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Can nutrition be promoted through agriculture-led food price policies? A systematic review

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ABSTRACT

Objective: To systematically review the available evidence on whether national or international agricultural policies that directly affect the price of food influence the prevalence rates of undernutrition or nutrition-related chronic disease in children and adults.

Design: Systematic review.

Setting: Global.

Search strategy: We systematically searched five databases for published literature (MEDLINE, EconLit, Agricola, AgEcon Search, Scopus) and systematically browsed other databases and relevant organisational websites for unpublished literature. Reference lists of included publications were hand-searched for additional relevant studies. We included studies that evaluated or simulated the effects of national or international food-price-related agricultural policies on nutrition outcomes reporting data collected after 1990 and published in English.

Primary and secondary outcomes: Prevalence rates of undernutrition (measured with anthropometry or clinical deficiencies) and overnutrition (obesity and nutrition-related chronic diseases including cancer, heart disease and diabetes).

Results: We identified a total of four relevant reports; two ex post evaluations and two ex ante simulations. A study from India reported on the undernutrition rates in children, and the other three studies from Egypt, the Netherlands and the USA reported on the nutrition-related chronic disease outcomes in adults. Two of the studies assessed the impact of policies that subsidised the price of agricultural outputs and two focused on public food distribution policies. The limited evidence base provided some support for the notion that agricultural policies that change the prices of foods at a national level can have an effect on population-level nutrition and health outcomes.

Conclusions: A systematic review of the available literature suggests that there is a paucity of robust direct evidence on the impact of agricultural price policies on nutrition and health.

ARTICLE SUMMARY

Article focus

- Undernutrition and overnutrition rates are on the rise and these conditions coexist in many low-income and middle-income countries.
- The quantity and quality of agricultural production shapes national diets, which are a key driver of the global burden of disease.
- There has been no systematic review of the evidence that agriculture-related food price policies affect nutrition and health outcomes.

Key messages

- Agricultural development and food production policies may influence rates of undernutrition and nutrition-related chronic diseases.
- Agricultural price policies have rarely been evaluated from a nutrition or health standpoint and the evidence base explicitly linking these policies to nutrition and health outcomes is extremely limited.
- Investigating the linkages between agriculture, nutrition and health requires interdisciplinary thinking and innovations in study design.

Strengths and limitations of this study

- The review was conducted by a multidisciplinary team using broad search criteria and a variety of databases from both the health and agricultural sectors.
- The focus of the review was on agricultural policies that directly affect the price of foods and thus does not consider other pathways of influence between agricultural and health outcomes.

INTRODUCTION

Dietary quantity and quality are primary drivers of disease burden. Globally, an estimated 1 billion people are undernourished, as assessed by the availability of energy, and about 2 billion are undernourished in micronutrients (essential vitamins and minerals).[1 2] At the other end of the spectrum, excess dietary consumption is in part responsible for the global epidemics of nutrition-related chronic diseases such as cardiovascular disease and cancer.[3 4] The huge scale of the double burden of undernutrition and overnutrition requires a broad and

twin-tracked policy strategy. The first track requires a scale-up of effective direct nutrition programmes and policies including breastfeeding support and dietary fortification or supplementation interventions.[5] The second track requires the harnessing of indirect interventions, including policies in closely related sectors such as food and agriculture to improve nutrition outcomes.[6] National programmes and policies generally attract significantly greater resource flows than those provided specifically for nutrition, and if they can be made more nutritionally sensitive, the scope for rapid improvements in nutrition status may be significant.

There are numerous agricultural policy levers that have the potential to change food prices and thereby nutrition outcomes. Of particular interest are policies broadly labelled output market interventions, including those that influence the price of food production and those that affect trade liberalisation and public-food distribution systems (table 1). These policies directly affect the relative prices of foods and, as such, are proximate determinants of food consumption and hence nutrition outcomes. Importantly, these policies may have the ability to act on both undernutrition and overnutrition, and ongoing global food price fluctuations have significantly intensified political interest in these policies.[7 8]

Food price policies and population nutrition status are separated by many often lengthy pathways of influence (figure 1). Food price policies can have direct effects on food consumption via food prices or indirectly through income generation. Changes in food prices have impacts on the quantity and quality of food consumption depending on the responsiveness of demand to price (direct and cross-price elasticities),[9] which will be mediated by a range of factors such as income level, urban or rural residence, education of household head and women's control of income. In addition, the relative price of commodities has an impact on the composition of processed foods, whose consumption can be further influenced by marketing strategies. The impacts of changes in food consumption on nutrition status and health depend on a number of complementary inputs such as access to clean water, sanitation and hygiene, child care provision, health services and opportunities for physical activity in addition to biological factors such as individual genotype and metabolism.

The primary research question addressed by this review was: is there any evidence from the worldwide published and unpublished literature that agricultural policies that directly affect the price of food (output price policies, trade liberalisation policies and public distribution systems) affect nutrition and health outcomes? Primary outcomes included rates of undernutrition, obesity and nutrition-related chronic disease. A review of this nature has never been attempted previously and it was therefore conducted to assess the evidence base on which to design and inform future policy outputs. Our immediate audience for this research is the policy evaluation research community in health, agriculture and development. By reviewing the nature and adequacy of the currently available evidence, we have the objective of improving the quality of evidence provided to policymakers in these sectors.

METHODS

We conducted a systematic keyword search up to December 2012 in five databases: MEDLINE, EconLit, Agricola, AgEcon Search and Scopus. Search terms included words and phrases relating to agriculture, agricultural price policies and nutrition and health outcomes. The full list of search terms is provided in box 1. Eldis (http://www.eldis.org/) and relevant organisational websites including the United Nations Food and Agriculture Organisation (http://www.fao.org/index_en.htm), World Bank (http://www.worldbank.org/); US Department of Agriculture (http://www.usda.gov/wps/

Table 1 Commonly used output market policy interventions that directly affect the price of foods

Policy type	Policy description
Output price policy	Policies aimed at influencing output prices, the prices which producers are paid for agricultural commodities, have been ubiquitous in both low-income and high-income countries. The range of domestic policy instruments used to influence output prices include taxes imposed at different points in the marketing chain and direct interventions in commodity markets (minimum support prices, state procurement, buffer stock operations etc)
Trade liberalisation	Agricultural trade policy involves an array of instruments including taxes, subsidies, quantitative restrictions on imports or exports and exchange rate policies. Trade policies affect food commodity prices through their impact on the prices and quantities of food imports and exports and they are often deployed in conjunction with domestic price policy instruments in pursuit of development and food security objectives[26]
Food subsidies and Public Distribution Systems (PDS)	Governments deploy an array of policy instruments to influence the prices that consumers pay for food including open-ended general subsidies, PDS with quantity rationing, food stamps, food-for-work programmes and incentives to stimulate changes in food consumption of specific population groups[27]

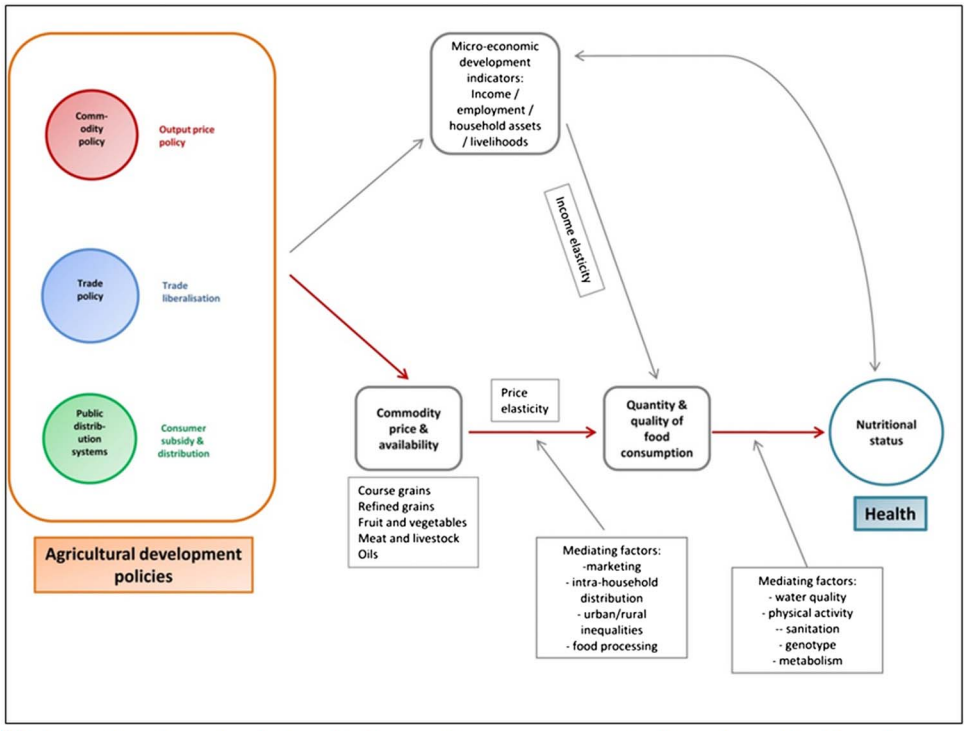

Figure 1 A conceptual framework linking food-price-related agricultural policies to food nutritional status and health*. *Pathways in red are the chains of influence that were systematically evaluated in this review.

portal/usda/usdahome), on which complex searches were not possible, were systematically browsed for relevant unpublished literature. Reference lists of included publications were hand-searched for additional relevant studies.

We included studies reporting in English and presenting multivariate quantitative analysis specifically designed to evaluate (ex post) or simulate (ex ante) the effects of specified policies using data-collected post-1990. Descriptive analyses, commentaries and narrative reviews were excluded, as were older evaluation studies (pre-1990) which are less relevant to the current agricultural policy, development or health landscape. Policies eligible for inclusion were existing or proposed national or international agricultural policies that could directly affect the price of food: defined as output price policies; trade liberalisation policies or public distribution system polices. Policies that were entirely hypothetical and those that could indirectly affect food price, such as those affecting technology, input prices, land reform, labour or water availability, were excluded.

Primary outcomes were child and adult undernutrition rates as measured by anthropometry (wasting, stunting, underweight) and clinical signs of vitamin and mineral deficiency, and child and adult overnutrition as assessed by anthropometry (overweight and obesity) and rates of nutrition-related chronic disease defined as any well-recognised measure of health outcomes including cardiovascular disease, diabetes or cancer. Nutrition and health outcomes associated with food pathogens and contaminants were excluded. All populations were eligible for inclusion.

Three reviewers (SH, LW and EHM) conducted a systematic search of the electronic databases and other primary data sources and screened the titles and abstracts. Studies were excluded at stage one if it was clear from the title or abstract that the article did not meet our inclusion criteria. The full text of potentially relevant studies were retrieved and scrutinised in duplicate (EHM and SH) to determine whether the study justified inclusion at stage two. Data were independently extracted, in duplicate, from relevant publications by two review authors (ADD and SH) for the following variables: country; policy; commodities; data sources and study population; study design and methods; outcomes reported; findings. Where there was a difference of opinion, disagreement was resolved through discussion with a third review author (BS). Where possible, the authors were contacted for additional information.

Each study included in the review was assessed for quality on the basis of the following criteria that were defined a priori as essential to answer the research question: a clear definition of the agricultural policy being examined; a clear definition of the nutrition or health outcome and how it was measured; a clear presentation of a multivariate quantitative analysis used to evaluate or simulate the effect of the specified policy. Statistical meta-analysis was not justified due to the marked heterogeneity of the included studies. We present a systematic, narrative summary of findings of the review.

Box 1 Agriculture policy, nutrition and health systematic review search terms

The search strategy was modified according the type of database and their capacity.

1 Databases with full Boolean search capacity: EconLit and Medline

Agricultur* AND (structural adjustment programme* or macroeconomic stabilisation

agricultur* reform or market reform or impact evalution or food retail or supermarket*or food procurement or food distribut*or World Trade Organization or WTO or GATT or Agreement on Agriculture or trade liberali#ation or quantitative restriction*or export subsid*or import subsid*or export tax* or export tariff*or import tax* or import tariff*or parastatal*or marketing board*or marketing intervention* or procurement or producer support or price stabili#ation or price floor*or price ceiling*or producer price* or consumer price*or "agricultur* adj2 surplus" or "demand elasticity adj2 food" or "price elasticity adj2 food*" or marketed surplus or self-sufficien* or exchange rate polic*or output price polic*

"food adj2 subsidy" or "food adj2 ration*"or agricultur* polic" or trade polic* or public distribution system* or globili#ation or foreign direct investment or economic reform*) AND (commodit*or oil*or meat* or animal product* or grain* or dairy product*or fruit* or vegetable*or food availability or suppl* or "food adj2 price" or consume or consumption or "calorie adj2 intake*" or "food adj2 intake*" or "calorie adj2 consum*" or food quantity or food quality or starvation or famine or hunger or overnutrition or malnutrition or undernutrition or low birth?weight or chronic disease* or nutrition-related chronic disease or cardiovascular disorder* or cardiovascular disease* or coronary heart disease or isch?emic heart disease or hypertension or atherosclerosis or isch?emic stroke or cerebrovascular disease or type 2 diabetes or obesity or osteoporosis or cancer*or metabolic disease*or non-communicable disease*or diet-related disease* or diet-related chronic disease*or "diet* adj2 transition" or nutrition transition or nutrient intake or micronutrient intake*or food security or food insecurity or consumption inequalit*)

An additional search was conducted for policies falling into the public distribution system category that were preceded by 'Food' rather than 'Agriculture' in the search string.

2 Databases with partial Boolean capacity: Agricola, Scopus (reviews only), AgEcon

Separate searches conducted for each policy area:

i. *Output price policy*: Agricultur* AND (output price polic* or producer support or price stabilization or price elasticity) AND (commodity* or food availability or food price or suppl* or meat or grain* or oil or fruit or vegetable or dairy or consum* or food intake or calorie intake or food security or overnutrition or health or malnutrition or chronic disease or hunger)

ii. *Trade liberalisation:* Agricultur* AND (trade liberali#ation or World Trade Organization or WTO or GATT or agreement on agriculture) AND (commodity* or food availability or food price or suppl* or meat or grain* or oil or fruit or vegetable or dairy or consum* or food intake or calorie intake or food security or overnutrition or health or malnutrition or chronic disease or hunger)

iii. *Foreign direct investment*: Agricultur* AND (foreign direct investment or food retail or food distribution or supermarket*) AND (commodity* or food availability or food price or suppl* or meat or grain* or oil or fruit or vegetable or dairy or consum* or food intake or calorie intake or food security or overnutrition or health or malnutrition or chronic disease or hunger)

iv. *Consumer subsidy and distribution:* Agricultur* AND (consumer subsidy or public distribution system or food subsidy or consumer price or procurement or food retail) AND (commodity* or food availability or food price or suppl* or meat or grain* or oil or fruit or vegetable or dairy or consum* or food intake or calorie intake or food security or overnutrition or health or malnutrition or chronic disease or hunger)

RESULTS

The search strategy identified 14 837 non-duplicate and potentially relevant publications (figure 2). Of these 13 727 were excluded as not relevant after reading their title and abstracts (step 1). The full texts of 1110 publications were screened and of these 1074 studies were excluded; 33 publications could not be located despite extensive efforts. The studies that could not be located represented less than 3% of the full text articles screened and, as far as could be assessed from the titles, did not consider nutrition and health effects of agricultural policies.

Despite an extensive search strategy, our review identified only four relevant articles (from five reports) meeting the inclusion criteria (table 2). Two of the reports were ex post evaluations and two were ex ante simulations. Two of the studies assessed the impact of policies that subsidised the price of agricultural outputs and two focused on public food distribution policies. A study from India reported on the undernutrition rates in children, and the other three studies from Egypt, the Netherlands and the USA reported on nutrition-related chronic disease outcomes in adults. All four reports met the predefined quality criteria.

The study that focused on undernutrition (table 2 Panel A) analysed data from the Indian State of Andhra Pradesh on the impact of the Public Distribution System (a programme that supplies rice, wheat, edible oils, sugar and kerosene at subsidised prices through a network of retail outlets known as fair price shops) on children's nutritional status.[10] This ex post analysis used secondary data to investigate the impact of a sharp increase in subsidised rice prices in 1992 on child anthropometry as measured by the Indian National Family Health Survey. Weight and age were recorded for 1575 children ≤4 years and multiple regression was used to assess differences in child undernutrition in relation to the time exposed to the high price regime. The analysis found no evidence of an association between length

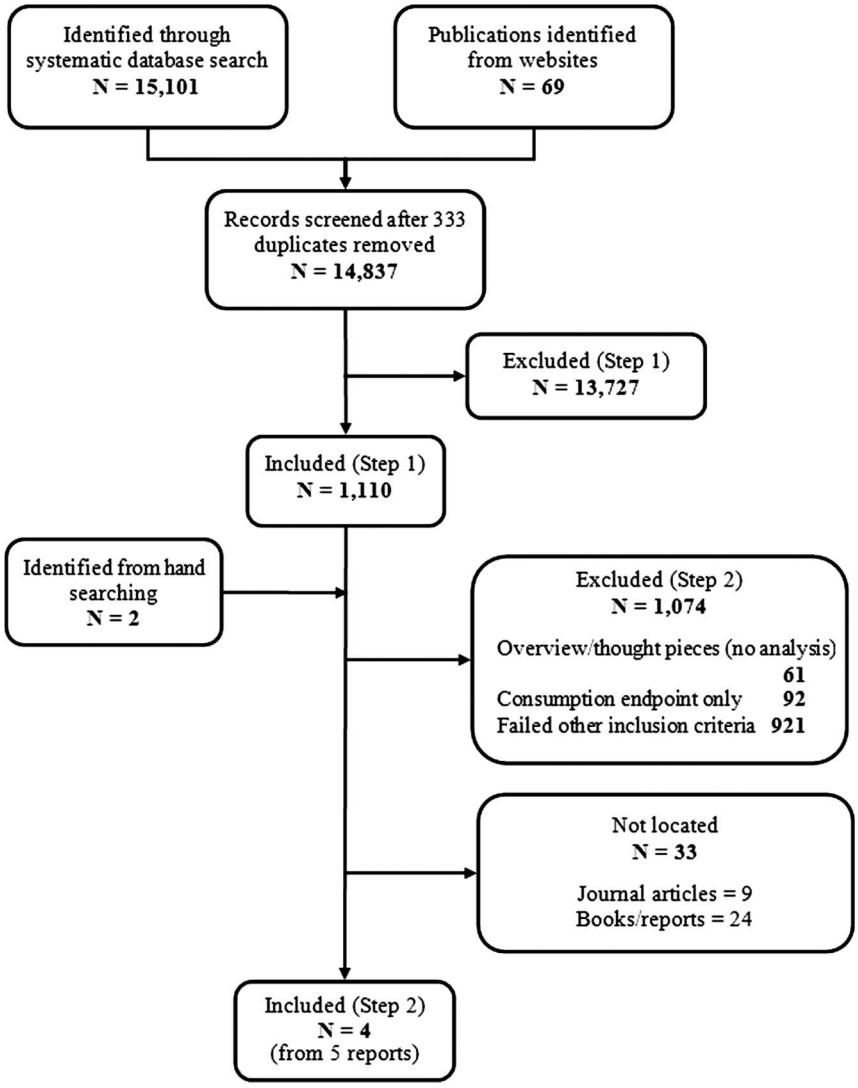

Figure 2 Flow diagram of publications for inclusion in systematic review.

of time spent in the higher price regime and child nutritional status as assessed by weight-for-age (an indicator of child underweight).

Three studies focused on over-nutrition or nutrition-related chronic disease outcomes. Of these three studies, two were ex ante modelling studies, one from the Netherlands,[11] one from the USA,[12 13] and one was an ex post evaluation using econometric and regression analysis of a policy in Egypt.[14] These three studies evaluated different policy scenarios in diverse settings with a range of health outcomes (table 2 Panel B).

The potential impacts of the removal of established farm subsidies (ie, output price policies) were modelled in two studies, one in the Netherlands[11] and one in the USA,[12 13] and the impact of a long-running public distribution system policy in Egypt was evaluated in the final study.[14] Two studies reported change in body weight as their health outcome,[12–14] and one study estimated change in disability-adjusted life-years (DALYs) and life expectancy.[11]

In the Netherlands, food consumption data from the National Nutrition Survey (1997–1998), recent estimates of disease frequency and mortality from the National Public Health Compass and the Central Bureau of Statistics, and estimates of relative risk of coronary heart disease, stroke and cancer[15 16] were used to conduct ex ante modelling of the consequences on health of the removal of the European Union withdrawal support policy for fruit and vegetable production (a component of the Common Agricultural Policy in which fruit and vegetable produce is withdrawn from the market place in order to keep producer prices high). Analysis suggested that this policy change could lead to an average increase in consumption of fruit and vegetables of 5–6 g/person/day. This increased consumption was associated with a small reduction in DALYs lost per year (via a reduction in the incidence of cardiovascular disease and cancer) and thereby a small increase in the population life expectancy of the order of 2–4 days.[11]

In the USA, ex ante modelling was conducted to estimate the effect of the removal of farm subsidies for grains (maize, wheat and rice) on adult weight using estimates of demand for food and other goods, farm-retail product and farm-commodity shares, food-to-energy, energy-to-weight

Table 2 Results of the systematic review: the effect of agricultural price policies on nutritional status and health

Author (year)	Country	Policy	Commodities	Data sources	Methods	Outcome	Findings
Panel A: undernutrition outcome							
Tarozzi[11]	India (Andhra Pradesh)	Indian food subsidy programme	Rice, wheat, edible oils, sugar and cooking oil	National Family Health Survey to provide data on child anthropometry in affected area	Ex post analysis of the effect of a higher price regime for rice covered by the subsidy programme. Multiple regression used to assess differences in child undernutrition in relation to time in high price regime	Weight-for-age	No evidence for an association between length of time spent in the higher price regime and child nutritional status as assessed by weight-for-age
Panel B: overnutrition and nutrition-related chronic disease outcomes							
Veerman *et al*[12]	The Netherlands	European Union withdrawal support policy	Fruit and vegetables	Estimate of fruit and vegetable (tonnes) withdrawn Dietary intake data from national nutrition survey Estimates of national disease frequencies Diet-disease relationship relative risks	Ex ante models of the effect of a change in dietary intake of fruit and vegetables on disease risks (potential impact fractions) and integrate the changes in disease-specific data into national life tables	Disability-adjusted life years (DALYs) and life expectancy	Removal of fruit and vegetable withdrawal policy would slightly increase fruit and vegetable consumption, reduce the incidence of cardiovascular disease and cancer, reduce the DALYs lost per year and modestly increase life expectancy
Asfaw[15]	Egypt	Egyptian food subsidy programme	Bread, wheat flour, sugar and cooking oil	Integrated Household Survey to provide estimate of household food expenditure (and hence food consumption) and body mass index of mothers	Ex post multiple regression and econometric estimation of effect of food subsidy policy	Body mass index of mothers	Increases in the price of bread and sugar were associated with significant reduction in body mass index of mothers
Okrent and Alston[13]	USA	Farm subsidies on grain commodities	Eight food groups consumed at home, a composite variable for food consumed away from home, and alcoholic beverages	National data on use of farm commodities and retail products Dietary intake data from national nutrition survey Estimated change in weight from change in calorie consumption	Ex ante equilibrium displacement models of the effect of removal of farm subsidy policy	Adult weight	Removal of existing farm subsidies on grain commodities would result in a modest reduction in weight

and weight-to-health multipliers. The models suggested that removal of the subsidy policy which would act to increase the price of grains would modestly reduce average adult weight by 0.11 kg/year.[12 13]

In Egypt, data from the 1997 Egyptian Integrated Household Survey was used to conduct an ex post evaluation of the established public distribution system policy, which provides bread, wheat flour, sugar and cooking oil at subsidised prices. An inverse relationship was identified between the price of subsidised bread and sugar and the body mass index (BMI—a measure of body weight independent of height) of mothers such that an increase of 1% in the price of 100 kcal in the form of bread or sugar was associated with a 0.1% decline in maternal BMI.[14] The analysis of the Egyptian public distribution system data also suggested that, particularly for consumers constrained by low household incomes, the subsidy programme acted to encourage the consumption of energy-dense foods with low nutrient quality.[14]

DISCUSSION

To our knowledge, this is the first systematic review of empirical evidence linking agriculture-based food price policies with nutrition outcomes. The studies identified in our review suggest that there is currently no direct evidence that agricultural policies that directly influence the price of food affect rates of undernutrition. However, the three studies that evaluated the effect of these policies on overnutrition suggested that they had a small effect on adult weight and risks of nutrition-related chronic disease. The review has also highlighted the surprising paucity of evidence assessing the impact of agriculture-based food price policies on nutritional and health outcomes.

Our review has several strengths including its systematic and exhaustive approach and the range of electronic databases used, reflecting the inter-disciplinary nature of the research question. We also searched grey-literature databases and the websites of significant organisations involved in agriculture and health. We constituted an inter-disciplinary team of researchers to conduct this review, which is an essential first step in trying to reduce the disconnect between agriculture and health research. However, there are some potential limitations of the review process. First, it is possible that this review did not identify all relevant publications, although we attempted to minimise this possibility by using very broad search terms, repeating our search in multiple relevant publication databases, hand-searching reference lists and contacting relevant subject experts. We were also not able to locate a small number (n=33) of potentially relevant studies. Second, the exclusion of non-English language publications may have introduced bias into our findings. Third, it is possible that peer-reviewed journals were less likely to publish articles reporting non-significant effects.[17] Fourth, the heterogeneity of policies and outcomes included in the review precluded the conduct of formal meta-analysis. Finally, and perhaps most importantly, in order to fully investigate the impact of agricultural policies on nutritional status, it would be necessary to expand the review to investigate the many policies and pathways of influence outside the scope of the current review.

The general finding of our review is consistent with the outcome of a recent systematic review of the effect of agricultural interventions (such as biofortification and home gardens) designed to improve childhood nutrition status which identified 23 evaluations published between 1990 and 2010 with credible counterfactuals.[18] The review found that fewer than half of the identified agricultural interventions that had been designed with the express purpose of improving nutrition had a positive impact on the nutritional status of children. Other reviews of the literature on agricultural interventions have come to a similar conclusion.[19–21]

Our review suggests that too little attention has been given to the quality of impact evaluation of agricultural policies and that this is an area where urgent cross-sectoral learning is needed.[22 23] Formal evaluation of national policies is common in both the agriculture and health sectors and attempts at evaluation of the health outcomes of potential or pilot agricultural policies have been undertaken previously using randomised[24] and non-randomised[25] methods, but cross-sectoral evaluation seems to present numerous obstacles. Developing credible impact evaluations for the effect of a food and agricultural policy on the nutrition status of individuals and populations is extremely challenging. There are many links in the causal chain; there are often significant lag effects as behaviours take time to change; there are many factors outside the control of the food and agriculture policy that condition nutrition outcomes; and there are few professional incentives for those implementing (and evaluating) food and agriculture interventions to measure and report success in terms of nutrition status. The various disconnects between the agricultural and health disciplines are common to many issues that have a seemingly compelling rationale for cross-sectoral and cross-disciplinary collaboration.

There are important implications to be drawn from this paper. For policy evaluation researchers, our primary audience, we highlight the value of bringing health and development research methods together to understand complex and rapidly evolving phenomena. The systematic review presented here indicates a clear need for future research that is rigorously implemented, with credible counterfactuals, and that extends across the causal chain from policy introduction to nutrition outcomes. However, this does not imply that the research community does not have a valuable role to play in providing policy advice now, based on the currently available evidence. There is strong evidence available on segments of the causal chain shown in figure 1. Such evidence, pieced together carefully and supported with the intuition of experienced researchers, can help

guide nutrition-sensitive agriculture price policy design while a rigorous evidence base encompassing the causal chain is built up.

For policymakers we note the potential that food prices may affect nutrition and health outcomes and suggest that, as the costs of applying a nutrition lens to development interventions are likely to be dwarfed by the benefits of doing so, these opportunities should be taken where at all possible.

Agricultural development is often hailed as an important instrument with which to improve food security and nutrition and health outcomes. Our review has highlighted how little rigorous evidence explicitly aiming to evaluate the nutrition impact of agricultural price policies is really available. If the potential of agricultural development and trade policies to improve nutrition outcomes is to be realised, a much greater focus on cross-sectoral evidence generation is urgently needed. The demand for evidence should come from policymakers and be fuelled by the media and civil society (including researchers). The ability to meet that demand is dependent on the vision and ambition of researchers, funders, data collection systems, journals and university administrators to tackle real-world problems rather than ones that have been artificially sliced and diced.

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