food groups were income inelastic. Meat, fish, and eggs appeared to be income elastic in urban areas because of their relatively high share of the food budget, compared with their share in rural areas. • Food demand was quite responsive to price changes. Thus, as prices of the commodities increased, expenditure allocated to them was expected to decline. • Demographic variables such as region, household size, and education were important in explaining observed differences in food consumption patterns. • If food supply can be increased to maintain food prices constant, increases in consumer incomes may result in considerable improvements in food consumption. Policies aimed at increasing food supply without a simultaneous increase in incomes of nutrient-deficient consumer groups may entail large nutritional waste and are therefore ineffective.
<p>Agarwal 1984 Pathways: 5, 7</p>	<p><i>India—National</i> To highlight why the issue of women and poverty requires special attention in India, and to assess the likely impacts of current patterns of agricultural growth on poor, rural women.</p>	<p>Literature review and analysis of secondary data</p>	<ul style="list-style-type: none"> • Direct impact of agricultural growth on female poverty is likely mediated by female access to income-earning opportunities. Female participation in the workforce is a direct result of poverty. • Indirect impact is mediated by household economic position total. • Female earnings are positively related to higher proportion of expenditure on food and basic necessities, and inversely related to extent of intrahousehold gender bias and dowry payments. • Mechanization has disproportionately affected women, easing work that is traditionally male (such as plowing) and displacing work that is traditionally female (such as processing). • The northwestern region has broadly seen the highest agricultural growth but historically has higher gender discrimination, evidenced by sex ratios.
<p>Ahmed and Lorica 2002 Pathways: 1, 2</p>	<p><i>Developing countries</i> To provide a framework for examining aquaculture's linkages to food and nutritional security by elucidating key hypotheses concerning the role of aquaculture in household food and income systems in developing countries.</p>	<p>Literature review with case study examples, including one from India</p>	<p>Analysis revealed clear evidence of positive income and consumption effects of aquaculture on households. However, employment effects were still not significant. National policies for aquaculture development will need to concurrently address the food security and poverty questions more sharply than has been done up to the present, by providing institutional and infrastructure support for access to resources such as land and water and to markets by poor households.</p>

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Alderman 1987 Pathways: 1, 2	<i>Karnataka</i> To discuss the effects of dairy cooperatives on milk and nutrient consumption and on income	Used multivariate regression techniques to analyze data from five rounds of household surveys collected between January 1983 and April 1984 in two of the three ecological zones of Karnataka covered by the Karnataka Dairy Development Project. Households surveyed in each zone (n = 806) came from 42 villages with dairy cooperatives (intervention group) and 10 villages without (control), stratified by landholding status.	<ul style="list-style-type: none"> • Dairy cooperatives increased milk production by up to 100 percent, mainly through changes in herd size and composition rather than increased output per cow. • No significant effect on other income, income distribution, cropping pattern, or grain price was seen. • A significant rise in the price of buffalo milk (of 3 percent) and a rise in the price of cow milk was seen. • A reduction in milk and nutrient consumption was found in nonproducers of milk in cooperative areas. • A reduction in milk consumption was also seen in milk producers, but intake of other nutrients increased due to increased income. • Any increase in nutrient intake appeared to be due to increased income rather than increased milk intake in areas with functioning milk cooperatives and was seen only in the milk producers themselves.
Atkin 2010 Pathway: 3	<i>India—National</i> To provide a more complete understanding of the nutritional agricultural trade on the poor through examining the role of tastes in international trade.	Introduced habit formation into an otherwise standard model of international trade and examined the predictions of this model, using data from the National Sample Survey (NSS), 43rd round (1987/88), both by looking across Indian regions and by examining the consumption patterns of interstate migrants.	Household tastes evolve over time to favor foods consumed as a child. The opening of trade causes preferred goods, which were impacts of relatively inexpensive in autarky, to rise in price. Results suggested that, holding total food expenditure constant, there will be an average caloric loss of 2.7 percent coming from the correlation between tastes and price changes (about 54 calories per person per day). Neglecting the correlation between tastes and agroclimatic endowments overstates the short-run nutritional gains from agricultural trade liberalization and masks potential caloric losses for laborers.
Babu, Thirumaran, and Mohanam 1993 Pathways: 1, 2	<i>Tamil Nadu</i> To analyze changes in energy and protein intake and intrahousehold allocation/gender bias due to changes in agricultural productivity.	Analysis of cross-sectional survey data from 120 rural households (nonagricultural, landless agricultural laborer, subsistence farming, and commercial farming) over six different seasons (three years). Measures included crop yields, food expenditure, food consumption assessed by weighed records, and household and individual energy and protein intakes, calculated using Indian food composition tables.	<ul style="list-style-type: none"> • Seasonality influenced variation in energy and protein intake, but subsistence agricultural households recovered faster from poor crop yields than market-oriented agricultural households. • Landless agricultural labor households consumed the lowest quantities of energy and protein in all the seasons and had the highest degree of gender bias, particularly in protein intake. • Nonagricultural households were least affected by variability in crop yields and seasonality. • While energy and protein intake of rural households was positively correlated with crop yields, the variations in yields worsened the gender bias. • Authors argued that reducing dependency of rural households on agriculture may reduce malnutrition and the gender bias associated with it.
Bains, Kaur, and Mann 2002 Pathway: 6	<i>Punjab</i> To measure the energy cost of selected household and farm activities for rural, low-income women.	Anthropometric indicators, food intake, and daily activity were recorded for 30 nonpregnant, nonlactating women aged 25 to 35 years. Energy expenditure was calculated by applying the energy cost of each activity as given by James and Schofield (1990).	All selected activities (farm and household) were categorized as light, except for grinding masala, mopping, mud pasting, harvesting wheat, separating paddy, and milking, which were categorized as moderate on the basis of FAO physical activity ratios. Overall daily effort was seen as likely to be light to moderate.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Barker et al. 2006 Pathway: 6</p>	<p><i>Maharashtra</i> To identify social and economic factors associated with an observed difference in thinness between men and women, and to explore the behavior that might underlie these associations.</p>	<p>Compared height and weight in men and women in 90 families in a rural, agricultural community, and assessed their social and economic details, fasting practices, and oil consumption.</p>	<ul style="list-style-type: none"> • Women in joint landowning families (in which several families or several generations of a family live together), where the main occupation was farming, were thinner than those in nonfarming families. This was not true of men in this type of family. • Men in “cash-rich” families had higher BMI than men in non-rich families. There was no corresponding difference in women’s BMI. • In a subset of 45 families, women were more likely to work full-time in farming than men, to carry the burden of all household chores, to have less sleep, and to eat less food away from home than men. Women fasted more frequently and more strictly than men. • Despite identifying significant differences in behavior between men and women in the same household, a direct link was not found between behavior and BMI.
<p>Bennett 1992 Pathways: 5, 6</p>	<p><i>India—National</i> To consider the effect of gender on access to employment, income, and consumption within the household and beyond.</p>	<p>Literature review with some new analysis of Indian national data, including from the 1981 census of India and the 32nd and 38th rounds of the NSS.</p>	<ul style="list-style-type: none"> • In families with 20 acres or more, none of the women worked for wages, while among the landless, female agricultural labor was common. • The incidence of female agricultural labor was positively correlated with district-level agricultural growth rates and (contrary to the theory that commercialization pushes women out of agriculture) with the share of gross cropped area planted in cash crops. • Increases in women’s income translated more directly into better health and nutrition for children than did increases in men’s income. • A woman’s employment outside the home may reduce the time she has for good childcare and feeding practices. Efforts to increase women’s labor force participation can help improve nutrition in the most vulnerable households, but they will be most effective if they are linked to provision of childcare facilities.
<p>Berman et al. 1997 Pathways: 5, 7</p>	<p><i>Haryana</i> To show that women’s employment and earnings foster increased allocations of household resources to children’s well-being, and that increased maternal empowerment positively influences household spending patterns.</p>	<p>Household and community study of maternal employment and child health in 1989/90, using data on maternal employment and resources allocated to young children during 1,006 episodes of illness reported from a sample of 276 lower-income rural households. Demand for healthcare was expressed as total expenditures per episode of illness and tested with a reduced-form approach derived from household economics. Several different models were run to test three hypotheses about the effect of women’s work and earnings.</p>	<p>While increases in household income were positively linked to greater expenditures on child healthcare, women’s earnings and labor force participation did not lead to increased expenditures for curative healthcare for young children. In fact, households where women are employed may spend less on curative health services for children, on average, than households where women are not paid workers, since women’s earnings consistently had a negative coefficient in the estimated equations, although this was not significantly different from zero. One model provided evidence that the amount of working time of women, both paid and unpaid income-generating work, contributed to this negative result, possibly through increasing the opportunity cost of seeking child healthcare. The attributes of work as well as the social and cultural environment were important mediators of such effects. More was spent on curative healthcare for boys than for girls, and there was some indication of higher spending for younger children.</p>

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Berti, Krasevec, and FitzGerald 2003 Pathway: 1	<i>Developing countries</i> To review the impact of agriculture interventions on nutritional status in participating households and to analyze the characteristics of interventions that improved nutrition outcomes.	Review of intervention assessments (including some in India and other South Asian countries), particularly focusing on investment in capital, as defined in the Sustainable Livelihoods Framework.	All of the studies included in the review had a nutrition monitoring component. Among them, the intervention group showed improvement or better status than the control group in terms of diet (21 of 25 cases), anthropometrics (7 of 16 cases), biochemical/clinical indicators (5 of 10 cases), and morbidity (5 of 8 cases). Nutrition by these measures was improved in 11 of 13 home gardening interventions, and in 11 of 17 other types of intervention. Those agriculture interventions that invested broadly in different types of capital were more likely to improve nutrition outcomes. Those projects that invested in human capital (especially nutrition education and consideration of gender issues) and other types of capital had a greater likelihood of effecting positive nutritional change, but such investment is neither sufficient nor always necessary to effect change.
Bhalotra 2010 Pathway: 6	<i>India—National</i> To investigate the impact of aggregate income shocks on infant mortality in India, and likely mechanisms.	Used individual data on infant mortality for about 150,000 children born from 1970 to 1997, merged by cohort and state of birth with a state panel containing information on aggregate income. Compared the effects of annual deviations in income from trend on the mortality risks of children born at different times to the same mother, conditional upon a number of state-time varying covariates, including rain shocks and state social expenditure.	Rural infant mortality was associated with income shocks. The author suggested that this was in part related to recessions' stimulating distress labor among mothers, leading to less time for childcare; the paper showed that there was a strong negative correlation between maternal labor supply and a range of child health and survival outcomes, and mothers' participation in rural agricultural activity had consistently adverse effects on each of the 10 indicators of health seeking studied. This effect was concentrated among rural mothers, among whom a 5-percent decrease in state income was associated with a 4.7-percent increase in agricultural work participation. Antenatal and postnatal health seeking were lower in recessions and lower among mothers who worked in agriculture.
Chand 2004 Pathway: 3	<i>India—National</i> To assess the impact of agricultural and trade reforms on agriculture, food security, income, and poverty in India.	National agricultural and economic data, including several rounds of NSS and government of India crop production data, were used to assess growth rates of agricultural output, food security, nutrition, regional equity, price stability, farm income, and welfare of consumers and producers.	<ul style="list-style-type: none"> • Patterns in poverty, undernourishment, calorie and protein consumption, and cereal intake showed that poverty and cereal intake played important roles in household nutritional security in rural India. High growth rates in output of fruits, vegetables, and livestock products in India during the 1990s did not help to improve nutrition in India, and stagnation in pulse production was a major cause of protein deficiency. • There was modest increase in per capita income of farm and labor households during reforms, contributed more by nonfarm incomes than by farm incomes. There was also significant reduction in poverty. However, household food security and nutrition worsened during reforms, the reason for which seems to be high growth in prices of cereals due to government policy.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Datt and Ravallion 1998 Pathway: 3	<i>India—National</i> To assess the extent to which India's rural poor share in agricultural growth. The study tested how much India's rural poor have benefited from gains in average farm productivity, what role labor and food markets have played, and whether the impacts were distributionally biased one way or another.	Estimation of a model of the joint determination of consumption–poverty measures, agricultural wages, and food prices, combining data from 24 household sample surveys spanning 35 years (24 rounds of the NSS, spanning 1958–94) with other sources, such as farm yield and the Consumer Price Index for Agricultural Labourers.	<ul style="list-style-type: none"> • Higher farm productivity brought both absolute and relative gains to poor rural households. A large share of the gains was via wages and prices, although these effects took time. The benefits to the poor were not confined to those near the poverty line. • The poorest in rural areas tended to be net consumers of food, in that they had insufficient land for their own consumption needs. So, to the extent that higher farm yields put downward pressure on food prices, the poorest will gain. Against this, there may be poor net producers of food who lose. In most of South Asia, the general presumption is that the poorest in rural areas will tend to gain from higher food output and hence lower food prices. • The poor gained in absolute terms from lower relative prices of food. However, this effect was not evident in measures of relative poverty. This study's results suggested that the bulk, but not all, of the gains to the poor from higher farm yields and higher real wages were via rising average living standards rather than improved distribution. • While the impact of agricultural growth on food prices was quantitatively small, even small food price changes can have large effects on absolute poverty.
De Walt 1998 Pathways: 1, 2, 3, 5, 7	<i>Developing countries</i> To examine the impacts of agricultural commercialization on consumption and nutritional status.	Reviewed the results of existing studies over the past decade (not in India specifically, but with implications for India).	<ul style="list-style-type: none"> • The income effects of shifts to cash cropping were highly dependent on pricing policy for cash crops. Short-term gains seen in some schemes food were often highly dependent on the maintenance of high prices for commercial crops. • Those schemes in which subsistence production was protected or stabilized were more likely to show positive results with an increase in income generated from cash cropping. • Increased income did not translate directly into increased food consumption at either the household or individual (child) level. Shifts in control of income from women to men were important. • Morbidity, especially from diarrheal disease, was an important predictor of child growth. A failure to improve morbidity of children may offset gains in food consumption, and in some instances a decrease in the time women have to care for their children as a result of commercialization has resulted in greater morbidity among children.
Deaton and Drèze 2009 Pathway: 2	<i>India—National</i> To review recent evidence on food intake and nutrition in India, particularly regarding the decline of average calorie intake during the last 25 years.	Literature review and analysis of data from NSS rounds from 1983 to 2004/05.	<ul style="list-style-type: none"> • The study found strong evidence of a sustained decline (of about 10 percent) in per capita calorie consumption during the last 25 years or so. The proportionate decline was larger among better-off sections of the population, and close to zero for the bottom quartile of the per capita expenditure scale. • Decline of per capita consumption was not limited to calories. It also applied to proteins and many other nutrients, the major exception being fat consumption, which has increased steadily. • It would be difficult to attribute the decline in calorie consumption to declining per capita incomes, or to changes in relative prices. Indeed, the evidence pointed to rising per capita incomes (especially—but not exclusively—among the better-off), with little change in the price of food—or calories—relative to that of other commodities. Thus, the main point was that per capita calorie consumption is lower today at a given level of per capita household expenditure, and this applies across the expenditure scale, at low levels of per capita expenditure as well as high. In other words, the decline in calorie consumption in rural areas is associated with a steady downward drift of calorie Engel curves, the plots of per capita calorie consumption against per capita expenditure. • One possible explanation for this drift is that calorie requirements have declined, due to better health as well as lower activity levels. • Because there is considerable uncertainty about the causes of the calorie decline (and because it is a poor indicator of nutrition overall), it is difficult to assess its welfare implications. There is an urgent need for better nutrition monitoring arrangements in India.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Deshpande, Mishra, and Mishra 2001 Pathway: 2</p>	<p><i>Madhya Pradesh</i> To assess food and nutrient intake, and differential expenditure on food and nonfood items, depending on household landholdings, in a rural population.</p>	<p>Cross-sectional study of 204 households in four rural villages.</p>	<p>High correlation between income and expenditure was observed, with no variation in proportion of income spent on food and nonfood items with income.</p>
<p>Dewey 1990 Pathways: 1, 2, 3, 7</p>	<p><i>India—National</i> To assess the impact and mechanisms of agricultural change (the growing of cash crops) on nutrition, and to discuss policy implications.</p>	<p>Literature review.</p>	<ul style="list-style-type: none"> • Changing agriculture affects the social and economic structure of communities, including altered land tenure, involvement with markets, labor relations, and migration for labor. Commercialization of agriculture can also have ecological impacts, altering ability to produce food. • Cash crops alter the availability and price of foods, and may entail a shift in the control of production away from the household. For a shift in agriculture to have a benefit for nutrition, income gains must be great enough to override any obstacles. • The value of cash crops is measured in monetary value and is volatile, whereas the value of subsistence crops is measured in nutritional value and is static; subsistence farmers make decisions to minimize risk rather than maximize profit. A household growing cash crops will make money rather than food, but this money may not cover the cost of food to eat. • Commercialization may lead to the substitution of purchased foods for traditional foods and a change in dietary diversity; the nutritional impact will depend on choices made and may be positive or negative, depending on initial diet quality, income levels, and crops grown. • Commercial agriculture can undermine the economic power of women, since it tends to be dominated by men, and this has been shown to reduce spending on food needs. Intrahousehold distribution may also be altered, with higher workloads for men leading to higher caloric requirements at the expense of other household members. • Commercialization of agriculture is a necessary component of rural development and provides a buffer against seasonal or climatic conditions. However, nutritional considerations and the role of women must be incorporated into policy to effect meaningful change in the circumstances of rural people.
<p>Dixit 2011 Pathway: 3</p>	<p><i>Gujarat</i> To analyze levels of rural poverty and nutrition in Gujarat, in the context of high economic growth in the state.</p>	<p>Literature review and data analysis comparing and correlating growth in Gujarat, contrasting with national and global trends, and assessing drivers of these.</p>	<p>High growth in Gujarat, which has followed the market-oriented trickle- poverty, and undernutrition rates in down pattern advocated by neoliberal economic policies, has not led to significant reductions in rural (as opposed to urban) poverty and undernutrition (calorie availability). Active state intervention in agriculture (focusing on poor farmers) and nutrition (possibly through food subsidies) is required in Gujarat.</p>
<p>Durnin, Drummond, and Satyanarayana 1990 Pathway: 6</p>	<p><i>Andhra Pradesh</i> To study physiological adaptations to seasonal food shortages.</p>	<p>Compared serial anthropometric measurements (three in lean season and three in harvest season) and food intake in 102 economically poor women working in agriculture and 30 nonworking, middle-income women.</p>	<p>There was a small loss in body weight and body fat, and reductions in energy intake, BMR, and exercise capacity in the working women. No changes occurred in the nonworking women. The nutritional stress imposed by the seasonal food shortage seemed minor in degree but did seem to induce some small adaptations.</p>

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Duvvury 1998 Pathway: 5	<i>India—National</i> To discuss the impact of structural adjustment on women working in agriculture.	Policy and literature review.	Funding for social support programs such as health and nutrition services, the PDS, and water and sanitation services has been cut back as part of economic reforms. Women are expected to increase time spent on agricultural and income-earning activities while not reducing time on household activities, and this is made more difficult by a reduction in these social safety nets.
FAO 2007 Pathways: 1, 2	<i>Himachal Pradesh</i> To document the main findings of vulnerability profiling work carried out in support of food security and livelihoods intervention planning at the state level.	The study followed a livelihoods-based approach, collecting qualitative and quantitative data over the year 2004/05. Methods included a review of existing data to identify information gaps, including NFHS-3 for nutrition and health data; stakeholder workshops to identify vulnerable livelihood groups; community-level qualitative research, including key informant interviews, focus group discussions, and in-depth semi-structured interviews; and validation workshops.	<ul style="list-style-type: none"> • Subsistence farming households, characterized by both dependence on rainfed agriculture and access to very small landholdings, were found to be highly vulnerable to food insecurity. • Marginal commercial farmers were found to be somewhat less vulnerable due to their higher returns on production. However, land fragmentation appeared to have intensified vulnerability to climatic and market-based shocks for this livelihood group. • The most chronically food insecure of the livelihood groups identified and analyzed were the primarily laboring households (either of local origin or economic migrants, farm or nonfarm labor).
Gaiha 1999 Pathway: 3	<i>India—National</i> To explore the reasons for persistent undernutrition in India despite social protection programs such as the PDS.	Data from 71 rural households, drawn from panel surveys covering the years 1979–84, were used to explore the contribution of income to demand for food and calories. This analysis was combined with state-level data on hunger and discussed in relation to policies.	Chronic undernutrition was found to persist in India despite adequate food supply. The problem was essentially distributional; low food entitlements reflect low incomes. Although the public distribution of food has a potentially significant role, actual benefits to the poor were negligible, while the fiscal burden has been increasing. Cost-effectiveness will require drastic reform of the system, particularly its targeting.
Gaiha 2002 Pathways: 2, 4	<i>Andhra Pradesh, Karnataka, Maharashtra</i> To assess to what extent expenditure switching occurred in response to the economic crisis and structural adjustment of the early 1990s, and to explore impact on the poor.	Macro and sectoral economic data (from the Economic Survey of India and the Monitoring Indian Economy) were combined with survey data from 159 households (chosen by probability proportional to size method to represent different agroclimatic zones in three states) in order to assess expenditure switching in response to impoverishment, income, and shocks.	<ul style="list-style-type: none"> • Switching between crop and other agricultural and nonagricultural incomes occurred in impoverished households, as a coping mechanism. • There was very little switching of expenditure; food, medical, and educational expenditures tended to rise or fall similarly. • There is a case for strengthening public provision of goods and services, particularly through the PDS.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Gaiha, Jha, and Kulkarni 2010 Pathway: 2	<i>India—National</i> To provide an alternative explanation to that of Deaton and Drèze (2009) for the observed decline in calorie and other nutrient intakes, specifically changes in the pattern of food consumption and intake of calories, proteins, and fats.	The explanation was embedded in a standard demand theory framework, assessing food prices and expenditure (as a proxy for income). Based on different experiments, the authors estimated robust demand functions for each of the three nutrients separately for rural and urban areas. Data came from the 50th and 61st rounds of the NSS (1993/94 and 2004/05, respectively).	Results showed consistently robust food price and expenditure effects and captured shifts in food price elasticities over time. Over and above these effects, there were shifts in demands due to factors other than those specified in the demand equation. For example, the authors found it plausible that part of the reduction in calorie consumption was due to health improvements and less strenuous activity levels—especially in but not necessarily confined to rural areas. So, while not rejecting the Deaton and Drèze (2009) explanation, the authors found it arguable that the demand-based explanations could complement it. Specific findings included these: <ul style="list-style-type: none"> • Cereal (rice and wheat) price was negatively related to the demand for calories, while the coefficient of inferior cereals was not significant. • Other food prices that reduced calorie demand were those of vanaspati oil (hydrogenated vegetable oil) and vegetables. • Food prices that were positively associated with calorie demand were those of milk/milk products/ghee/butter, sugar, eggs, pulses/nuts, and dry fruits/others. • Since these coefficients are elasticities, they are comparable. Cereal prices had a moderately negative elasticity while sugar had a moderately positive elasticity. Other (absolute values of) elasticities were relatively small. • Per capita expenditure (as a proxy for income) had a significant positive effect on calorie demand, with a high elasticity.
George 1984 Pathways: 2, 3	<i>Kerala</i> To discuss the implications of starting an Anand-style dairy cooperative in a village in Kerala.	Described the findings of a livestock survey and a survey of 207 rural households.	Small amounts of milk are currently purchased or produced within households and are predominantly given to children. It was hypothesized that the introduction of an Anand-style dairy cooperative would reduce dairy intake directly and indirectly, through the reduction in availability of small quantities for purchase with preference for bulk sale, and through a decline in the manufacture of ghee in the local area.
Ghosh 2007 Pathway: 6	<i>India—National</i> To assess the overall effects of land reform on female nutrition, measured as women’s height.	Individual-level data from NFHS-2 (1998/99) was merged with a state-level dataset on land reform legislations in India’s 16 major states.	Preliminary results suggested that land reforms, especially reforms targeting the abolition of intermediaries and imposition of land ceilings, did lead to a significant improvement in women’s height.
Griffiths and Bentley 2001 Pathway: 7	<i>Andhra Pradesh</i> To examine the emerging nutrition transition for women living in rural and urban communities in India, and to identify socioeconomic, regional, and demographic determinants of overweight and thinness.	Logistic regression analyses were applied to NFHS-2 data.	Overall, 37 percent of women were underweight and 12 percent overweight. In the rural areas, in which 74 percent of the sample resided, 43 percent had a low BMI; women from lower socioeconomic groups were significantly more likely to have a low BMI, and women working in agriculture were 1.52 times more likely to be underweight (confidence interval 0.39 to 1.16 times).
Gupta 2009 Pathway: 3	<i>India—National</i> To examine the main elements of agricultural policy in light of recent economic and agricultural developments, particularly the food price crisis, climate change, and the malnutrition problem in India.	Literature review and analysis of national production, consumption, and economic data.	<ul style="list-style-type: none"> • Continued growth of the agriculture sector is important for maintaining food and nutrition security, and enhancing the purchasing power of the rural population. • Expansion of agriculture requires public investment in agriculture and rural infrastructure, and regulation of farm inputs and services. • There is a need to create employment opportunities and balance foodgrain self-sufficiency with agricultural diversification to higher-value crops for improved income and nutrition.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Haddad and Zeitlyn 2009 Pathway: 3	<i>India—National</i> To assess why economic and agricultural growth in India has not led to large improvements in undernutrition.	Presented and summarized papers from more than 20 Indian authors.	Argued that the problem of undernutrition reflects failures in governance (accountability and corruption) and targeting, and that the benefits of economic growth have not trickled down to the poor, while the wealthy are increasingly using private services.
Islam and von Braun 2008 Pathway: 3	<i>South Asia</i> To assess the past and potential role of agriculture in reducing poverty in South Asia.	Policy review.	Encouraging agricultural and rural growth will not be enough to ensure that the poor are included in the benefits of growth. Investments in education, health, and nutrition are also required. A pro-poor rural growth strategy must adopt a concept of nutritional deficiency that goes beyond calories. The human resources agenda for rural poverty reduction should include increased attention to micronutrient malnutrition and food safety as well as to agriculture–health linkages. Development of the food system to improve food security and nutrition is thus part of pro-poor agriculture and rural development.
Jha 2007 Pathway: 3	<i>India—National</i> To examine the key elements of the contemporary agrarian crisis and its possible consequences for agricultural laborers.	Keynote background paper using national-level agricultural statistics.	<ul style="list-style-type: none"> • Agriculture requires substantial state support, and it is precisely this support that has been hit hard by neoliberalism. • The all-India annual absorption of foodgrains per capita fell by 22 kilograms between 1995–98 and 2000–03. This would imply that a larger section of the population is further exposed to food vulnerability, reflected in hunger and malnutrition.
Jha, Gaiha, and Sharma 2006 Pathway: 2	<i>India—National</i> To test the hypothesis that an increase in income would increase nutrient intake.	Nutrient–expenditure elasticities for two macronutrients (calories and protein) and five micronutrients (calcium, thiamine, riboflavin, carotene, and iron) are calculated using an all-India sample of rural households for 1994.	For each nutrient, the respective elasticities were positive and significant, suggesting that an increase in income would increase nutrient intake. Increases in income of the poor would lead to greater increases in their nutrient intake as compared with the nonpoor, although the magnitudes would be small.
Jha, Imai, and Gaiha 2009 Pathway: 3	<i>India—National</i> To analyze the effects of access to rural public works (RPW) and the PDS, a public food subsidy program, on consumption poverty, vulnerability, and undernutrition in India.	Used NSS data, 50th and 62st round (1993/4 and 2004/5). Used the treatment effects model and propensity score matching (PSM) model to take account of the sample selection bias in evaluating the effects of RPW or PDS on poverty. Also applied the pseudo-panel model to test for effects on vulnerability.	Found significant and negative effects of household participation in RPW and food-for-work programs on poverty, undernutrition, and vulnerability in 1993 and 2004. Poverty and undernutrition were significantly higher for households with access to PDS than for those without, although PDS had significant effects in terms of reducing vulnerability of households in 1993 and 2004. PDS decreased vulnerability based on 80 percent of the poverty threshold. Results of the treatment effects model by state show considerable diversity of policy effects across states.
Jones et al. 2005 Pathway: 1	<i>South Asia</i> To evaluate a horticulture initiative in rural Nepal in terms of nutrition knowledge, complementary feeding, and the production and consumption of vitamin A–rich and high-value crops.	Cross-sectional study of participants 36 months after initiation of the program.	Nutrition knowledge was very low in this population, but knowledge was higher in the group having received the intervention. This group was also more likely to feed nutritionally rich complementary foods to children, to preserve foods, and to consume home-produced micronutrient-rich plant foods.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Joshi 2004 Pathway: 2	<i>Punjab</i> To highlight changes in the levels of real farm income, investment, and household consumption in rural Punjab during the Green Revolution.	Analyzed changes in income and consumption over time. Data were collected and reported regularly between 1970/71 to 2000/01 by Punjab Agricultural University, from 300 farmers in different agroclimatic zones, using the cost accounting method.	<ul style="list-style-type: none"> • Farm household income (total) increased from Rs 4,594 in 1970/71 to Rs 50,124 in 2000/01. • Per capita real farm family consumption expenditure increased from Rs 740 to Rs 6,215 between 1971/72 and 2000/01. • The proportion of expenditure on food items increased from 55.40 percent in 1970/71 to 59.57 percent in 1980/81 and came down thereafter to 40.94 percent in 2000/01. • The proportion spent on fuel, clothing, and housing increased from 32.49 percent to 45.76 percent over the same period. The share of education in total expenses always remained below 2 percent.
Kataki 2002 Pathways: 1, 3	<i>South Asia</i> To compare food consumption habits, nutritional status, and cropping patterns since the emergence of the rice–wheat cropping system.	Data from the FAO, World Health Organization (WHO), and field surveys in Nepal were combined in order to look at cropping patterns, child stunting and underweight, and adult malnutrition (BMI < 18 or > 25) in different areas of India.	<ul style="list-style-type: none"> • Cereal consumption was correlated with stunting and underweight, suggesting that much of the reason for slowed progress in combating malnutrition is micronutrient malnutrition. • Shifting to diversified cropping (including more legumes and vegetables) would improve micronutrient status, and could provide sufficient diverse foods in a predominantly vegetarian society such as India.
Kaur 2005 Pathways: 5, 7	<i>Punjab</i> To assess female time use and employment in the household and the agriculture sector, and discuss the implications.	Time use survey data (contrasted with official census statistics) from two time periods (1989/90 and 2000) to evaluate women’s time use.	<ul style="list-style-type: none"> • The official estimate of women’s participation in agriculture was a gross underestimate. Women played a significant role in income-generating activities, particularly in caring for livestock and agricultural laboring. • Development has led to some withdrawal of women from the labor market and confined them to household and reproductive work, the burden of which has increased with development. This household labor and production of goods for consumption rather than sale is not captured in macro-level statistics.
Kennedy 1994 Pathways: 2, 4, 7	<i>Developing countries</i> To assess the impact of agricultural commercialization on the nutrition and health status of women and children, and the mediators of any impact found.	Analysis of nutrition, health, demographic, and socioeconomic data collected in several methodologically similar case studies undertaken in various settings, including one in India.	<ul style="list-style-type: none"> • None of the case studies reported showed a clear negative effect of the commercial agriculture schemes on children’s health and nutritional status either in the food-based commercialization schemes or in the nonfood cash-crop schemes. • The increases in income that are associated with participation in the various commercial agriculture schemes were not found to decrease child morbidity, at least in the short and medium run captured by the studies. Gains in health will depend on the type of nonfood expenditure seen with increased incomes; expenditure that does improve health may be short-run expenditure (for example, medicines), or long-run expenditure (for example, improved housing or education). • While increases in income would be expected to bring about improvements in overall health and welfare in the longer term, in the short term it appeared that increases in income must be combined with public action to improve the health environment in order to have significant effect. • Beyond total household income, female-controlled income had a positive and significant effect on household food intake in many cases. Female-controlled income was more likely than male-controlled income to be spent on food. Therefore, household food security appeared to be influenced by both the total amount of household income and the proportion of income controlled by women. • Increased household income in rural areas, based on agricultural growth (which also includes the smallest farmers and the landless), can make a major contribution to solving the hunger problem. However, it cannot in itself provide a complete solution to the problem of child malnutrition.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Khullar, Sekhon, and Kaur 2007 Pathways: 2, 3</p>	<p><i>Punjab</i> To assess the dynamics of consumption over two decades in rural India, and the influence of liberalization and social factors.</p>	<p>Used secondary data from the survey Family Budget of Selected Cultivators in Punjab from 1981/82, 1995/96, and 2002/03 to assess expenditure on food and nonfood commodities across income groups.</p>	<ul style="list-style-type: none"> • Proportionate expenditure on food items declined over the period of decades. Among food items, both expenditure and quantity consumed declined for rice, milk and dairy, and sugar. Expenditure also declined for wheat and increased slightly for fruits, while quantity of oil and ghee consumed increased. • Proportionate expenditure on nonfood items increased over the decades, particularly on housing, lighting, and education. • The effects of income and liberalization were positive for most food items and for total domestic expenditure. “Social forces” appeared to have influenced spending as much as rising income.
<p>Krishna 2006 Pathway: 2</p>	<p><i>Andhra Pradesh</i> To assess reasons for households’ moving into and out of poverty over 25 years and the coping strategies they employed.</p>	<p>The stages-of-progress approach, involving focus group–style interviews, was developed in order to understand concepts of poverty in the study area and gain insight into potentially useful policies to avoid poverty. Households were then categorized according to these concepts of poverty and assessed for change in status.</p>	<ul style="list-style-type: none"> • The proportion of poor households had not changed over time, but many households had moved into or out of poverty. • Food, rudimentary shelter, repayment of overdue debt in installments, and basic clothing were seen as the most important expenditures in all villages, in that order. • Health and health-related expenses constituted numerically the single largest factor associated with descent into poverty, but the effects of this factor upon descent into poverty were compounded by the presence simultaneously within the household of high-interest private debt. High social expenses on marriages and funerals constituted another important reason for households’ descent into poverty. Everything else being the same, the odds of a nonpoor household’s falling into poverty increased by more than four times when it was faced simultaneously with both of these conditions. Drought was another important factor significantly associated with descent into poverty. • Diversification of income sources—and not employment generation in the private or public sectors—constituted the most important factor associated with escaping poverty in this region. Diversification within agriculture was more important than diversification to other businesses. Irrigation was significantly associated with many cases of escaping poverty. • Policies should look at both raising households out of poverty and keeping them from falling into poverty, based on actual reasons for each of these situations.
<p>Kumar 1977 Pathways: 1, 2, 7</p>	<p><i>Kerala</i> To assess child nutrition in relation to source of household income.</p>	<p>Cross-sectional study.</p>	<ul style="list-style-type: none"> • The component of household income with the most consistently positive effect on child nutrition was farm income, suggesting that subsistence production had a protective effect on nutrition. • Wage income was not related to child nutrition except in households where the mother was in the labor force, implying that maternal income plays a more important role than paternal income in regard to child nutrition.
<p>Kumar and Dey 2006 Pathway: 2</p>	<p><i>India—National</i> To assess nutritional status and identify factors influencing nutritional intake of farm households in rural India.</p>	<p>Household survey using data from NSS rounds 1983 to 1999/2000, assessing income and undernourishment (protein and calorie intake below threshold levels reported in NSS data).</p>	<p>Incidence of poverty and undernourishment was greater among landless agricultural laborers and small landholders (< 1 hectare). Education, rice–wheat cropping systems, irrigation, livestock, and aquaculture were identified as major factors affecting poverty and food security, and these need to be accorded high priority.</p>

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Kumar, Mruthyunjaya, and Dey 2007 Pathway: 3</p>	<p><i>India—National</i> To assess long-term changes in food consumption patterns in poor and nonpoor Indian households, and the implications of these changes for nutrition and food policy.</p>	<p>Cross-sectional survey using data from the 38th and 55th NSS rounds (1983 and 1999/2000), covering 71,385 rural and 48,924 urban households (total 120,309). Per capita expenditure of sample households was used as a proxy for per capita income. Prices of food items were computed by dividing the expenditure by the quantity consumed. Changes in consumption pattern were assessed using the indicators of quantity of food items, budgetary share, and calorie intake, and calories from different food items were calculated using conversion factors provided by the National Sample Survey Organisation (report number 405). Households consuming below a threshold level of calories (1,800 kcal/person/day for rural households, 75 percent of the recommended value) and protein (48 g/person/day) were treated as malnourished.</p>	<p>Increases in income, urbanization, and consumer perceptions regarding food quality and safety were effecting changes in the food consumption pattern, and these were pervasive changes. Food consumption was seen to be diversifying toward vegetable oils, fruits, vegetables, milk, and eggs. With increasing urbanization, declining poverty, and rising disposable income, the demand for these items is expected to increase. These changes have significant bearing on demand and trade for food, agricultural diversification, market access, research priorities, and resource allocations to achieve food and nutritional security. These changes should be guided by suitable reforms in technologies, institutions, and policies to accelerate the diversification process, and inter alia improve the food and nutritional security of the poorest of the poor.</p>
<p>Lokesh and Hanstad 2004 Pathways: 1, 2</p>	<p><i>Karnataka</i> To determine the nutritional and income benefits from intensively used homestead gardens, based on Indian policy of providing plots smaller than 1 acre to landless families, as prescribed in the 10th Five-Year Plan in India (2003–08).</p>	<p>A small sample (9 households) was purposively chosen to represent the formerly landless, now with small homestead plots; those with small agricultural holdings and medium homestead plots; and those with larger agricultural holdings and larger homestead plots. Data were collected on food produced and consumed (nutritional value of the products consumed by the household was calculated based on Indian Council of Medical Research standards), and income derived.</p>	<ul style="list-style-type: none"> • All interviewed households consumed from their plot more than the Indian average and more than the recommended intake of vegetables, although less than the recommended intake of fruits and milk. • Respondents reported that 90–100 percent of the vegetables and fruits, and 100 percent of the milk products consumed by their households were produced on their homestead plots, although the pattern of vegetable and fruit consumption differed from season to season. • Average annual income from selling excess produce or animal products was significant, equaling annual wage earned in some groups. • The study illustrated the role that homestead plots can play in providing significant supplemental nutrition and income to rural households; with sufficiently sized plots and some extension support from the government, the role could be even more significant. The results demonstrated the potential of the micro-plot approach to land reform proposed in India's recently adopted 10th Five-Year Plan.
<p>Misra 2000 Pathway: 7</p>	<p><i>India—National</i> To examine the role of female labor force participation in combination with other important factors in explaining interstate variations in rural poverty.</p>	<p>Used a single-equation approach to analyze pooled poverty estimates from 1973/74, 1983, and 1993/94, from government data.</p>	<p>The impact of female (farm) labor force participation on rural poverty was significant, accounting for around 10 percent of interstate variation. There is a need for more nonfarm opportunities for women, to further reduce poverty.</p>

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Murthy, Lakshmi, and Bamji 1999 Pathway: 1</p>	<p><i>Andhra Pradesh</i> To assess the impact of home gardening on improved vitamin A status.</p>	<p>Feasibility study.</p>	<p>At the end of the three-year extension project, 95 percent of households had started growing perennials and 86 percent seasonal varieties. Although some impact on the incidence of Bitot's spots was seen in preschool children, home gardening alone may not be enough to eradicate vitamin A deficiency in communities where the incidence is high, and complementary measures may need to be considered, such as selective medication or food fortification.</p>
<p>Panwar and Punia 1998 Pathway: 7</p>	<p><i>Haryana</i> To assess the effect of source and type of income, and level of education on nutrient intakes in rural-dwelling pregnant women.</p>	<p>Sociodemographic interviews and weighed food records were conducted with 90 pregnant women in rural communities (45 from farming households and 45 from nonfarming).</p>	<ul style="list-style-type: none"> • Mean daily intakes of energy, calcium, and iron were lower than RDA for all groups. Protein intake of nonfarming women was significantly lower than RDA. Intake of fat by pregnant women was double the RDA. The mean daily intakes of thiamine, riboflavin, and niacin by women of both the communities were found to be adequate, and intakes of folic and ascorbic acids inadequate. • Income of pregnant women did not show any influence on nutrient intakes, but the educational level of women reflected differences in vitamin intakes, with higher intakes in those with higher education levels.
<p>Patnaik 2003 Pathway: 3</p>	<p><i>India—National</i> To analyze the nature of the economic policy regimes associated with globalization, and to contextualize the issues of land rights and gender in the present era.</p>	<p>Illustrated the main theoretical propositions with reference to the experience of India in the 1990s.</p>	<ul style="list-style-type: none"> • Deflationary policies in the face of unemployed resources condemn millions of people to declining income, asset loss, nutrition decline, and even starvation. Today in India, enormous food stocks in excess of 60 million tons coexist with falling average nutrition and starvation deaths, but all suggestions for a massive food-for-work program are being dismissed by the deflationists, expressing the view on the same fallacious ground, that it would increase the fiscal deficit and crowd out private investment. In the present era of liberalization, the primary export thrust is at the expense of declining nutrition levels for the mass of the population. • It is socially irrational, and politically dangerous, to let grain rot while employment falls and more people go hungry. No amount of apologetics by way of academic arguments that Indians do not need as much food as others do, or that nothing is wrong on the nutrition front because the poor are diversifying their diets away from cereals to animal products, is going to remove the fact that per capita total calorie intake has been falling in rural areas everywhere, except in two states (Kerala and West Bengal). These states that have prevented a decline in per capita total calorie intake in both urban and in rural areas, and registered a rise in average nutrition, are precisely those that have ensured rising consumption per capita of the basic cereal food staples.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Patnaik 2008 Pathway: 3	<i>India—National</i> To critique the prevalent analysis and prescriptions regarding food security and poverty in India.	Opinion.	<ul style="list-style-type: none"> • The agrarian crisis is serious and widespread, and has been created by public policies that have been deflationary, combined with trade liberalization when world primary prices have been declining. • The prevalent analysis by policymakers, the Planning Commission, and the government is illogical and in patent contradiction to the trends in the economy, interpreting severe loss of purchasing power and enforced decline in effective demand for foodgrains as its very opposite, overproduction, in relation to an allegedly voluntary reduction of foodgrain intake by all segments of the population, and reaches the dangerous conclusion that foodgrain output should be cut back. • The majority of consumers are themselves rural and directly involved in production as cultivators and laborers, so deflationary policies hit them hard in both of their roles as producers and consumers. Price deflation does not benefit even landless laborers since it is part of a process of income deflation, which raises unemployment faster than prices fall. Our economists, estimating poverty by the indirect method, are still caught in the old conceptual trap of equating relative food price decline with declining poverty, without understanding that the adverse unemployment effects of deflation can swamp out any benefit of food price fall.
Patnaik 2009 Pathway: 3	<i>Developing countries</i> To distinguish the long-term and immediate factors giving rise to the food crisis in India and other developing countries.	Literature review and analysis of national-level data.	Policies that divert foodgrains to feeding livestock take food away from the already poor through a dual route: increasingly unequal distribution of income (and food) both within developing countries and between advanced and developing countries. The latter route is strongly associated with a second contradiction: one between food consumption and exports. Under free trade policies that pressure developing countries to remove barriers to trade and shift their land use increasingly to exports, there is a contradiction between food for domestic consumption and exports for the benefit of others. Finally, agriculture's growing reliance on energy presents a third contradiction.
Pica-Ciamarra and Otte 2009 Pathway: 3	<i>India—National</i> To review the major pathways through which poultry-sector growth can contribute to improved nutrition and poverty reduction in India.	Secondary analysis of data and literature, considering the entire poultry supply chain, from day-old chick to bird to plate.	<ul style="list-style-type: none"> • Poultry farming and employment along the supply chain represent a path out of poverty for only a limited number of households, whereas increased availability and affordability of poultry meat and eggs for both rural and urban poor, which are mostly net buyers of food, is the most effective way through which poultry-sector development can contribute to improved nutrition (and poverty reduction). • Public investments in support of backyard poultry farming development remain important for enhancing the nutritional status and reducing the vulnerability of many rural households. The promotion of selected small-scale market-oriented poultry units in rural areas is expected to contribute to improved nutrition and rural economic growth through increased supply and lower prices of animal proteins as well as second-round productivity and employment effects. Large-scale commercial poultry integrators have comparative and competitive advantages in providing urban consumers, many of whom also live below the poverty line, with affordably priced poultry meat and eggs.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Rais, Pazderka, and Vanloon 2009 Pathways: 1, 2</p>	<p><i>Uttarakhand</i> To investigate food production and agro-biodiversity in an area in the middle ranges of the Himalayas.</p>	<p>Comprehensive household survey involving 10 percent of households in the surveyed areas.</p>	<ul style="list-style-type: none"> • Output from the average farm provided only about half of the household energy requirements; therefore most families also participated in off-farm activities to support food and other requirements. • The insufficiencies associated with farming were due to the small landholdings of the typical household and to the low productivity and limited economic value of the crops that were grown. There is therefore a need to develop policies that will continue to support the rich agro-biodiversity in these areas while providing for the nutritional and economic needs of the population.
<p>Rajuladevi 2001 Pathways: 2, 4</p>	<p><i>Tamil Nadu</i> To measure variations in the levels of living of landless agricultural labor households in wet and dry rice regions.</p>	<p>Assessed by participatory research, interviews, and direct observation in 50 landless households in each of four villages. Data were collected on food intake in wet and dry seasons, household income, and expenditure.</p>	<p>The majority of sample households survived on cereal, and had only one main meal per day, a stark indicator of food insecurity. Female-headed households were the most adversely affected group in the study villages, irrespective of caste. The landless people's lack of basic needs (clothing, shelter, household equipment, and healthcare) revealed more of their destitution than did measures of conventional food intake.</p>
<p>Rani and Rao 1995 Pathway: 5</p>	<p><i>Andhra Pradesh</i> To analyze the socioeconomic and demographic factors that predict nutrition and health knowledge of mothers of preschool children.</p>	<p>Cross-sectional study of 460 mothers in 12 rural villages, using standardized knowledge tests.</p>	<p>Occupation was the strongest negative predictor of nutrition and health knowledge, with mothers engaged on their own farm or as agricultural laborers at a greater disadvantage with regard to exposure to nutrition and health information. Nutrition communication programs were recommended to women in the labor force in rural communities.</p>
<p>Rao 1998 Pathway: 3</p>	<p><i>India—National</i> To investigate the claim made by Ravallion (1998) that there is no causal significance backing the positive correlation between food prices and poverty and that it is not an income-distribution effect.</p>	<p>Critique.</p>	<ul style="list-style-type: none"> • With changing food prices but real mean consumption expenditure unchanged, a consequent distributional effect occurred both with and without changes in nominal shares. • The Gini index obtained in Ravallion's study used a uniform deflator rather than class-specific deflators, which captured the effect of an index of nominal inequality rather than real inequality. • The distribution component of poverty in Ravallion's study was systemically biased through not having separate deflators for the poverty line and the mean consumption expenditure; it thereby implicitly set the ratio to a constant.
<p>Rao et al. 2003 Pathway: 6</p>	<p><i>Maharashtra</i> To investigate the relationship between a mother's physical activity and the birth size of her baby in a rural Indian population.</p>	<p>Prospective observational study. Activity scores were derived from questionnaire responses using published data on energy costs to weight the contributions of various activities. Physical activity was assessed at 18 (+/- 2) and 28 (+/- 2) weeks of gestation. Birth outcome, maternal weight gain, and neonatal anthropometry were then assessed.</p>	<ul style="list-style-type: none"> • Maternal weight gain was not related to activity score at 18 weeks but was inversely related at 28 weeks of gestation. • No association between maternal activity and the incidence of prematurity or stillbirth was found. • Excessive maternal activity during pregnancy was associated with smaller fetal size in rural India.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Rao 2006 Pathway: 7	<i>India—National</i> To critically examine the conceptual linkages between land rights for women, household food security, and gender equality.	Literature review.	The paper argued that in a context of diversified rural livelihoods, the contribution of agricultural production to household subsistence has been declining. This trend has been reinforced by a decline in public investment, stagnant growth, and fluctuating prices for agricultural products. Men have been able to access the better-paid, nonfarm jobs, leaving women behind to manage agricultural production. The renewed link between production and food security in agricultural policy has, however, meant allowing men not to have responsibility for household food security. While a right to land for women is a positive development, it appears also to be leading to an enhancement of work burdens, without much change in terms of status or decisionmaking authority.
Rao, Gokhale, and Kanade 2007 Pathway: 6	<i>Maharashtra</i> To measure the energy costs of typical daily activities performed by women in rural India.	Cross-sectional study covering 26 different activities, with assessment made by indirect calorimetry using the Oxylog (Morgan) portable oxygen consumption meter.	<ul style="list-style-type: none"> Using estimates of BMR from FAO, WHO, and the United Nations University (UNU), most daily activities of rural women could be classified as very light and light on the basis of PAR (physical activity ratio). Rural women's overall daily activity pattern was categorized as moderate on the basis of PAL (physical activity level).
Rao et al. 2009 Pathways: 5, 6	<i>Maharashtra</i> To analyze the impact of seasonality on maternal intake and activity on neonatal size in farming communities.	Cross-sectional study of 797 women in six rural villages, assessing maternal anthropometry, dietary intakes (24-hour recall and food frequency questionnaire) and activity pattern (questionnaire) at 18 (+/-2) and 28 (+/-2) weeks' gestation, and neonatal anthropometry, June 1994 to April 1996.	<ul style="list-style-type: none"> Both energy and protein intakes and maternal activity levels were highest in harvest time. Mean birth weight was lowest at this time. Complete exposure (16 weeks) to the harvest season in late gestation could increase birth weight by 90 g in poor farming communities in rural India and the benefits could be increased further by lowering maternal activity. Seasonality should be considered when planning interventions.
Rao et al. 1993 Pathways: 1, 2	<i>Madhya Pradesh</i> To assess the nutrition status of children from tribal areas dependent on agriculture, the forest, or both for food and income.	Nutrition survey undertaken in areas with three distinct economies and large tribal populations.	<ul style="list-style-type: none"> Stunting was high (48–59 percent) in all three areas, and highest in the predominantly agricultural area. Wasting was high (4.8–7.2 percent) in all three areas, and highest in the predominantly forest-based area. The area that fared best in terms of anthropometry was the area where food and income were procured from both agriculture and the forest.
Ravallion 1998 Pathway: 3	<i>India—National</i> To assess the effects on India's poor of higher food prices stemming from recent or proposed policy reforms.	Analysis of 24 rounds of the NSS, spanning 1959–94.	There is a strong positive correlation between the relative price of food and India's poverty rate. This article questioned how reform critics have interpreted this correlation. The author asserted that it is not an income-distribution effect. Rather it appeared to be due to covariate fluctuations between average consumption and food prices due to other variables, including food supply; bad agricultural years simultaneously lower rural living standards and increase food prices. The correlation is uninformative about the welfare effect of a sustained increase in the relative price of food.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>Ravallion 2000 Pathway: 3</p>	<p><i>India—National</i> To assess whether and why higher food prices are associated with higher incidence of rural poverty, given that from the data publicly available, it is not known whether people living at India's poverty line are, on average, net consumers or net producers of food.</p>	<p>Measures of poverty were estimated on distributions of per capita expenditure on goods and services from 24 rounds of India's NSS, 1958–94.</p>	<p>Higher relative prices of food in India have typically been associated with higher poverty incidence and lower real agricultural wages. Yet it is very unlikely that the rural sector as a whole could be worse off from a higher relative price of food. Instead, the correlation with poverty can be explained by shocks to aggregate food output: In good agricultural years, rural living standards will tend to rise, and they will fall in bad years. At the same time, the price of food will tend to be higher in bad agricultural years and fall in good years. The government of India attempts to buffer food prices from such shocks to output through its procurement and storage decisions. A negative correlation between expenditure and the price of food will emerge; but it is spurious, being attributable to a common third variable, namely food output. The available measure of agricultural output, despite its high level of aggregation and imperfect matching to the household survey rounds, is nonetheless able to account for longer term movements in the rural poverty rate. Critics of reform appear to have misread the lessons for policy. The results of this paper suggested that the time series data have been misinterpreted by the opponents of reform; the correlation between poverty and food prices arose from negative co-movement between average rural expenditures and food prices from year to year, rather than a common trend in poverty measures and food prices, or distributional effects of food price changes. But these data cannot be used to support the view that higher food prices due to policy reform will, on their own, reduce rural poverty.</p>
<p>Sable, Goswami, and Singh 2004 Pathway: 2</p>	<p><i>Maharashtra</i> To study income and expenditure patterns in rural households.</p>	<p>Household income and expenditure was assessed by questionnaire/interview in households divided by income source (crop producers, vegetable producers, dairy producers, and landless households) and amount (low: < Rs 20,000, high: > Rs 45,000).</p>	<p>The highest monthly income was seen in vegetable-producing households and the lowest in landless laboring households. Percent expenditure was highest in landless laboring households, but total expenditure on food was lowest in these households. Total food expenditure was highest in dairy-producing households.</p>
<p>Salam, Babu, and Mohanakumaran 1995 Pathway: 1</p>	<p><i>Kerala</i> To compare home garden subsistence agriculture with commercial agriculture in terms of nutrition, biological productivity, and ecological sustainability.</p>	<p>Literature review.</p>	<ul style="list-style-type: none"> • The home gardens of Kerala very often combine crops with livestock rearing. The animals not only enhance the nutritional status of the household members but also help to augment the farm income through the sale of milk, eggs, and kids. • Home gardens provide high nutritional security, whereas commercial agriculture provides low nutritional security. • Home garden agriculture as practiced may be defined as a need-oriented, intensive, and integrated multi-species production system around the dwellings in smallholdings, aimed to achieve greater resource use efficiency with biological productivity and environmental sustainability.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
Saxena 2001 Pathway: 3	<i>India—National</i> Mid-term review of India's Ninth Five-Year Plan.	Policy review.	Food consumption among the poor in India has gone down in the last 10 years, yet the level of foodgrains stock with the Food Corporation of India (FCI) has been increasing, signifying lack of purchasing power among the poor, distorted food security policies, and inadequate distribution capacity. The challenge is to reduce foodstocks to roughly half their present level and use them for reducing malnutrition, without adversely affecting farmers. The paper suggested some necessary changes.
Saxena 2004 Pathway: 3	<i>India—National</i> To discuss several government of India schemes aimed to alleviate household malnutrition.	Review of policies and impacts, using macro-level data from the government of India and the FAO.	Total expenditure on schemes to reduce malnutrition is around Rs 300 billion per year, but inefficiencies in their operation result in limited impact. Backward regions suffer in many ways: first, because FCI operations are not extended to these regions (FCI buys paddy from farmers only in Punjab, Haryana, and Andhra Pradesh; elsewhere it buys rice from millers); second, the poor do not get rations because of the malfunctioning of food-based schemes; and third, farmers suffer because of unloading of FCI stocks from the targeted PDS shops and food-for-work sites to the market, which depresses market prices. <ul style="list-style-type: none"> • Most schemes suffer from weak monitoring, lack of transparency, and inadequate accountability in management. We cannot therefore separate the question of efficient food distribution from the general question of improving governance and people's participation. • To improve economic access to food for the poor and to support people on trajectories out of poverty is not so much a matter of additional resources but of better policies, sound delivery mechanisms, and commitments from both the central government and the states to improve program management, reporting, and governance, including stakeholder monitoring, and to develop indicators for assessing public participation.
Sharma 2005 Pathways: 2, 7	<i>India—National</i> To examine factors that influence demand for nutrients.	Data were taken from the NSS (1983 and 1999/2000) and the NFHS-2 (1998/99).	There was no significant difference in intakes of most nutrients between households self-employed in agriculture and agricultural laboring households. Mothers who exercised autonomy in household decisionmaking enhanced the nutritional status of their young children.
Swaminathan 2008 Pathway: 3	<i>India—National</i> To assess the impact of the liberalization-induced policy of narrow targeting of the PDS on food security.	Descriptive study using 61st-round NSS data.	<ul style="list-style-type: none"> • Targeting has led to the large-scale exclusion of genuinely needy persons from the PDS (60 percent or more of the population was effectively excluded from the PDS in an overwhelming majority of states) and a clear deterioration of coverage in states like Kerala, where universal PDS was most effective. • Targeting has adversely affected the functioning and economic viability of the PDS network and led to a collapse of the delivery system. • The objective of price stabilization through transfer of cereals from surplus to deficit regions of the country has not been achieved. • There were reports of large-scale leakages from the system.
Tarozzi 2005 Pathway: 3	<i>Andhra Pradesh</i> To assess whether a sudden increase of the price of rice supplied by the PDS had a negative impact on child nutrition.	Secondary analysis of NFHS survey data for time periods directly after the price increase (1992/93), assessing whether weight-for-age deteriorated and whether outcomes were worse the longer the high prices persisted.	Most children in the sample showed poor anthropometric performance generally, but longer exposure to high prices were not accompanied by worse nutritional status, as measured by weight-for-age.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>von Braun and Kennedy 1994 Pathways: 1, 2, 3, 5</p>	<p><i>Developing countries</i> To identify the driving forces of increasing commercialization of subsistence agriculture, and assess and describe its effects on household real incomes, food consumption, expenditures on nonfood goods and services, and nutritional and health status in different settings. Also to evaluate policies and programs to cope with possible adverse impacts on income, consumption, and nutrition that arise during the commercialization transition, and to foster beneficial impacts.</p>	<p>Comprehensive microlevel studies were undertaken in several countries (including India) with similar methodologies. The results were presented in separate papers within the book, and brought together through a common conceptual framework and summary.</p>	<ul style="list-style-type: none"> • Integration of traditional smallholder agriculture into the exchange economy is part of a successful development strategy. Specialization and commercialization of farming households within a more diversified agricultural and rural economy are part of the development process. Specialization and development of markets and trade, which are characteristic of commercialization, are fundamental to economic growth. • Given current infrastructure, technology, education, and social security systems—or rather the lack of all these—subsistence agriculture is often the only feasible and most efficient mode of economic activity in rural areas of low-income countries. To overcome the subsistence orientation, however, in such a way that the poor are not adversely affected even in the short run remains the challenge of policy on commercialization of agriculture for economic development and nutritional improvements. • There was a conscious effort by smallholder producers in all study settings to maintain subsistence food production along with new commercial production, despite apparently higher returns on land and labor from the cash crops. While cultural and taste factors may play a role, this reliance on food from own production under household control was a response to high transaction costs and risks related to market, employment, and production. It can largely be viewed as an insurance policy. • The positive effects of commercialization for household food security were greatest when incremental income and employment from commercialization were most concentrated among the malnourished poor. • In all study settings it was observed that with rising income from commercial crops, absolute spending for food consumption increased. In some study settings, adverse effects of increased commercialization for household spending on food were found at the margin. It should be stressed that these effects at the margin were not the net effects of increased commercialization. • Generally, women’s work in agriculture was reduced not only relatively but also absolutely with rising income, which correlated with increased farm size in most of the study locations. From this angle, there was little support for the hypothesis that commercialization of agriculture leads to increased workloads for women, with potential adverse effects on childcare and nutrition. Sociocultural situations determined quite different effects of commercialization on women’s work in agriculture. • Women’s work in commercialized crops and women’s direct control over income from these crops tended to be much less than that of men and, frequently, even disproportional to the labor input into the crops. In none of the schemes studied did women play a significant role as decisionmakers and operators of the more commercialized crop production lines. • The effects of commercialization on children’s welfare were mediated, in part, through the income–consumption link, which was found to have favorable effects on children’s nutritional status. Potential linkages between income, children’s education, and demand for children’s labor that may result from new labor-intensive commercialized crops may also be relevant. In general, no strong relationships were found between income and children’s health. Poor household and community health and sanitation environments overshadowed potential positive effects of income for health improvement. • The net nutritional effect (in terms of anthropometric indicators) of incremental income was modest, except in very poor households under acute food consumption constraints, since the increased income did not decrease morbidity. Increased income and increased food availability contributed to solving the hunger problem but not the problem of preschool children’s malnutrition, which results from a complex interaction of lack of food and morbidity. • The study summarized with five policy and program design issues that are important for maximizing the potential benefits from agricultural commercialization and for minimizing damage.

Table A.2—Continued

Study	Geographic area and aims	Study design	Key findings
<p>von Braun and Kennedy 1986 Pathway: 2</p>	<p><i>Developing countries</i> To evaluate the competition between cash crop (a food or nonfood crop produced for sale) and food-crop production, and its effects on income and nutrition.</p>	<p>Aggregate country data for 78 countries (including India) were used for a rough assessment of the scope and development of that competition. Available research was reviewed within a conceptual framework of the potential effects of increased cash cropping on nutrition.</p>	<ul style="list-style-type: none"> • It is frequently assumed that expansion of cash cropping is at the cost of staple food production. This, however, did not appear to be a generalizable effect. Growth in area allocated to cash crops positively correlated with growth in staple food production. • Critical relationships that determine food consumption and nutrition were affected by increased cash cropping. These effects may be positive or negative, and the actual outcome depended on factors such as the actual increase in real income from cash cropping and its distribution, income composition, change in who controlled income (men or women), effects on the allocation of time of household individuals (especially mothers), nutritional knowledge, and health and sanitation factors. • A number of studies showed that the positive effect of increased cash income on calorie consumption may be quite small, even among the poor. This may be a result of changes in income composition and income control within the household. • That women's roles were not adversely affected by increased commercialization of semi-subsistence agriculture is of crucial importance for nutrition. If improved nutrition is a concern, such factors must be considered along with the average income effects of a project or program. • A crucial question for policy and program design remains: whether potential adverse effects of increased cash cropping on nutrition are of a short- or a long-term nature.
<p>von Braun et al. 2005 Pathway: 3</p>	<p><i>India—National</i> To assess strategic issues and reform options in Indian agriculture and rural development.</p>	<p>Policy review.</p>	<ul style="list-style-type: none"> • Whereas India's agricultural policy is still rooted in the goal of self-sufficiency in grains, consumption patterns are changing fast toward high-value agricultural products such as fruits and vegetables, livestock products, and fish. The policy environment is lagging behind the structural change occurring in India's consumption and production baskets. The high malnutrition rates seen in India therefore reflect severe problems on the distribution front. • The reasons for this paradox of high malnutrition alongside high economic growth lies in the neglect of, as well as misallocation of resources in, agriculture and rural development, especially in the later phase of the reform process initiated in 1991. The average annual rate of growth in agriculture fell from more than 4 percent per year during 1992/93 to 1996/97 to less than 2 percent per year during the period 1997/98 to 2002/03, and it remains low. • The paper proposed five key areas for the Indian government to address in order to stimulate pro-poor agricultural growth and rural development: <ol style="list-style-type: none"> 1. Increase investments in rural infrastructure and in agricultural research and development 2. Reorient its social safety nets 3. Manage water use through institutional changes 4. Liberalize marketing and trade policies to encourage production and marketing of high-value food products 5. Establish and strengthen a rules-based multilateral trading system through World Trade Organization (WTO) negotiations, or foster bilateral or regional free trade agreements with major developing countries in the region and beyond, as well as streamlining domestic markets, institutions, and infrastructure.

Source: Author's compilation.

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