Safety Nets Can Help Address the Risks to Nutrition from Increasing Climate Variability[1,2]

Harold Alderman*

World Bank, Washington, DC 20433

Abstract

Models of climate change predict increased variability of weather as well as changes in agro-ecology. The increased variability will pose special challenges for nutrition. This study reviews evidence on climate shocks and nutrition and estimates the economic consequences in terms of reduced schooling and economic productivity stemming from nutritional insults in childhood. Panel data covering up to 20 y indicate that that short-term climate shocks have long-term impacts on children that persist, often into their adult lives. Other studies document the potential for relief programs to offset these shocks providing that the programs can be implemented with flexible financing, rapid identification of those affected by the shock, and timely scale-up. The last of these presumes that programs are already in place with contingency plans drawn up. Arguably, direct food distribution, including that of ready-to-use therapeutic food, may be part of the overall strategy. Even if such programs are too expensive for sustainable widespread use in the prevention of malnutrition, scalable food distribution programs may be cost effective to address the heightened risk of malnutrition following weather-related shocks.   J. Nutr. 140: 148S–152S, 2010.

Introduction

The various projections of climate change anticipate substantial changes in agro-ecological zones with expected increases in food prices and loss of livelihoods on a wide scale, both of which will affect nutrition, as discussed in the papers in this workshop. There is, moreover, both substantial spatial and temporal variability around the projected trends. For example, although various models project that maize yields will fall 10–20% in Africa by 2050, the mean loss masks the fact that some areas, particularly highlands, will have modest gains Whereas others will have even more substantial reductions (1). Moreover,

seasonal crop failures will likely increase; the Intergovernmental Panel on Climate Change (2) assesses the probability of an increase in heavy precipitation events as very likely with attendant damage to crops. Similarly, the Intergovernmental Panel on Climate Change sees likely increases in cyclone activity and in area exposed to drought.

As discussed in this workshop, a warmer planet on average will influence food consumption and nutrition through changes in prices and earnings; climatic variability poses additional challenges. Households, particularly agricultural households, need to be prepared both for shocks that affect their current earnings (including price shocks) as well as shocks that reduce their future livelihood by degrading or destroying assets. The inability to protect a household from income and asset shocks can result in irreversible consequences across generations through reduced investment in nutrition, health, and schooling (3). This paper discusses the evidence for this claim in regards to nutrition as well as lays out principles for a safety net system that might be set up to respond to the increased climate variability.

The durability of nutritional shocks

A range of studies has addressed the long-term consequences of child malnutrition for education or adult earnings or both. Only rarely can this be measured by tracking the beneficiaries of a randomized intervention, as in the study by Hoddinott et al. (4) from Guatemala. Clearly, an experimental design most easily avoids the potential bias that stems from the fact that health and subsequent educational attainments both reflect household decisions regarding investments in children's human capital. More commonly, however, the causal effects of child malnutri-

tion are distinguished from associations by employing instrumental variables estimates of nutrition in the first period of a panel data set and looking at the impact of instrumented nutrition in a later period. It proves to be a challenge to find data appropriate to this task, because it requires longitudinal data that contain information on determinants of nutrition that are of sufficient magnitude and persistence to affect a child's stature in the first period yet sufficiently transitory not to directly affect subsequent human capital investments, including schooling.

Often, the transitory shocks used in such studies are weather events (5–7). Short-term deviations from long-term spatial price environments, often indirectly due to weather shocks, can also provide this information if sufficient variation is present in the data (8). The results in these cited studies using shocks to separate out the impact of malnutrition from that of poverty are consistent with the experimental evidence from Guatemala. They are also consistent with studies that use policy changes to distinguish the impact of nutrition per se from the pervasive impact of poverty (9).

Similarly, floods can also cause nutritional insult, as observed following the 1998 floods in Bangladesh (10). Although this particular panel study only traced children for 1 y after the floods, there is no particular reason to suspect that the malnutrition caused by these floods would have essentially different long-term impacts than those caused by a different climatic shock.

Collectively, these studies confirm the hypothesis that childhood malnutrition will lower the productivity and earnings of survivors on average in a manner that is distinct from the other effects of poverty on human capital investments. That is, the bad luck of being 2 y old when a drought occurs can affect a child's lifetime earnings whether or not the household's income recovers from the shock. The loss of earning potential can often be substantial. For example, during droughts in Zimbabwe in 1982/1983 and 1983/1984 infants <2 y old, the period a child is most vulnerable to undernutrition, had higher undernutrition attributable to the weather shock. As mentioned, this allows for identification of the causal role of childhood stunting in school completion as well as in achieved height by 2000. In this case, the economic costs of stunting were estimated as a 14% reduction in lifetime earnings (6). This estimate is based on the expected increase of earnings if the median height for age Z-score were raised from the levels observed in the sample to zero and, thus, the reported estimate is not specific to the costs of drought. However, because the coefficient of drought in this study accounts for nearly 60% of the gap between the nutritional status in this sample from Zimbabwe and the international reference, the results are consistent with a drought impact of over 7% of lifetime earnings.

This may be particularly large due to the duration of the back-to-back droughts at the time of the baseline in Zimbabwe as well as the limited stock of household assets. Indeed, although it is well established that child malnutrition affects adult earning potential, the marginal contribution of drought to the total economic costs of malnutrition is likely context specific. For example, the results of Alderman et al. (9) reveal a smaller, but still significant, impact of drought on nutritional status of a child <5 y of age in the period 1991–1994 in the Kagera district of Tanzania. This study also shows the expected delay in schooling from this change in nutritional status as well as in years of schooling completed by 2004. The data also allow an estimate of a wage equation for this district. Thus, the results can be used to simulate the difference in expected lifetime earnings for males when there was a drought during their childhood compared with the absence of such a shock. A single drought in the first 5 y of children's lives can lead to a decline in the mean height of

roughly 1% of the median in the reference population (pest damage or fire has an impact of a similar magnitude, but these shocks are not included in this calculation). Ultimately, this leads to reduced investment in schooling and a mean loss of lifetime earnings of 1%. Although this is much smaller than the estimate for Zimbabwe, in part because the covered age group in the Tanzania study was less narrowly focused on the most vulnerable years, it is still over $100 in present value when future earnings are discounted at a 3% discount rate. This discount reflects the perspective of most economists that future earnings need to be discounted to accommodate the fact that a dollar today is preferred to a dollar in the future, because the former can be invested to yield more than a dollar at the future date. However, there is no universally agreed rate of discounting.

This estimate is a lower bound, because it is based only on the impact of malnutrition on years of schooling. The wage equation in that study also indicates a substantial and significant association of height and wages, possibly partially a proxy for the amount of learning per year of school attended. If the childhood malnutrition led to a decrease in adult height, not estimated in the Tanzania study but found to be the case in that from Zimbabwe, the present value of the loss of lifetime earnings of the survivors would be approximately tripled. The use of an order of magnitude approximation rather than a more exact estimate is deliberate; a drought is not a precisely calibrated intervention, unlike, e.g., the dosage of a supplement.

Avoiding these economic losses

What programs would preempt excess malnutrition in the wake of a drought? While the recent review of successful nutrition interventions in the *Lancet* (11) specifically mentions that food-aid in nonemergency situations is often counterproductive and not recommended, it also acknowledges that there may be scope for such aid in natural disasters. Yamano et al. (12) provide an empirical illustration from Ethiopia. This study initially verified that the amount of food aid a community received was associated with both the current weather shock as well as historic poverty of the communities. This approach to the estimation controls for the nonrandom distribution of food aid and, thus, controls for the fact that poorer, and more malnourished, villages received higher amounts of assistance. In the absence of food aid, a 10% increase in crop damage reduced the growth in a 6-mo period for children who were between 6 mo and 2 y of age by 1.8%. Moreover, the results also indicate that where food aid was distributed the aid largely offsets the expected increase in malnutrition attributable to harvest losses. The study, however, also observed that this assistance merely held the line; malnutrition rates in Ethiopia remained among the highest in Africa. Moreover, the study did not address the issue of whether an equal amount of cash assistance would have done as much or more to prevent malnutrition. Although the Ethiopia panel was not long enough to indicate the impact of the drought on subsequent schooling, when considering the results from Tanzania and Zimbabwe, it is likely that the food aid indirectly also protected lifetime earnings of these children.

More generically, there are some common features of countercyclical programs aimed at addressing the potential consequences of a climate shock: *1*) flexible funding mechanisms; *2*) rapid identification of beneficiaries; and *3*) efficient and adaptable administrations (13). Indeed, these features are not unique to weather events; they are also elements of successful programs to address financial crises as well as price shocks.

Nevertheless, flexible financing proves to be hard to achieve. Because economic shocks reduce revenues just as they necessi-
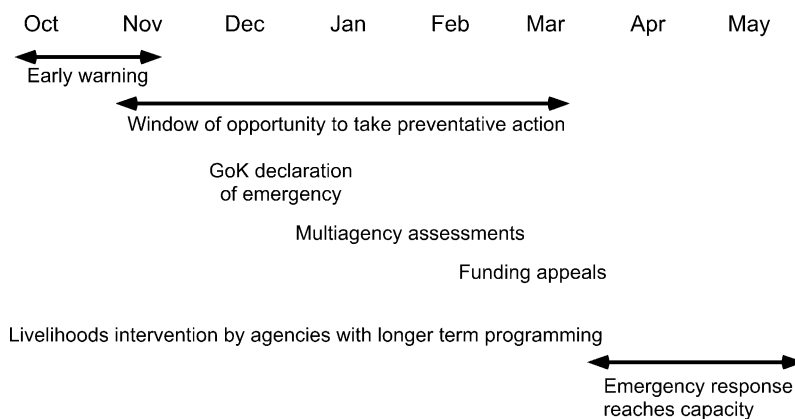
FIGURE 1 Timeline of key events in Greater Horn of Africa Drought Crisis, 2005–06. Reproduced with permission from (14). Abbreviation: GoK, Government of Kenya.

tate an increase of government expenditures, spending on safety nets or public health programs is often procyclical, i.e. it often contracts when need increases. Some countries such as India, Mexico, and the Philippines hold reserve funds for their relief programs. Similarly, Maharashtra state in India earmarked a specific tax to fund countercyclical public works. Whereas such funding may be adequate for local emergencies, the needs imposed by large covariate shocks such as cyclones often cannot be met without external support or deficit spending or both. Thus, a risk layering strategy is most plausible. Households would cope with moderate shocks using both informal and formal mechanisms. More severe or longer lasting shocks would prompt safety nets financed by governments using current revenues and earmarked reserves as well as debt. Other commercial instruments including catastrophe bonds, those that have higher than average yields but which forfeit principal, should a prespecified disaster occur, can also be included to provide predicable financing for low probability events. But the modest market gains for such financial instruments prior to the 2008 fiscal crisis are unlikely to recover in the short term; for most low income countries, disaster assistance from donors will remain part of the risk response to climate-induced disasters.

Quick-disbursing funding mechanisms are essential. Various early warning systems have been designed to identify slow onset disasters, but often they are divorced from immediate decisions. Instead of feeding into parametric triggers, their information is often filtered through cumbersome bureaucratic and political processes. Thus, most bilateral and multilateral aid flows are slow, relying on appeals that are only triggered after field assessments. This is illustrated by a case from the Horn of Africa (**Fig. 1**) (14). Often assistance ends up being pro-cyclical as a result of delays in financial assistance. Not infrequently, disaster response is also underfunded, with commitments not honored. For example, United Nations Consolidated Appeals for 2003–2005 totaled $13.3 billion but were funded only to $4.9 billion. Moreover, many donors respond to disasters by bringing forward funds already committed, so assistance is not all additional.

The International Monetary Fund (IMF)[3] and The World Bank have contingency financing instruments, used only infrequently. The IMF's Emergency Natural Disasters Assistance was used only 27 times globally for natural disasters between 1962 and 2005, at which time a new program to enhance the Fund's

ability to help low-income countries deal with sudden and exogenous shocks, the Exogenous Shocks Facility (ESF), was approved. Although the ESF was intended to be more attractive to low-income countries, it was not utilized by such countries in the first 3 y of its existence. Thus, in September, 2008 the ESF was modified to include both a rapid access component with no conditions or prior actions as well as a larger, longer term component that does have conditionalities. The new regulations have proven more attractive to low income countries.

Some recent World Bank lending has also added a flexible component of contingent grants disbursed on prespecified triggers into lending instruments. For example, these have been part of lending to Colombia's Natural Disaster Vulnerability Reduction, the Caribbean Hurricane Insurance Pool, Ethiopia's Productive Safety Net, and the Mongolia Livestock Support. Such funding may encourage, or crowd-in, private investment as observed with IMF assistance to Grenada after Hurricane Ivan in 2004.

It may also be possible to use insurance to achieve countercyclical funding of government safety net programs, although few countries have explored it. This may reflect the difficulty of setting up a new product line, with ambiguity risk stemming from the inability to project new climate risks with the data on hand contributing to high premiums. The World Food Program briefly entered into a commercial insurance contract on behalf of the Government of Ethiopia to ensure a portion of that country's safety nets program. Similarly, Mexico's national and subnational governments fund social programs with commercial insurance, as humanitarian organizations and nongovernmental organizations might consider. In a related manner, micro-finance institutes might seek reinsurance to avoid a liquidity crisis, such as the one faced by the Grameen Bank in Bangladesh in 1998, when insured clients across the country found they could not repay loans after widespread flooding.

Perversely, donor programs, often compartmentalized into humanitarian and development assistance, might set up disincentives for governments to finance their own safety nets. Indeed, after weather indexing insurance for Nicaragua had been priced in the global reinsurance market, the government declined to pursue the program, citing the international assistance following Hurricane Mitch in 1998 as an indication of dependable alternatives. This tendency, the Samaritan's dilemma, might be addressed by a risk layering strategy in which donors continue to fund low frequency events, through insurance or other means, but encourage or even subsidize other countercyclical strategies at a local level.

Although there is extensive experience with the targeting of income or food transfers on the basis of indicators of chronic poverty, ex post targeting to mitigate state contingent needs requires different data and different implementation. Because most proxy indicators of poverty or food security, such as land or other asset ownership, are relatively static, countercyclical programs may use other indicators responsive to shocks. Clearly, nutritional screening can serve this purpose. Given the cost of collecting data for short-term use, an alternative targeting approach might use a combination of community targeting and self-targeting. Public works and commodity subsidies for grains primarily consumed by the poor, such as yellow maize, are examples of self-targeting. Household targeting could be mixed with geographic targeting to identify communities that would in turn deliver resources to individuals.

Because safety net programs have to be scaled up rapidly when needs increase and scaled back when the crisis subsides, unless programs are designed prior to the occurrence of a shock, it is difficult to set a program up in time to meet most needs. For example, 2 y after earthquakes in Gujarat, India, only $700 million of $3.1 billion in donor pledges and reprogrammed World Bank lending had been spent.

What type of program might be considered? Many safety nets for shocks are in-kind food assistance, although increasingly cash transfers can be found in low income settings, sometimes using post offices or mobile telephones for the logistics of transfers. If it is not already in place, however, the infrastructure for cash transfers to remote areas can not easily be established in crisis situations. An alternative to direct income or food transfers household income may be supported through public works programs. Public works, particularly targeted to low wages, can respond to a range of economic shocks. The Maharashtra Employment Guarantee Scheme expanded by 64% in response to a drought in 1982. The full impact of such public works programs goes beyond the immediate income transfer. The assets created may also be explicitly targeted to poor agrarian communities. But, again, unless the shelf of projects is prepared prior to a drought or flood with local input into the selection, the value of the assets created is likely to be modest. Use of local contractors is clearly advisable if timeliness is essential, but relaxing safeguards on procurement can lead to wasteful spending, as in New Orleans following Hurricane Katrina.

Nutritional considerations for safety nets

Many transfer programs are designed to address income loss and to allow a household to preserve its asset base following an adverse weather event. They often do not assist labor-poor households nor do they always explicitly address the needs of children. Targeted supplementary feeding is clearly more focused on preventing the nutritional insults that may occur. With the increased availability of locally produced ready-to-use foods (RUF), which are less susceptible to spoilage than powered milk-based supplementary foods and which do not require mixing with water, this approach can be managed by community health workers. Indeed, it may be hard to separate the intrinsic advantage of the products promoted with RUF from the advantages of the community-based management of care. Reviews have shown that RUF can reduce mortality in a cost-effective manner (15–17). Such calculations of cost effectiveness can be applied to mortality reduction for which a cash benefit can not be reliably assigned.

However, this curative function is only one dimension of the potential benefits of RUF. Arguably, they can be useful in preventing malnutrition, an outcome that is more amenable to benefit cost calculations. Such calculations may assist in refining the debate on who should receive food assistance. For example, using the Tanzania results discussed above and assuming that the drought occurred when the child was 1 y and the lower range of the estimates of benefits, any intervention aimed at children at risk of an increase in malnutrition that costs <$100 would yield a positive economic rate of return.

However, the practicality of using a criterion that is less stringently targeted to distribute RUF to children who are not currently malnourished but who have a heightened risk is still controversial (18). A recent study indicates that preventive supplementation in the lean season in Niger can prevent wasting (19). That study did not observe a decline in mortality. Although the authors of that study focused on the reduction in wasting, for which there is comparatively little evidence on the long-run economic costs, they also noted an improvement in the Z-score for height for age in the treatment group relative to the control of 0.14 (95% CI 0.11–0.18). In an editorial accompanying this study, Lynnette Neufield (20) indicated the need for additional cost effectiveness studies. Add to this call one that requests studies on what similar food assistance can do in the time of a drought, although, of course, the ethics and logistics of such a study would necessarily be different from the one by Isanaka et al. (19). The benefits in an acute crisis likely differ from the benefits in other circumstances. Whatever consensus emerges on the use of a range of new products to broaden strategies for complementary feeding in normal environments (21), it is likely that the benefits and, hence, the benefit:cost ratio will be different when addressing a climatic shock.

This ratio also depends on the costs. Aid agencies often address crises with general food distribution. Adding the distribution of RUF, whether peanut or grain and soy based, geographically and temporally targeted to children in such situations finds a midway point between the well-establish role for these foods in therapeutic feeding for severely malnourished children and the still-controversial use of similar products for the prevention of malnutrition. Such distribution needs to preempt any increased risk that age-appropriate exclusive breast-feeding promotion may be undermined by the distribution of RUF designated for children. As the logistics of timely responses to climate shocks improves, the ability to prevent malnutrition by including the distribution of such foods should similarly improve.

Acknowledgments

Literature Cited

1. Thornton P, Jones P, Alagarswamy G, Andresen J. Spatial variation of crop yield response to climate change in East Africa. Glob Environ Change. 2009;19:54–65.

2. Intergovernmental Panel on Climate Change. Fourth assessment report. Geneva: Intergovernmental Panel on Climate Change; 2007.

3. Dercon S. Insurance against poverty. Oxford: Oxford University Press; 2005.

4. Hoddinott J, Maluccio JA, Behrman JR, Flores R, Martorell R. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. Lancet. 2008;371:411–6.

5. Alderman H, Hoogeveen H, Rossi M. Preschool nutrition and subsequent schooling attainment: longitudinal evidence from Tanzania. Econ Dev Cult Change. 2009;57:239–60.

6.   Alderman H, Hoddinott J, Kinsey W. Long term consequences of early childhood malnutrition. Oxf Econ Pap. 2006;58:450–74.

7.   Hoddinott J, Kinsey B. Child growth in the time of drought. Oxf Bull Econ Stat. 2001;63:409–36.

8.   Alderman H, Behrman J, Lavy V, Menon R. Child health and school enrollment: a longitudinal analysis. J Hum Resour. 2001;36:185–205.

9.   Yamauchi F. Early childhood nutrition, schooling and sibling inequality in a dynamic context: evidence from South Africa. Econ Dev Cult Change. 2008;56:657–82.

10. Del Ninno C, Lundberg M. Treading water: the long-term impact of the 1998 flood on nutrition in Bangladesh. Econ Hum Biol. 2005; 3:67–96.

11. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, et al. What works? Interventions for maternal and child undernutrition and survival. Lancet. 2008;371:417–40.

12. Yamano T, Alderman H, Christiaensen L. Child growth, shocks, and food aid in rural Ethiopia. Am J Agric Econ. 2005;87:273–88.

13. Alderman H, Haque T. Countercyclical safety nets for the poor and vulnerable. Food Policy. 2006;34:372–83.

14. Humanitarian Policy Group. Saving lives through saving livelihoods: critical gaps in the response to the drought in the Greater Horn of Africa. HPG Briefing Note. London: HPG; 2006.

15. Ashworth A. Efficacy and effectiveness of community-based treatment of severe malnutrition. Food Nutr Bull. 2006;27 Suppl 3:S24–48.

16. Collins S, Sadler K, Dent N, Khara T, Guerrero S, Myatt M, Saboya M, Walsh A. Key issues in the success of community-based management of severe malnutrition. Food Nutr Bull. 2006;27 Suppl 3:S49–82.

17. Linneman Z, Matilsky D, Ndekha M, Manary MJ, Maleta K, Manary MJ. A large-scale operational study of home-based therapy with ready-to-use therapeutic food in childhood malnutrition in Malawi. Matern Child Nutr. 2007;3:206–15.

18. Enserink M. The peanut butter debate. Science. 2008;322:36–8.

19. Isanaka S, Nombela N, Djibo A, Poupard M, Van Beckhoven D, Gaboulaud V, Guerin PJ, Grais RF. Effect of preventive supplementation with ready-to-use therapeutic food on the nutritional status, mortality, and morbidity of children aged 6 to 60 months in Niger: a cluster randomized trial. JAMA. 2009;301:277–85.

20. Neufeld LM. Ready to use therapeutic foods for the prevention of wasting in children. JAMA. 2009;301:327–8.

21. Dewey KG, Adu-Afarwuah S. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. Matern Child Nutr. 2008;4:24–85.

22. Badham J. World food crisis: a wake-up call to save a generation of children. participants statement: Castel Gondolfo, Italy, 25 January, 2009. J Nutr. 2010;140:130–1.

23. Bloem MW, Semba RD, Kraemer K. Castel Gandolfo Workshop: An introduction to the impact of climate change, the economic crisis, and the increase in the food prices on malnutrition. J Nutr. 2010;140: 132–5.

24. Nabarro D. Editorial comment: helping the vulnerable. J Nutr. 2010;140:136–7.

25. de Pee S, Brinkman H-J, Webb P, Godfrey S, Darnton-Hill I, Alderman H, Semba RD, Piwoz E, Bloem MW. How to ensure nutrition security in the global economic crisis to protect and enhance development of young children and our common future. J Nutr. 2010;140:138–42.

26. Webb P. Medium- to long-run implications of high food prices for global nutrition. J Nutr. 2010;140:143–7.

27. Brinkman H-J, de Pee S, Sanogo I, Subran L, Bloem MW. High food prices and the global financial crisis have reduced access to nutritious food and worsened nutritional status and health. J Nutr. 2010;140: 153–61.

28. Darnton-Hill I, Cogill B. Maternal and young child nutrition adversely affected by external shocks such as increasing global food prices. J Nutr. 2010;140:162–9.

29. Ruel MT, Garrett JL, Hawkes C, Cohen MJ. The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. J Nutr. 2010;140:170–6.

30. Christian P. Impact of the economic crisis and increase in food prices on child mortality: exploring nutritional pathways. J Nutr. 2010;140: 177–81.

31. Thorne-Lyman AL, Valpiani N, Sun K, Semba RD, Klotz CL, Kraemer K, Akhter N, de Pee S, Moench-Pfanner R, et al. Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. J Nutr. 2010;140:182–8.

32. Campbell AA, de Pee S, Sun K, Kraemer K, Thorne-Lyman A, Moench-Pfanner R, Sari M, Akhter N, Bloem MW, Semba RD. Household rice expenditure and maternal and child nutritional status in Bangladesh. J Nutr. 2010;140:189–94.

33. Sari M, de Pee S, Bloem MW, Sun K, Thorne-Lyman A, Moench-Pfanner R, Akhter N, Kraemer K, Semba RD. Higher household expenditure on animal-source and nongrain foods lowers the risk of stunting among children 0–59 months old in Indonesia: implications of rising food prices. J Nutr. 2010;140:195–200.

34. West KP, Mehra S. Vitamin A intake and status in populations facing economic stress. J Nutr. 2010;140:201–7.

35. Semba RD, de Pee S, Sun K, Bloem MW, Raju VK. The role of expanded coverage of the national vitamin a program in preventing morbidity and mortality among preschool children in India. J Nutr. 2010;140:208–12.

36. Sztam KA, Fawzi WW, Duggan C. Macronutrient supplementation and food prices in HIV treatment. J Nutr. 2010;140:213–223.

37. Timmer CP. Preventing food crises using a food policy approach. J Nutr. 2010;140:224–8.