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The Nutrition Sensitivity of Food and Agriculture in South Asia

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Abstract

Through a review of the literature, this paper examines the links of food and agriculture with nutrition in South Asia, a region characterized by a high level of malnutrition. The review finds that the level and stability of food prices play a critical part in food consumption, with rising prices affecting poor households the most. Although public food transfer programs are aimed at addressing this, most are too small to have a marked effect in protecting or promoting nutrition. Several supply-side food and agricultural interventions suggest promise in improving nutrition, although their effects have yet to be well identified. These include the cultivation of home gardens, animal farming, and use of biofortification and post-harvest fortification. All these efforts will be futile, however, without parallel efforts to mitigate the effects of climate change.

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Introduction

Malnutrition is prevalent in South Asia. The region has among the highest burdens of child undernutrition in the world. Thirty-six percent of children under age five are stunted, or too short for their age, an indicator of chronic undernutrition. Sixteen percent are wasted, or too thin for their height, an indicator of acute malnutrition (UNICEF, WHO, and World Bank 2017). South Asia also has a high prevalence of micronutrient deficiencies, overconsumption, and diet-related noncommunicable disease (Development Initiatives 2017).

Globally, evidence is growing on how food and agricultural policies and interventions can help enhance nutrition. Several recent reviews have synthesized this global knowledge.[1] Among the strategies discussed in the literature, an increasingly prominent one is the promotion of nutrition-sensitive food and agricultural interventions. This strategy seeks to tackle malnutrition and micronutrient deficiencies by emphasizing the production and consumption of foods that are rich in nutrients. Indeed, the evidence suggests that nutrition-sensitive food and agricultural interventions can increase the consumption of nutritious foods and improve dietary diversity (Ruel et al. 2018). The evidence also suggests that dietary diversity, particularly the inclusion of animal-source foods, is associated with improved nutrition (Bhutta et al. 2013; Kim et al. 2017; Headey et al. 2018). The evidence tends to be weaker on a direct link between nutrition-sensitive food and agricultural interventions and improvements in nutrition.

This paper reviews the evidence on nutrition-sensitive food and agricultural interventions in South Asia. It contributes to the discussion in the literature by improving the understanding of the proven links between these interventions and nutrition in the region.

The paper differs from existing reviews in two important ways. First, we focus our review on evidence from eight South Asian countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. This allows us to narrow the discussion to evidence that is contextualized to South Asia (Webb and Kennedy 2014). Reviews covering evidence across many countries tend to have more stringent requirements on the methodological rigor of the studies they include, while those covering specific countries tend to be more comprehensive and include studies using weaker methodologies. Our work falls between these two ends of the spectrum. We include an extensive set of studies, which provides broad insight into the region and topics of interest, but we also impose clear standards for inclusion. In addition, we examine a wider set of food and agricultural interventions, which allows for a review of nutrition sensitivity from farm to fork—ranging from food production and supply to food demand and consumer behavior.[2]

In the first part of the review, we focus on consumers and the factors that influence their choices for acquiring and consuming nutritious foods, drawing on evidence from South Asia. The overarching food environment plays a big part in determining what foods consumers purchase

[1] See Bhutta et al. (2013) for a review of nutrition-specific interventions, Bhutta et al. (2015) for a review of delivery platforms, and Masset et al. (2012), Girard et al. (2012), and Ruel, Quisumbing, and Balagamwala (2018) for a review of nutrition-sensitive agri-food interventions.

[2] Note that we exclude certain links between agriculture and nutrition that are not necessarily food-related, such as those between livestock, health and sanitation, and nutrition.

and consume—and may constrain their ability to buy and eat nutritious foods. Many factors can shape this food environment—including the availability and accessibility of foods, food prices and consumer income, and the traits, convenience, marketing, and desirability of food products. But our review finds that the level and stability of food prices are critical in food consumption, especially among poor people. Malnutrition, undernourishment, and food insecurity tend to rise with food prices. Conversely, a drop in staple food prices in South Asia means that households spend a smaller share of their budgets to obtain enough calories—and can then shift their spending toward obtaining enough nutrients. The policy focus of governments in the region is moving away from the price of food generally toward the price of nutritious food specifically.

Consumer food choices do not hinge only on availability and affordability. Tastes, preferences, and desirability also play a part. "Sticky" food preferences—those difficult to change—may influence nutrition if foods are expensive or unavailable. The desirability of food products may be affected by branding, advertising, and certification. All these in turn can help determine the kind of information consumers receive about specific foods. And they can influence style trends—which foods are popular and which are not—and increase or decrease demand for food products.

In the second part of the review, we focus on supply-side factors. We begin by discussing food production and distribution in South Asia, specifically the role of agricultural growth and productivity and that of public food distribution systems. We then focus on the production of nutritious foods, reviewing the evidence on small-scale production of vegetables and animal-source foods and on the use of biofortification and post-harvest fortification to enhance the nutritional value of food. Finally, we discuss the role of climate change and how it is affecting the supply of nutritious foods in the region.

Governments use public food transfer programs to make food available and affordable to poor households. Our review reveals that such programs tend to be inframarginal or too small to have a meaningful effect on nutrition. These programs can be made more nutrition-sensitive by coupling transfers with health services, nutrition education, and food fortification.

Small-scale, home-based production of nutritious foods can also help improve nutrition, because increasing access to a food generally increases its consumption. Home gardens, for example, allow households to grow their own vegetables to eat, improving their dietary diversity and nutrition intake. In addition, income earned by selling any excess may allow poor households to add more meat and fish to their diets, though scalability remains a concern (Hirvonen and Headey 2018).

Using biofortification or post-harvest fortification to enhance the nutritional value of food may be the most cost-effective way to reduce widespread malnutrition. Biofortification involves engineering seeds so that crops provide sufficient levels of certain nutrients, while post-harvest fortification involves adding micronutrients during processing (after production but before consumption). These strategies have been shown to succeed given a good-quality product, an appropriate target population, and sufficient consumption of the fortified food by the population. Small-scale trials of fortification have found gains in consumers' micronutrient levels.

Yet efforts to improve the production of food—including nutritious food—will be futile if governments do not also take steps to mitigate the effects of climate change and to adapt to such change. Climate change is expected to lower agricultural yields, reducing the availability of food, and to compromise the nutritional value of crops, reducing the quality of food. These effects are likely to be quite pronounced in South Asia relative to other regions.

Overall, the trends and evidence suggest a complex set of relationships that will require countries, governments, and policy makers to take multisectoral and multidimensional approaches to tackle malnutrition in South Asia.

Methodology

This paper reviews evidence published between January 2000 and June 2017. We follow the methodology used in similar systematic reviews, where the process consists of three stages: an expanded search, a screening, and coding (Hannes 2011; Tanner, Candland, and Odden 2015; Tanner et al. 2016; Critical Appraisal Skills Programme 2017).

The search strategy involved a pilot followed by comprehensive data collection. The pilot tested search terms and allowed us to gain experience with search mechanisms. On the basis of the results, we refined the concepts of interest and identified a broader set of appropriate search terms for conducting the main bibliographic database search. We used seven databases for the main search: EconLit, Science Direct, AGRICOLA, IDEAS, DIALOG, PubMed, and ERIC.[3]

The search method used three categories of search terms. *Category A* consists of agricultural interventions, including nutrition-sensitive agriculture; home production of nutritious and diverse foods (for example, home gardens, fisheries, livestock and poultry breeding, growth of traditional crops, and crop diversification); fortification of staple crops (for example, biofortification and fortification); value chains (encompassing storage, processing, distribution, retailing, and quality and safety controls); food environment (covering accessibility and availability, affordability and price, and acceptability and desirability); food assistance; environment and resources; and agricultural growth. *Category B* consists of outcomes (level, quality, diversity, distribution, security, and nutrition). *Category C* consists of the list of South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka) and the regional term "South Asia." Details on the search terms are presented in Table 1. Some searches, notably for "nutrition-sensitive agriculture" and "value chains," yielded no relevant results and are thus omitted from discussion in the paper.[4]

After completing the database search, we began the screening process. The screening strategy applied inclusion and exclusion criteria to determine the relevance of each study. After completing the screening, we coded in three steps for studies determined to be relevant through the screening. First, we conducted a 10-minute review of each relevant study to ensure that the

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[3] Except for IDEAS, we searched each database in its entirety for each term or set of terms. Based on initial results for all outcomes associated with a topic, we screened 100–150 papers for each agricultural intervention. If there were very few results, we moved to the next outcome.

[4] This is not to say, however, that there is not a growing research agenda on nutrition-sensitive value chains in the region. We refer readers, for example, to a research agenda on this area by the Leveraging Agriculture for Nutrition in South Asia (LANSA) consortium.

work met the criteria. Next, we assessed the quality of all studies that passed the 10-minute review, assigning one of three possible ratings (from highest to lowest quality): AAA, AA, or A. The ratings were based on the study's internal validity and the quality of evaluation design. Finally, we fully coded the studies, considering, among other relevant information, econometric strategy; variables included; outcomes of interest; location, level, and unit of analysis; estimated effect; and data collection procedures.

The results of our screening and coding process are presented in Table 2. We found a total of 5,350 papers. We removed 4,856 during the screening process, leaving 494 relevant papers. During the coding process, we removed another 222 papers, leaving us with 272 final, relevant papers.

In addition to the formal search process outlined above, we also performed an informal search and review of additional studies and incorporated some of their findings in our paper. Specifically, we identified several key reports and papers outside the formal search process, and we also received papers sent to us by stakeholders and other interested parties.

Ultimately, this paper cites 206 articles and reports; of these, 139 are among the 272 papers from the formal review process, and 75 were added from the informal review.

Demand: Consumers' food environment

Food production drives food availability (Khan, Azid, and Toseef 2012). But production alone is not enough for availability. Where food is produced can matter (Amarasinghe, Samad, and Anputhas 2005; Hussain and Routray 2012). And simply producing more food is insufficient to address issues of food security and nutrition (Henegedara 2015). Though increased food supply can help reduce malnutrition, it has a declining marginal effect (Smith and Haddad 2001). These dynamics must be understood within the context of the food environment (Gaiha and Kulkarni 2005; Kandpal and McNamara 2009; Sarkar and vanLoon 2015).

Consumers' food choice

The food environment is the setting in which food acquisition occurs, and it influences decisions about what people eat. Two domains within the food environment—the personal and the external—determine food consumption and nutrition (Turner et al. 2017). The external food environment relates to the world "out there", within a given context. That is, it focuses on exogenous elements, including food availability, prices, properties, marketing, and regulation. The personal food environment conversely focuses on endogenous elements, such as the accessibility of food for an individual, the affordability of that food, and the convenience and desirability of food, perceived by an individual. Nutrition, however, is driven by the interaction of income and the food environment, though this relationship may have unpredictable or variable effects. Recent work has highlighted concerns about obesity in South Asia, for example, as rising incomes have facilitated spending on less nutritious diets (Gaiha, Jha, and Kulkarni 2010).

The food environment both provides and constrains consumer opportunities and also signals to consumers what foods to purchase. It affects diets by influencing how income can be spent on food—by determining what food products are available as well as their affordability, convenience, and desirability. External food environment traits, including branding, advertising, and certification, can play a part in food products' prices, as well as influence the personal food environment through product desirability and consumption (Minten, Reardon, and Sutradhar 2010). Other factors that can influence the demand for food products include the external food environment traits such as availability and content of information, style trends, and certification (Ayyaz, Badar, and Ghafoor 2011; Dhivya 2014; Banerji et al. 2016).

Researchers have recommended several frameworks for analyzing the food environment, with suggestions for areas and types of study (Turner et al. 2017), measurement for better identification of the food environment (Tiwari, Skoufias, and Sherpa 2013; Herforth and Ahmed 2015), and government interventions for shaping the food environment (Levitt, Pelletier, and Pell 2009; Birner, Sekher, and Raabe 2012). A study of the food environment in India has found that an individual's personal food environment is the main driver of his or her consumption of calories and protein (Kumar et al. 2012). A similar study in Nepal has found that while food security improved after trade liberalization and major changes to the external food environment, the effect varied, largely because of regional differences in personal food environments and in the accessibility of food (Pyakuryal, Roy, and Thapa 2010). These studies have been largely alone in their attempts to analyze the food environment in South Asia.

Food prices

Price plays a critical part in food consumption. When prices are lower, food is more affordable (Dixon et al. 2015). But a reliance on low prices for adequate food consumption leaves households vulnerable to price shocks (IFPRI 2017).[5] This is especially true for poor consumers, who tend to be disproportionately affected by increases in food prices (Akter and Baser 2014). Food price increases are also likely to increase food insecurity, malnourishment, and malnutrition (Ahmed 2000; Panda and Ganesh-Kumar 2008; Faridi and Wadood 2010; Nirmali and Edirisinghe 2010; Korale-Gedara, Ratnasiri, and Bandara 2012; Gustafson 2013; Rosegrant et al. 2014; Shabnam et al. 2016).[6] But these findings are not universal, particularly over time. In the long run, higher food prices may provide a stimulus to the rural economy by raising agricultural production and incomes for farmers and by increasing labor demand and wages for workers (Jacoby 2015).

Cost of nutritious foods

The discussion around food prices has increasingly focused on the cost of nutritious foods. Recent reviews have shown that nutritious diets are more expensive (Herforth and Ahmed 2015).

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[5] Food imports are an important part of this story, though beyond the scope of this paper. For more information on this topic, see Chabot and Dorosh (2007), Agostinucci and Loseby (2008), Dorosh (2008a, 2008b), Hazell (2009), Gaiha et al. (2012), Timmer (2013), and Halimi (2016).

[6] Most studies in this area have found associations. An exception is a study of wasting in India's Andhra Pradesh. Before the 2007 food price spike, wasting prevalence in the state fell slightly, from 19.4 percent in 2002 to 18.8 percent in 2006. But when food prices spiked, the rate increased substantially, to 28 percent, with the increase especially pronounced among low- and middle-income households. Price increases were significantly associated with a decrease in children's rice consumption, and lower rice consumption was significantly associated with lower child weight-for-age (Vellakkal et al. 2015).

While there are a variety of reasons for this, regional differences play an important part. Many nutritious foods are highly perishable and thus less tradable (Monsivais, McLain, and Drewnowski 2010; Headey 2017). Other factors that can widen regional differences in availability and price include topography and infrastructure, as in Nepal (Thapa 2015), and conflict, as in Afghanistan (D'Souza and Jolliffe 2013).

The cost of nutritious foods has greater effects on poor households. For these households, the relatively high prices of nutritious foods result in lower consumption of these foods and higher consumption of less nutritious foods, which tend to be more calorie- or energy-dense (Andreyeva, Long, and Brownell 2010; Green et al. 2013; Darmon and Drewnowski 2015; Miller et al. 2016). Moreover, at a certain point, vulnerable households cannot afford to make cuts to calories. Instead, when food prices rise, such households sacrifice dietary diversity and quality, so that their overall caloric intake remains unchanged even as its nutritional value decreases (D'Souza and Jolliffe 2010, 2014). Specifically, poorer households are forced to substitute away from fruits, meats, eggs, pulses, sugar, milk, and other "luxury" food products (Aziz et al. 2011; Gaiha, Jha, and Kulkarni 2014). Wealthier households are not forced to make the same cuts to dietary diversity (D'Souza and Jolliffe 2012). This is likely a "portfolio effect," as households that consume a broad portfolio of food products experience a smaller adverse effect on their consumption when the price of one particular food product rises (Gustafson 2013).

It is also becoming increasingly difficult for poor households to consume a diet rich in vegetables, dairy, or meat, as the prices of these foods have risen quickly relative to those of cereals (Meenakshi 2015). The solution to this problem is not clear, as providing households with food subsidies does not guarantee that they will use their freed-up income to purchase and consume nutritious foods. Narrowing the gap in prices between nutritious and less nutritious foods remains a major challenge across South Asia.

Supply: Production and distribution of nutritious foods

Agricultural growth and productivity

Expanding the agricultural sector has been championed as a more effective way to reduce poverty than targeting other sectors, in part because agriculture tends to employ more poor people (Ligon and Sadoulet 2007; Christiaensen, Demery, and Kuhl 2011; Christiaensen and Martin 2018). Boosting agricultural output in a country can also improve food security and nutrition. But the global evidence on this is sparse, and the link between agricultural growth and nutrition is less clear (Kirk, Kilic, and Carletto 2018).

The little evidence from South Asia is slightly more positive. Research in India has shown that states with higher growth in agricultural output have lower stunting rates among children and higher body mass index among women. In addition, states with higher levels of agricultural output have lower rates of child undernutrition (as measured by stunting, wasting, and underweight) and lower rates of adult undernutrition (as measured by men's and women's body mass index). And households with agricultural income had higher caloric intake than households without such income (Gulati et al. 2011; Headey, Chiu, and Kadiyala 2012; Vepa et al. 2014; Kolady, Srivastava, and Singh 2016).

Growth in agriculture can come from using more inputs (fertilizer, seed, and the like), using more land, or improving the productivity of inputs and land (through improved seeds or other technologies). In India, a study has found that districts with higher land and labor productivity rates have lower child underweight rates—and that this association of underweight with factor productivity is stronger than that of underweight with government provision of health and water (Vepa et al. 2015). Improvements in cereal productivity can lead to higher incomes, which can increase demand for nutritious foods. But if the supply of these nutritious foods is constrained, their prices will also rise, making them less affordable. In Bangladesh, for example, rapid growth in rice yields was associated with the early introduction of complementary foods and improvements in child weight-for-height, but the yield increases did not to lead to improvements in dietary diversity or in measures of chronic undernutrition among children (Yu 2012; Headey and Hoddinott 2016).

Public food transfers

Public food transfer programs are widespread in South Asia. Such programs are designed to reach the poorest and most vulnerable households. Questions about their effect on nutrition occur at a time of growing debate around the inefficiency of these large-scale programs and of moves by a growing number of countries to ease price controls and liberalize their food markets. A recent work by Alderman, Gentilini, and Yemtsov (2018) summarizes the discussion on food transfer programs. It emphasizes that while the global evidence indicates that food subsidies are as effective as cash in increasing consumption, they are less efficient. These shortcomings have spurred governments to shift from in-kind transfers to vouchers and cash, and from universal to targeted coverage.

Food transfer programs tend to be inframarginal and thus have little effect on nutrition. Broad meta-analyses, though biased toward studies in Latin America, suggest that the effects of food transfers on food consumption do not further translate into effects on nutrition. Food transfers could be made more nutrition-sensitive by coupling them with health services, nutrition education, and food fortification (Alderman, Gentilini, and Yemtsov 2018).

Even the evidence from the world's largest food transfer program, in India, is mixed. The Public Distribution System provides subsidized grain to 800 million people through a network of more than 500,000 fair price shops. The unparalleled scale of the program inevitably makes its operations complex, involving public procurement, price support, price stabilization via buffer stocks, food grain distribution, and controls on private trade. The main criticisms of the system are that it is prone to excessive leakage and incorrect targeting, resulting in the erroneous inclusion or exclusion of beneficiaries. Evidence shows that the Public Distribution System is costly, generates inefficiencies in grain markets, and extends few, if any, benefits to intended beneficiaries. Abuses occur in the grading, weighing, and bagging of grains; storage facilities remain insufficient; and lack of transparency and accountability leads to corruption. More recently, the Indian government has instituted reforms to address and reduce leakage, with some success (Zhou and Gandhi 2000; Umali-Deininger, Sur, and Deininger 2005; Kattumuri 2011; Baliram 2013; Himanshu 2013; Bhattacharya, Falcao, and Puri 2018).

Some evidence suggests that the Public Distribution System has improved caloric intake among beneficiaries, especially after the implementation of program reforms (Himanshu 2013; Narayanan and Gerber 2016). Similarly, the program has been shown to have positive effects on dietary diversity by increasing consumption of pulses and protein, including in the Indian state of Chhattisgarh (Krishnamurthy, Pathania, and Tandon 2014), in villages in eastern India (Parappurathu et al. 2015), and across other states of the country (Raghbendra, Imai, and Gaiha 2008). But other studies have concluded that the program's effect on consumption of pulses is too small to enhance the nutrient intake of beneficiaries (Chakrabarti, Avinash, and Devesh 2016) and that even its effect on caloric intake is minor (Bhagowalia and Chandna 2016). Still other studies have suggested that the size of the effect varies widely across states (Raghbendra, Imai, and Gaiha 2008) and that the effect on caloric and protein consumption can be very large in some states (Das Gupta 2014). The program's effect can also vary across subgroups. Among rural workers, for example, the Public Distribution System is associated with lower caloric consumption than among the rest of the population, for whom positive effects (increased caloric consumption) have been observed (Bhattacharya 2014). Research has provided little evidence about the program's effect on other nutrition outcomes.

Another factor influencing the effect on nutrition is the target population, which has changed as the Public Distribution System shifted from universal to targeted coverage, then back to universal coverage. Two papers have rigorously explored the question of targeting. The first, which looks at all of India, identifies two potentially countervailing effects of a universal system. First, there is generally a low elasticity of caloric intake to food grain subsidy, suggesting that a targeted program with larger transfers would perform better at improving food security. But second, targeting reduces the likelihood of poor households participating in the program (Kochar 2005). Another study, in the state of Odisha, notes that the shift from a targeted to a universal food transfer program resulted in improvements in dietary intake and quality, and a decline in the share of households consuming less than the recommended daily allowance of calories, fats, and protein (Rahman 2016).

Positive nutrition outcomes have been observed for other targeted programs in India, such as the Integrated Child Development Services, which provides food and other services to children under age six and their mothers, and the Mid-Day Meal Scheme, which provides free school lunches to students. Daily food supplements provided under the first program have been found to improve child height-for-age (Naline and Viswanathan 2016), while the second program has been associated with increased caloric intake (Himanshu 2013). More rigorous evidence from Madhya Pradesh has shown that the Mid-Day Meal Scheme is linked to improved daily nutrient intake (Afridi 2010; Dercon and Sanchez 2011). Monitoring plays a crucial part in all these programs. In the state of Odisha, additional supplementation provided under the Mid-Day Meal Scheme failed to improve hemoglobin levels on its own, but improvements were observed with the addition of high-intensity monitoring of school meals (Berry et al. 2017).

Other countries in South Asia have had mixed experiences with public food transfer programs. Both Bangladesh and Nepal took steps toward liberalization, with different outcomes. Bangladesh downsized its Public Food Grain Distribution System, making it more cost-effective. It also opened up the program to competition from the private sector, which has proved more efficient at marketing grains than the public sector. As a result, cereal prices declined, price variability decreased, and rice and wheat markets became integrated across the country. Rice intake increased among the poorest 40 percent of the population (Chowdhury, Farid, and Roy 2006). Nepal similarly downsized its Public Food Distribution System, removing a host of agricultural subsidies between 1980 and 1990. After such reforms, food availability improved and the rate of undernourishment declined. But liberalization made differences in outcomes between regions in the country more pronounced. While Bangladesh concurrently invested in integration across the country during liberalization, Nepal did not make such investments, with persisting effects to this day (Pyakuryal, Roy, and Thapa 2010).

Small-scale production of naturally nutritious foods

Small-scale home gardens (or kitchen or backyard gardens) and production of livestock, poultry, and fish have gained popularity as ways to increase food consumption and improve nutrition. Food production at home allows households, particularly those headed by women, to gain control over food security and nutrition. These practices may also provide small-scale market opportunities from sales of excess products (Rahman and Sousa-Poza 2010; Wilcox et al. 2014; Murty, Rao, and Bamji 2016). And they can increase households' dietary diversity (Birdi and Shah 2016), which in turn has been shown to be associated with improved nutrition in Nepal, for example (Malapit et al. 2015; Shively and Sununtnasuk 2015).

HOME GARDENS

Home gardens are small plots that are close to home and generally used to cultivate vegetables.[7] For the many households that cannot afford to purchase vegetables, home gardens make it possible to grow them easily (Gautam, Suwal, and Sthapit 2009). Evidence suggests that home gardens increase household food consumption (Bhatta et al. 2008; Schreinemachers et al. 2015; Schreinemachers, Bhattarai et al. 2017; Schreinemachers, Rai et al. 2017). Home gardens tend to produce a large quantity of vegetables (Chada et al. 2012). Studies in Bangladesh have found that in most months, such gardens produce enough vegetables to satisfy household needs (Irfanullah et al. 2008; Ferdous et al. 2016). Similarly, a study in India has found that home gardens yield enough produce not only to feed the household but also to allow for sales of excess (Murty, Rao, and Bamji 2016).

Beyond increasing food consumption, home gardens can also improve nutrition. In India, their introduction helped households meet the total beta carotene and vitamin C requirements for a four-member household (Chada et al. 2012). In Bangladesh, such gardens increased the average household supply of plant proteins by 171 percent, iron by 284 percent, vitamin A by 189 percent, and vitamin C by 290 percent (Schreinemachers et al. 2015). Further research in Bangladesh has shown that home gardens offer a cost-effective way to reduce iron, vitamin A, and zinc deficiencies (Schreinemachers, Patalagsa, and Uddin 2016). These nutrition gains likely occur through increased vegetable consumption and improved dietary diversity (Jana et al. 2015; Birdi and Shah 2016).

[7] In addition, there is emerging evidence on similar strategies in alternative environments, including floating gardens (Irfanullah et al. 2008), school gardens (Schreinemachers, Rai et al. 2017), and home rooftop gardens in urban areas (Islam 2004).

LIVESTOCK, POULTRY, AND FISH

The small-scale farming of livestock, poultry, and fish offers another potential strategy for ensuring food security and nutrition (Kumar and Dey 2006). As with kitchen gardens, findings indicate that these farming practices often generate sufficient food for household consumption, such as through fish farming in Bangladesh (Toufique and Belton 2014) and poultry farming in India (Pica-Ciamarra and Otte 2010). The literature contains plenty of suggestive evidence of the nutritional benefits of such farming practices, particularly for fish (Roos, Islam, and Thilsted 2003; Belton, van Asseldonk, and Thilsted 2014; Amarasinghe, Kumara, and De Silva 2016; Gurung 2016).[8] Consumption of fish improves vitamin A and calcium levels (Thompson et al. 2014) and can also raise iron, zinc, and B-12 levels (Bogard et al. 2016).

Evidence indicates that household livestock ownership can improve nutrition. In Afghanistan, sheep ownership reduced the incidence of anemia (Flores-Martinez et al. 2016), and in Bangladesh and India, livestock ownership increased household food consumption as well as caloric and protein intake (Rahman and Sousa-Poza 2010; Gaiha et al. 2012). Research has also tied gains in child nutrition and health to cow ownership and access to dairy products (Choudhury and Headey 2018; Headey et al.2018).

POSITIVE EFFECTS, BUT CHALLENGES TO ADOPTION

For all interventions encouraging small-scale production, evidence suggests that having access to a type of food or food product, be it vegetables or animal products, tends to increase food consumption (Nielsen, Roos, and Thilsted 2003; Jones et al. 2005; Irfanullah et al. 2008; Murshed-E-Jahan and Pemsl 2011; Bageant, Liu, and Diao 2016; Murty, Rao, and Bamji 2016). Many interventions also produce excess food to sell (von Braun et al. 2005; Wilcox et al. 2014). With livestock especially, households can generate large income gains (Rahman and Sousa-Poza 2010) as well as good returns on investment (Shanta et al. 2017). Income gains have been linked with a higher likelihood to consume vegetables, fish, and tubers (Dillon, Mcgee, and Oseni 2015). And while it is not always the case (Basole and Basu 2015), higher income and wealth have been linked with nutrition gains (Headey et al. 2015).

Despite the benefits of such practices, some households may struggle to successfully adopt small-scale cultivation. Adequate training and continued education are important inputs (Murshed-E-Jahan and Pemsl 2011; Wilcox et al. 2014; Jana et al. 2015; Hudson, Krogman, and Beckie 2016). Responding to this need, cultivation interventions have integrated an education component, such as in Nepal (Miller et al. 2014; Darrouzet-Nardi et al. 2016; Haselow, Stormer, and Pries 2016; Osei et al. 2017) and in Bangladesh (Haselow, Stormer, and Pries 2016). For all such interventions, though, it is important to highlight this caveat: Even with education and adequate access to food, there can be no guarantee of improvements in dietary diversity, let alone increases in consumption (Schreinemachers, Bhattarai et al. 2017; Schreinemachers, Rai et al. 2017).

[8] The method of production of aquaculture is of some concern. There are nutritional differences between farmed and wild fish, with farmed fish having fewer micronutrients (Belton, van Asseldonk, and Thilsted 2014; Bogard et al. 2016).

Enhancement of the nutritional value of food

Interventions that target micronutrient deficiency are often considered to be the most cost-effective public health programs (Berry, Mukherjee, and Shastry 2012). Among these, micronutrient fortification has shown promise in South Asia as a means to improve nutrition (Asare-Marfo et al. 2013). One strategy is through biofortification, promoted by organizations such as HarvestPlus. Biofortification is the process of breeding staple food crops, which often have little nutritional value, to have sufficient levels of specific micronutrients. A second strategy involves fortification of food, generally spearheaded by governments and their stakeholders in collaboration with the food industry.[9]

BIOFORTIFICATION

Biofortification is targeted at foods widely consumed by poorer households, often starchy staple food crops with little intrinsic nutritional value. The aim of biofortification is to provide sufficient levels of vitamin A, iron, and zinc through these crops. Evidence suggests a promising future for biofortified crops in South Asia, particularly for rice and wheat and for countries including Afghanistan, Bhutan, India, and Nepal (Asare-Marfo et al. 2013). HarvestPlus (2016) has identified several pathways through which biofortified crops may improve nutrition.

First, nutrients in crops can improve micronutrient status. The presence of micronutrients in a food crop does not necessarily mean that they are absorbed by humans during and after consumption. But models and direct study in human populations indicate promise (HarvestPlus 2016). While much of the evidence is based on simulations, it suggests that biofortified crops offer important potential for improving human micronutrient levels. These crops include iron-rich wheat, rice, and pearl millet in India (Stein et al. 2008; Finkelstein et al. 2015; Finkelstein, Haas, and Metha 2017), zinc-fortified and beta carotene–fortified rice in Bangladesh (Arsenault et al. 2010; De Moura et al. 2016), and vitamin A–fortified fish in Bangladesh (Fiedler et al. 2016).

Second, producers and consumers generally accept biofortified crops. Studies of consumer acceptance indicate that consumers prefer biofortified crops as much as conventional ones or even more so. These findings are based on situations in which consumers had no additional information about the nutritional traits of biofortified varieties. When given that information, consumers preferred all attributes of biofortified varieties to non-biofortified ones (Banerji et al. 2016; HarvestPlus 2016). Producers also accept biofortified crops, which can be cultivated without reducing yields relative to those of conventional varieties (HarvestPlus 2016).

Yet controversy exists around biofortified crops and genetically modified crops more generally (Qaim and Kouser 2013). Some critics argue that efforts should be targeted toward increasing consumption of foods that are naturally rich in micronutrients, such as vegetables and pulses (Weinberger 2005). Others view biofortified crops as “unnatural.” Such perceptions can pose a challenge for biofortification. For nutrition gains to be realized, people must be willing to eat

[9] Home fortification is a third option. This can be done by sprinkling sachets of micronutrients on meals prepared at home or by consuming a fortified spread that can be eaten with cereal products (Berry, Mukherjee, and Shastry 2012). This option is not discussed in this review.

biofortified crops and to grow them (Stein et al. 2005). Accounting for this, several simulation studies include pessimistic nonadoption scenarios in addition to the best-case outcomes of widespread adoption and cultivation (Stein et al. 2005; Stein et al. 2007; Stein et al. 2008; Arsenault et al. 2010; De Moura et al. 2016).

Finally, biofortification is cost-effective. Indeed, evidence suggests that it has the potential to be more cost-effective than many other interventions aimed at reducing micronutrient deficiency (Meenakshi et al. 2010; HarvestPlus 2016). Many studies support this, having assessed cost-effectiveness on the basis of improvement in micronutrient intake and increase in Disability-Adjusted Life Years (Qaim, Stein, and Meenakshi 2007).[10] Most such studies have been conducted in India and look at the question with respect to biofortified rice and wheat. Estimates of the cost of saving one Disability-Adjusted Life Year through consumption of these foods range from $0.36–1.90 under optimistic adoption and consumption scenarios (Stein et al. 2005) to a spread of $0.73–7.31 (Stein et al. 2007).

Studies generally agree that iron-rich wheat and rice are cost-effective (Stein et al. 2008). Golden rice has been projected to be similarly cost-effective. By adopting golden rice, India alone could save a total of 1.4 million Disability-Adjusted Life Years and reduce the prevalence of vitamin A deficiency by 8.8 percent (Stein, Sachdev, and Qaim 2006). Indeed, research has suggested that biofortification is a cost-effective and practical method for reaching malnourished individuals across South Asia, particularly those who live in rural areas and may lack access to diverse diets, supplements, or fortified foods.

FORTIFICATION

Fortification provides a way for improving the nutritional qualities of foods through the addition of micronutrients after production but before consumption. This occurs primarily through commercial fortification, where nutrients are added during the processing of food. Government support and funding of such food products is essential for their development. Once the fixed costs of creating fortified food products are sunk, commercial producers may be more willing to sell such products to the public (Berry, Mukherjee, and Shastry 2012). While little research has been done on commercial fortification, evidence from India suggests that this strategy can be successful at the community level (Varma et al. 2007). And in Bangladesh, simulations show that a process for fortification of vegetable oil could reduce the number of people with inadequate levels of vitamin A from 115 million to 86 million—a decrease of 25 percent (Fiedler, Lividini, and Bermudez 2015).

Small-scale trials of fortification are more common than large-scale trials, but suggest success at improving micronutrient levels. For example, micronized ferric pyrophosphate in extruded rice decreased iron deficiency in Indian schoolchildren (Moretti et al. 2006; Radhika et al. 2011). In addition, traditional food supplements such as nuts, oilseeds, and millet cooked in clarified butter improved calcium, iron, and zinc levels in lactating mothers (Kajale et al. 2014).

[10] Disability-Adjusted Life Year is a measure of overall disease burden, expressed as the number of years lost due to ill health, disability, or early death.

There are some shortcomings, however. While using food supplements with clarified butter led to increased weight gain in infants, it also resulted in obesity and overweight status in women (Kajale et al. 2014).

Outcomes may also be limited by the initial conditions of the population. A study of preschoolers, schoolchildren, and women in Sri Lanka failed to find a reduction in anemia prevalence from consuming iron-fortified wheat flour because of low baseline levels of anemia in the population (Nestel et al. 2004). In Nepal, a vitamin A fortification program aimed at reducing night blindness in pregnant women had limited efficacy because women were too deficient in iron to successfully absorb the vitamin (Graham et al. 2007).

Other research on commercial fortification has focused on the effect of salt iodization. With support from UNICEF, the Global Alliance for Improved Nutrition (GAIN), and the Bill & Melinda Gates Foundation, many South Asian countries have made iodization of salt a priority (GAIN 2012). India, in particular, has served as a test case. In the 1960s, the nation implemented mandatory fortification of salt. This requirement was lifted in 2000, leading to a dramatic decrease in the consumption of iodized salt. During this time, a number of studies emerged about the importance of iodine, with salt as the primary method of consumption (Mason et al. 2002; Kramer et al. 2016). The Indian government reinstated a mandatory iodization program in 2005, and today more than 70 percent of households in India consume iodized salt (GAIN 2012). Double-fortified salt, which is fortified with both iron and iodine, has also been considered to reduce micronutrient deficiency. While some studies have shown that the introduction of double-fortified salt increases consumer intake of iron and iodine and reduces anemia (Horton, Wesley, and Mannar 2011; Venkatramanan et al. 2017), cost-benefit analysis suggests that its application is best suited to cases where food fortification alone does not achieve desired outcomes (Horton, Wesley, and Mannar 2011).

Beyond questions of how foods should be fortified, another issue involves the target populations for these products. Targeting has generally focused on children and breastfeeding women. Schoolchildren are easily targeted because of the prevalence of school feeding programs. They are also a suitable target population because they are undergoing substantial physical and mental development and require more nutrients than other population segments. Effective programs are aimed not only at increasing nutrient intake (Bhagwat et al. 2014) but also at ensuring that consumers will actually consume the fortified food. A study from Bangladesh has found increased food intake following the addition of amylase (an enzyme) to flour, a staple of diets in the country (Hossain, Wahed, and Ahmed 2005).[11]

Importantly, while fortification and biofortification potentially offer efficient and cost-effective strategies for improving nutrition in South Asia, they should form part of a comprehensive system of interventions. These strategies are complements to, not substitutes for, other strategies (Qaim, Stein, and Meenakshi 2007) and should not be used as stand-alone solutions.

Weather and climate change

[11] In addition to targeting children in school feeding and other nutrition programs, studies also mention fortifying junk foods as a possible channel for increasing children's consumption of fortified foods (Ritu and Gupta 2015).

WEATHER, AGRICULTURAL PRODUCTION, AND NUTRITION

Uniquely exposed to climate and the natural environment, agricultural production is extremely vulnerable to weather shocks and natural disasters. Rainfall shocks and extreme weather events affect food production, food security, and nutrition. While the outcomes of negative rainfall shocks (much less than average rainfall) are well documented, positive rainfall shocks (much more than average rainfall) may also have important effects. A positive rainfall shock may have a positive effect on income through improved agricultural production but also a negative effect on the disease environment, with wet conditions promoting the spread of illnesses. In Nepal, the positive income effect has been shown to dominate the negative disease-environment effect, leading to improved child weight-for-age and height-for-age (Tiwari, Jacoby, and Skoufias 2017). The sensitivity of nutrition to rainfall is mitigated by investments in health facilities and transport infrastructure (such as roads and bridges) (Shively 2017). Similarly, in India, positive rainfall shocks in early childhood have been found to increase child height-for-age and weight-for-age (Mendiratta 2015).[12]

CLIMATE CHANGE, FOOD SECURITY, AND NUTRITION

Climate change exacerbates the already pronounced adverse effects of weather and weather variability on agriculture. The increase in greenhouse gas emissions is raising the earth's temperature, increasing rainfall and the incidence of extreme weather events. Climate change has been noted as a new threat to agriculture and food security (Gahukar 2011; Ahmad, Iqbal, and Farooq 2015). In the Hindu Kush subbasin of Pakistan, India, Nepal, and China, farmers have noticed an increase in floods, landslides, drought, and disease, all potentially associated with climate change. These events can be linked to a decline in the production of staple crops and an increase in food insecurity (Hussain et al. 2016).

In South Asia, climate change could affect food security through an expected decrease in agricultural productivity. In India, modest temperature increases over the next three decades may lead to a substantial decline in agricultural output, with a corresponding small decline in consumption for most rural households (Jacoby, Rabassa, and Skoufias 2011). In Bangladesh, one study has found that the overall effect of climate change by 2030 on national income is likely be small. But the effect on the agricultural sector is projected to be much larger, leading to reduced output, increased imports, and reduced caloric consumption (Banerjee et al. 2015).

In Nepal, farmers already experience erratic rainfall, increased frequency of floods and droughts, and soil degradation, as well as an increasing incidence of insects, pests, weeds, and diseases. Despite the availability of mitigation strategies, agricultural productivity and food security are declining in the country (Shrestha and Nepal 2016). In contrast, in the Walwe Basin in Sri Lanka, climate change appears to be having a positive effect on food security and environmental quality, as demonstrated by higher yields and production. But weather extremes will be more frequent around the world in the future, making adaptation strategies necessary (Droogers 2004).

[12] While not directly related to nutrition, in Bangladesh, poverty and food insecurity are greater in coastal regions, exposed to weather risks including cyclones (Rahman, Kranz, and Bauer 2012; Mohsena et al. 2018). In Pakistan, floods have been shown to cause large losses in agriculture (Dorosh, Malik, and Krausova 2010).

While the focus of the development community had shifted from calories to nutrients in recent years, climate change is redirecting the discussion back to calories, as the trend threatens the sufficiency of basic food production. Winners and losers will emerge in the short term, but in the longer term, climate change is expected to have an overall negative effect. In agriculture, it is expected to adversely affect yields through losses in productivity, with greater projected effects in South Asia than any other region of the world. In South Asia, climate change is also expected to lead to an increase in food prices, a decline in production, and a reduction in the consumption of meat and cereals. Calorie availability and child calorie consumption are projected to decrease. By 2050, climate change is expected to have contributed to an increased prevalence of severe stunting—and to a greater degree in South Asia than in other regions (Lloyd, Koyats, and Chalabi 2011). Globally, experts estimate that an additional $7 billion will be needed each year to mitigate such effects of climate change on child undernourishment (Nelson et al. 2009; Bandara and Cai 2014; Choudhury, Headey, and Masters 2018).

Even as climate change is expected to reduce the quantity of food being produced, the global increase in carbon dioxide emissions that fuels climate change is already affecting the quality of food by reducing the nutrients that are available in plants. In 2004, it was documented that the nutritional value of 43 garden crops in the United States had decreased for six nutrients between 1950 and 1999. Initially, experts attributed the decreases to changes in cultivated varieties, as trade-offs exist between high-yielding varieties and high-nutrient-content varieties (Davis, Epp, and Riordan 2004). But recent rigorous experiments have highlighted the role of carbon dioxide emissions. Specifically, a higher concentration of atmospheric carbon dioxide reduces protein, zinc, and iron, and increases carbohydrates, in such crops as rice, wheat, barley, and potato (Loladze 2014; Myers et al. 2014).

South Asia is particularly vulnerable. By 2050, Africa and South Asia are expected to have the highest number of people placed at new risk of zinc deficiency because of elevated carbon dioxide, with close to 48 million people at risk in India alone (Myers et al. 2015). And 53 million people in India may be at risk of protein deficiency in the future because of the decrease in plant nutrients (Myers et al. 2015; Medek, Schwartz, and Myers 2017).

Climate change mitigation and adaptation

Climate change not only affects agricultural productivity but is itself affected by agricultural production. Agriculture accounts for 25 percent of the world’s greenhouse gas emissions. To address this issue, a “climate-smart food system” may provide a triple win: improved agricultural productivity, adaptation or greater resilience to climate change, and mitigation or reduction of greenhouse gas emissions (Klytchnikova et al. 2015).

Mitigation strategies, such as decreased use of coal, wood, and natural gas, might be more detrimental for poor people, and poor people may also have limited access to adaptation strategies. For example, strategies to reduce greenhouse gas emissions may lead to a more rapid deterioration of food access for poorer populations globally (Tabeau et al. 2017). In Pakistan, wealthier and more-educated farmers are more likely to employ adaptation strategies deemed to be effective at improving food security, and using more of these adaptation strategies has been found to lead to greater food security (Ahmad, Mustafa, and Iqbal 2016; Ali and Erenstein 2017).

Another concern is the potential trade-offs between adaptation and mitigation, and between adaptation and nutrition sensitivity. Some adaptation strategies may further stress the environment. In Bangladesh, for example, shifting into horticulture crops and tobacco cultivation improved food security, but cultivation of cash crops, such as tobacco, had negative environmental effects (Bala and Hossain 2012). Some adaptation strategies may be more nutrition-sensitive than others. Millet offers a promising, suitable option for India. The grain is genetically diverse and better able to adapt to a changing environment compared with other cereals; at the same time, it is high in protein and micronutrients, ideal for the government's goal to improve nutrition (Padulosi et al. 2015). In implementing adaptation strategies, governments should consider not only their potential for sustained productivity and their effect on food security and nutrition, but also their potential effect on the environment.

Conclusion

This paper presents findings from a systematic review of the relationship of food and agriculture with nutrition in South Asia. The evidence linking food and agriculture with nutrition is broad, though highly variable in quality. Several food and agricultural interventions have been shown to improve dietary diversity and nutrition in South Asia. These include programs to enhance the nutritional value of cereals and staple crops through mass fortification and biofortification, and home production of naturally nutritious food through small-scale home gardens, animal husbandry, or aquaculture.

Indeed, the literature on biofortification of crops and fortification of food is extensive, with several studies establishing the effectiveness of fortification interventions. But this work is often conducted in a highly controlled environment or as simulations or ex ante studies. Additional research in field settings is needed to better understand the broader effects of fortification (Berry, Mukherjee, and Shastry 2012). Gaps also exist in the literature with respect to implementing fortification, distributing fortified seeds, and generating demand for fortified food and seeds among consumers.

Studies on these topics are emerging, including a broad examination of Bangladesh's rice biofortification intervention (Hossain, Husain, and Datta 2004). But much remains to be considered. For example, little evidence connects fortification interventions with specific, measurable nutrition outcomes, such as micronutrient intake or an individual's status as underweight, stunted, or wasted. Thus, while these interventions show promise, few have demonstrated rigorous and quantitatively established relationships with nutrition.

With a few exceptions, results in the overall body of literature on food and agricultural interventions are best described as correlative or suggestive. Much of the evidence is based on small case studies, ex ante simulations, or crude analyses with little external validity. Strengthening the quality of the evidence around much of the work we have reviewed is a priority.

Emerging trends are creating even more gaps in the research. We highlight three as important areas for further research. First, rapid urbanization carries important implications for food systems as well as for their evolution, development, and management. While half the world's population today lives in cities, by 2050 that share is expected to exceed 65 percent. And as urban populations continue to grow, the urban share of undernourished children—one in three today—is also likely to rise unless issues in urban food systems are addressed (Beddington et al. 2017). Differences in food consumption are often driven by differences in wealth. Wealthier households tend to have greater access to fruits and vegetables and more time to prepare nutritious meals. In contrast, poorer households are more likely to rely on high-calorie, processed, convenience foods (Tefft et al. 2017). This can result in undernutrition and micronutrient deficiencies as well as in overweight, obesity, and diet-related noncommunicable diseases (Gaiha, Jha, and Kulkarni 2010; Beddington et al. 2017).

Second, less food reaches consumers than is produced—because of both food loss (occurring in the production, post-harvest, and processing stages) and food waste (occurring at the retail and final-consumption levels). Indeed, it is estimated that a third of the food produced for human consumption globally is lost or wasted, amounting to 1.3 billion tons of food each year (Gustavsson et al. 2011). The economic cost of food waste is estimated to total $1 trillion annually. But the hidden costs of food waste extend to adverse effects on the environment. Globally, wasted and discarded food ranks as the third-largest emitter of greenhouse gases, next only to the countries of China and the United States (FAO 2014).

Third, more-nutritious foods, such as animal-source foods, fruits, and vegetables, are more susceptible to food-safety hazards. Unsafe food may make people sick, causing acute or chronic illness. The costs resulting from these effects can be substantial. In low- and middle-income countries, they amount to about $110 billion each year in lost productivity and medical expenses (Jaffee et al. 2018). In 2010, the global burden of foodborne illness stemming from 31 types of hazards in 14 geographic regions was estimated to total 33 million Disability-Adjusted Life Years, arising from 600 million illnesses and 420,000 deaths. In comparison, air pollution results in the loss of 76 million Disability-Adjusted Life Years annually, and malaria in the loss of 82 million (WHO 2015). In 2011, India registered 100 million cases of foodborne diseases. By 2030, that figure is predicted to rise to 150–177 million because of the expected rise in incomes and the corresponding dietary transition to higher consumption of fruits, vegetables, and meat (Kristkova, Grace, and Kuiper 2017).

Encouragingly, possible solutions exist for all these emerging challenges. Countries will need to consider them, act, and learn.

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Table 1. Search Terms

Category	Search terms
Category A: Interventions	
Nutrition-sensitive agriculture	agriculture, nutrition-sensitive agriculture
Home production of nutritious and diverse foods	
Home gardens	home gardens, kitchen gardens, backyard gardens, horticulture, house farming
Fisheries	small-scale fisheries, aquaculture, artisanal fishing, fish farms
Livestock and poultry	livestock, animal husbandry, animal rearing, livestock breeding, dairy, dairy development, dairy cooperatives, dairy enterprise, dairy value chain, milk yield, poultry, poultry development, chicken
Traditional foods	traditional food, local food, indigenous food, native food, ethnic food
Crop diversification	crop diversification
Fortification of staple crops	
Biofortification	biofortification, agronomic biofortification, genetic biofortification, biological fortification
Fortification	fortification, post-harvest fortification, fortified food, crop fortification
Value chain	food value chain, supply chain
Storage	food storage
Processing	food processing, agricultural processing
Distribution	food distribution
Retailing	food retailing, food marketing, wholesale
Quality and safety	food quality, food safety, aflatoxin, quality-control, quality-assurance
Food environment	food environment, personal food environment, external food environment
Accessibility and availability	transportation, access to markets, infrastructure, local infrastructure, roads, distance to market, distance from market, food access
Affordability and prices	food prices, cost of food
Acceptability and desirability	food acceptability, willingness to pay, food choice
Food assistance	food assistance, food distribution, food distribution programs, school feeding, food aid, food aid distribution, public food distribution system
Environment and resources	forests, climate smart agriculture, conservation agriculture, climate, climate risk, climate variability, weather, weather shocks, agricultural insurance, index insurance
Agricultural growth	agricultural growth, employment in agriculture

Table 1. Search Terms

Category	Search terms
Category B: Outcomes	
Level	food consumption, calories, caloric intake
Quality	food quality, micronutrient intake, macronutrient intake, macronutrient needs, micronutrient needs, healthy food
Diversity	diet diversity, dietary diversity, consumption diversity, food consumption score, FCS
Distribution	intra-household allocation, child consumption, intra-household consumption bias, intra-household reallocation
Security	food security, food insecurity, HFIAS, food livelihood
Nutrition	nutrition, nutritional status, malnutrition, malnourishment, stunting, height for age, HAZ, wasting, weight for height, WHZ, wasting, underweight, weight for age, WAZ, obesity, anemia, stature, physical stature, iodine deficiency
Category C: Geography	
Geographic scope	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka, South Asia

Table 2. Results of Search, Screening, and Coding

Database	**Documented** results	**Screened** as relevant	**Coded** as relevant
EconLit	1,215	201	73
IDEAS	2,154	146	103
Science Direct	58	12	12
AGRICOLA	123	46	35
DIALOG	22	0	0
ERIC	12	2	0
PubMed	1,766	87	49
Total	5,350	494	272