

Agriculture, nutrition and the green revolution in Bangladesh[☆]



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ABSTRACT

This paper explores agriculture and nutrition linkages in Bangladesh, a country that achieved rapid growth in rice productivity at a relatively late stage in Asia's Green Revolution, as well as unheralded progress against undernutrition. To do so, we first outline a simple conceptual model to identify the different impacts that productivity growth in a food staple(s) might have on child nutrition outcomes, with a particular focus on changes in diets at the household and child level. We then apply this framework to a descriptive overview of the evolution of Bangladesh's food system in recent decades. We show that this evolution is characterized rapid growth in yields and calorie availability, but relatively sluggish diversification in both food production and consumption, despite increasing reliance on imports for dietary diversification. Next, we create a multi-round district level panel that links changes in nutrition survey data with agricultural sample survey data over 1996–2011, a period in which rice yields rose by more than 70%. We then use this panel to more rigorously test for associations between yield growth and various anthropometric and child feeding indicators. Consistent with our descriptive evidence on dietary changes, we find that rice yields predict the earlier introduction of complementary foods to young children (most frequently rice) as well as increases in their weight-for-height, but no improvements in their dietary diversity or height-for-age. Since Bangladesh has one of the highest rates of child wasting in the world, these significant associations between yields and child weight gain are encouraging, but the lack of discernible effects on children's dietary diversity or linear growth is cause for concern. Indeed, it suggests that further nutritional impacts will require diversifying the Bangladeshi food basket through both supply and demand-side interventions.

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1. Introduction

Despite a surge of recent interest in identifying the impact of agriculture on maternal and child nutrition, the existing scientific literature has brought little light to bear on the core question of whether large scale agricultural programs – particularly longstanding efforts to increase cereal yields – significantly alter nutrition outcomes (Ruel and Alderman, 2013; Pinstруп-Andersen, 2013). Much of the literature has been confined to cross-sectional studies for which even indirect policy attribution is very difficult (Bhagowalia et al., 2012; Dillon et al., 2014; Hoddinott et al., 2015), or to more experimental studies of small scale livestock or homestead gardening interventions (Berti et al., 2004; Leroy and Frongillo, 2007; Masset et al., 2012).

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Yet advocates of agriculture-led development typically have in mind much larger scale agricultural programs and policies in the spirit of Asia's "Green Revolutions" (Bezemer and Headey, 2008; Diao et al., 2010; Hazell, 2009; Mellor, 1976; Pinstруп-Andersen, 2013). These Green Revolutions were led by the research and development (R&D) of improved rice, wheat and maize varieties, which – along with associated policies to promote the expansion of irrigation, fertilizers and other inputs – have contributed to rapid growth in Asian food production over the past 40 years. Rice yields, for example, have increased by around 150% in Bangladesh, northern India, Indonesia and Pakistan since the 1960s, while wheat yields in these countries increased by some 250% (FAO, 2014).

Despite its fundamental contribution to poverty reduction, surprisingly little is known about the impact of Asia's Green Revolution on nutrition, and much of what has been written is speculative at best (see Hazell, 2009 for some review). Optimists have focused on the contributions of Green Revolution investments to household calorie consumption and national food security (Pinstруп-Andersen and Jaramillo, 1991), but no work that we are aware of has directly examined impacts on child level feeding practices (particularly the timing and diversity of complementary feeding) or nutrition outcomes. Pessimists point to the adverse micronutrient consequences of reduced biodiversity in monocropping systems, particularly lower consumption

of pulses, coarse grains and fish (Bouis, 2000; Shankar et al., 2005), and also to the harmful health and nutritional impacts of excessive use of fertilizers and pesticides (Brainerd and Menon, 2014). Yet no work that we are aware of has examined the impacts of growth in cereal yields on changes in individual nutrition outcomes or diets. This knowledge gap exists because the Green Revolutions of the 1960s, 1970s and 1980s largely preceded the kinds of large, multi-topic surveys that are typically a prerequisite for identifying the welfare impacts of large-scale interventions (Elbers and Gunning, 2013).

This paper seeks to fill this knowledge gap by exploring the nutritional impacts of rice productivity growth in Bangladesh. Bangladesh is an ideal case study for several reasons. First, for political reasons, Bangladesh was a relatively late adopter of Green Revolution technologies (Evenson and Gollin, 2003), meaning that much of its productivity growth occurred during more recent periods of improved statistical surveillance. From 1997 to 2011 (the period of our analysis) yield growth for rice averaged 3.6% per annum on the back of increased adoption of improved varieties and the rapid expansion of the irrigated dry season rice crop. Second, productivity growth in Bangladesh coincided with substantial improvements in preschooler nutritional status. In 1996/97, rates of preschooler stunting (height-for-age Z scores < -2) and mild wasting (weight-for-height Z scores < -1) were 53 and 54% respectively. These were among the highest rates of undernutrition in the world at that time, although by 2011 rates of moderate stunting and mild wasting had both fallen to around 40% (Headey et al., 2015). Third, Bangladesh has a relatively rich array of nutritional and agricultural data; the dearth of such data has undoubtedly been a constraint to exploring the impacts of agricultural growth on nutrition in other Green Revolution countries.

Our analysis involves three steps. First, we outline a conceptual framework for thinking about the complex linkages between the economic impacts of the Green Revolution (on farm incomes, wages and food prices) and child nutrition outcomes, with a specific focus on child diets/feeding practices as a key impact pathway (Section 2). We then turn to descriptive evidence of how the evolution of agricultural production and trade has influenced national food supply, household diets and child feeding practices in Bangladesh (Section 3). Here we not only describe the well-known drivers of yield growth in Bangladesh rice production (namely the conventional Green Revolution “package” or high yielding varieties, irrigation and chemical inputs), but also the agroecological constraints that have limited Bangladeshi agriculture’s capacity to diversify food production away from rice. Imports have provided some imperfect substitution for the lack of diversification in domestic production, but the net result has been a very limited diversification in food consumption, especially among young children.

We then attempt more formal tests of these linkages by constructing a small district-level panel dataset comprised of nutritional indicators from five rounds of the Bangladesh Demographic Health Surveys (over 1996/97 to 2011) and district level data on rice yields from the Bangladesh Bureau of Statistics (the construction of which is described in Section 4). With these data we use difference-in-difference estimates to explore whether growth in rice yields significantly predicts preschool nutritional status and feeding patterns (dietary diversity, and the timing of introducing complementary foods), as well as maternal nutrition outcomes (Section 5). We find that yield growth predicts improvements in child weight gain and an earlier introduction of solid foods (most of which is rice), but does not predict improvements in linear growth (height gain) or improved dietary diversity. We also find no significant associations between yields and maternal body mass.

Given the limitations of our data and the lack of existing evidence on agriculture–nutrition linkages in Bangladesh, our concluding remarks cautiously reflect on these findings. One important limitation of our analysis is that our small district level panel precludes the use of more experimental estimation techniques that might allow us to draw more confident causal inferences. Hence we do not claim to causally identify the nutritional impacts of rice policies and investment per se. This

study should instead be viewed as a preliminary exploration into the nutritional impacts of Green Revolution-style agricultural development strategies.

Bearing this important caveat in mind, several of our exploratory findings are economically and biologically plausible, and are certainly pertinent to the important policy question of whether agricultural development strategies should continue to focus on improving the productivity of key staples, or instead leverage agriculture for diversifying diets. We show that Bangladeshi diets remain heavily under-diversified, and that this lack of diversification is likely a major constraint to achieving further reductions in child stunting, as well as various micronutrient deficiencies not directly addressed in this paper. Accelerating dietary diversification will require research and policy experimentation on a wide range of both supply and demand-side interventions.

2. Conceptualizing the linkages between rice productivity growth and child nutrition

How might rapid growth in a staple crop influence child nutrition outcomes? In Fig. 1 we present a simplified framework for thinking through the various connections between rice productivity growth and changes in nutrition. At the top of Fig. 1 we focus on policy-driven growth in rice yields (particularly the combination of agricultural R&D, irrigation expansion and policies that affect other inputs, such as fertilizers). Economic research has demonstrated that growth in staple food production influences farmer incomes directly, but also has indirect effects on the demands for unskilled labor (Mellor, 1976; Hazell, 2009). This influence on labor earnings explains why the rural landless have typically benefited from Asia’s Green Revolutions (Hazell, 2009). In partially closed economies an increase in rice production also reduces real rice prices, with important implications for food security (Shahabuddin and Dorosh, 2002). However, the effects of rice productivity growth on the consumption of other foods is ambiguous. Higher

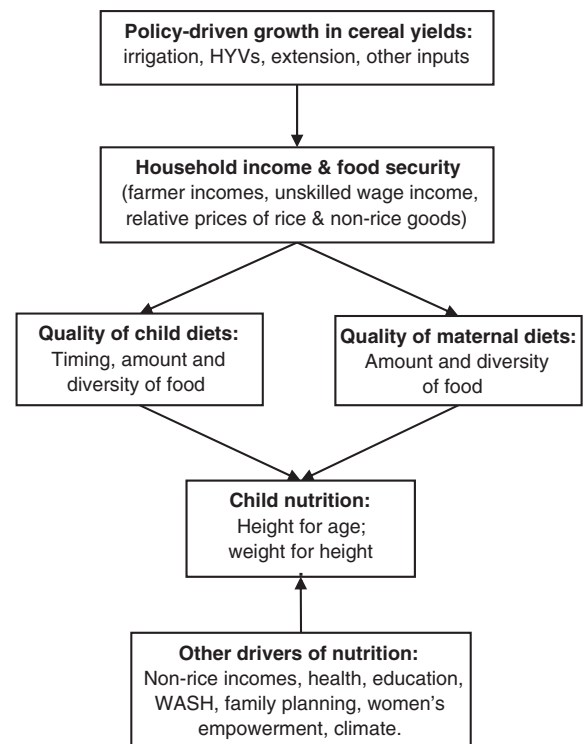


Fig. 1. The linkages between yield growth, dietary changes and nutrition outcomes. Notes: WASH refers to water, sanitation and hygiene. Source: Authors’ construction.

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