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Globalisation of agrifood systems and sustainable nutrition

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The globalisation of agrifood systems is a mega-trend with potentially profound nutritional implications. This paper describes various facets of this globalisation process and reviews studies on nutritional effects with a particular focus on developing countries. Results show that global trade and technological change in agriculture have substantially improved food security in recent decades, although intensified production systems have also contributed to environmental problems in some regions. New agricultural technologies and policies need to place more emphasis on promoting dietary diversity and reducing environmental externalities. Globalising agrifood systems also involve changing supply-chain structures, with a rapid rise of modern retailing, new food safety and food quality standards, and higher levels of vertical integration. Studies show that emerging high-value supply chains can contribute to income growth in the small farm sector and improved access to food for rural and urban populations. However, there is also evidence that the retail revolution in developing countries, with its growing role of supermarkets and processed foods, can contribute to overweight and obesity among consumers. The multi-faceted linkages between changing agrifood systems and nutrition are a new field of interdisciplinary research, combining agricultural, nutritional, economics and social sciences perspectives. The number of studies on specific aspects is still limited, so the evidence is not yet conclusive. A review at this early stage can help to better understand important relationships and encourage follow-up work.

Agriculture: Food systems: Small farms: Triple burden of malnutrition

In spite of progress in the reduction of global hunger, the world is far away from a situation of sustainable food security and nutrition for all. Close to 800 million people are chronically undernourished in terms of energy, 2 billion people suffer from micronutrient deficiencies, and 1.9 billion people are overweight or obese^(1,2). These three forms of nutritional problems are sometimes referred to as the triple burden of malnutrition^(3,4). This triple burden contributes to impairments in physical and cognitive human development, reduced productivity, susceptibility to infectious and chronic diseases, and premature deaths⁽⁵⁾. Reducing the different forms of malnutrition requires improved food policies and targeted

nutrition interventions. However, in addition to concrete nutrition interventions, better knowledge about how global mega-trends affect food choices and nutritional outcomes is also required. Such knowledge can help identify appropriate policy action to strengthen positive nutrition effects while avoiding undesirable outcomes. One mega-trend with potentially profound nutritional implications is the increasing globalisation of agrifood systems, which is the focus of this review paper.

Globalisation has many facets. It involves increasing exchange of goods and services through international markets. Economic theory predicts that trade promotes income growth, as participating countries can better



harness their comparative advantages. Empirical studies show that, in many cases, trade also contributes to poverty reduction and that countries that are better integrated into the world economy tend to have lower levels of undernourishment^(6,7).

However, globalisation of agrifood systems goes beyond a mere increase in agricultural trade. It also involves international exchange of knowledge, with spillovers of agricultural technology and production patterns across countries. Consumer preferences and lifestyles are changing, becoming more alike internationally^(8,9). Foreign direct investments of agribusiness companies, including large multinational retailers, are rising^(10,11). In many developing countries, modern supermarkets are replacing traditional grocery outlets at a rapid pace^(11,12). Changing consumer preferences and retail structures also affect the organisation and complexity of food value chains. New standards for food quality and food safety are proliferating, often entailing closer vertical coordination and integration through contracts and certification schemes⁽¹³⁾. Sustainability labels that differentiate foods produced according to certain environmental and social criteria, such as organic or Fairtrade, are increasingly popular with food companies, retailers and upper-income consumers⁽¹⁴⁾. These transformations change the way food is produced, processed, distributed and consumed. They may therefore affect nutrition in positive or also in negative directions. The wider nutritional implications are not yet well understood^(15–18).

Here, I review some of the empirical evidence on linkages between globalising agrifood systems and nutrition. I focus on developing countries, as this is where most of the malnourished people live. This is a new field of interdisciplinary research, combining agricultural, nutritional, economics and social sciences perspectives. The number of available studies is still limited; most look at specific features of the agrifood system transformation in individual countries. Hence, results cannot be generalised. Nevertheless, a review at this early stage can help to better understand important relationships.

Especially on the nutritional effects of the rapid rise of supermarkets for food consumers and farming households in developing countries we have ourselves conducted several recent studies in the GlobalFood Program of the University of Goettingen. Given the dearth of other empirical research in this particular direction, I will synthesise some of our own results and discuss them in the light of the related literature. I will also try to provide some brief insights into the methodologies used in the original studies, in words accessible for a broad readership. This may help to stimulate follow-up research in this emerging and important interdisciplinary field.

Globalisation of agricultural technologies

The beginnings of agriculture date back to about 10 000 BC. Since then, farmers in different parts of the world have constantly innovated. Successful innovations were

adopted more widely, and some of the technologies and practices also spilled over to other parts of the world. Until the 19th century, this process of innovation and international spillovers was relatively slow. Since the late 19th century, however, agricultural research became more scientific. New insights about plant genetics, plant nutrition and advancements in the chemical industry speeded up the process of agricultural innovation substantially⁽¹⁹⁾. The development and spread of improved crop varieties and the use of chemical fertilisers and other modern inputs led to massive increases in agricultural productivity in the USA and Europe during the first half of the 20th century. These technology-based increases in food production were important to feed rapidly growing populations. However, it took a while until modern technologies were adapted and used more widely also in developing countries. In the 1950s and 1960s, population growth outpaced food production in large parts of Asia, so that there were serious concerns about looming famines.

Green Revolution

The Rockefeller Foundation and other development organisations were instrumental in launching several public sector research programmes aimed at adapting new agricultural technologies to tropical and subtropical conditions and make them available to farmers in the developing world. Since the late-1960s, high-yielding varieties of rice, wheat and maize developed through these international programmes were widely adopted by farmers in Asia and Latin America⁽²⁰⁾. Combined with a rise in the use of irrigation, fertilisers and other agrochemicals these new varieties contributed to a doubling and tripling of agricultural yields within a relatively short period of time. These technological developments and the resulting increase in food production became widely known as the Green Revolution^(20,21). Due to various constraints, the Green Revolution was less pronounced in Africa.

What were the nutritional implications of this Green Revolution? The production increases in major staple foods improved the availability and affordability of food energy. This is especially relevant for poor population segments that typically spend a large proportion of their income on food. Simulations demonstrate that mean consumption levels of food energy in developing countries would have been 10–15 % lower had the high-yielding varieties of major cereal crops not been introduced⁽²⁰⁾. Thus, the Green Revolution has contributed significantly to reducing undernourishment in Asia and Latin America. The predicted famines were prevented and poverty rates declined considerably^(20–23). Norman Borlaug, the chief wheat breeder of the Rockefeller Program in the 1960s, and often referred to as the father of the Green Revolution, received the Nobel Peace Prize in 1970 for his contribution to world food supplies.

While the effects of the Green Revolution in terms of food energy supply are undisputed, impacts on other forms of malnutrition are less clear. When access to energy improves and living standards rise, poor people



start putting more emphasis on dietary diversification. Hence, higher yields and lower prices of staple foods may have contributed indirectly to improved dietary quality as well. Conversely, the strong focus on only a few major cereals changed the relative profitability of crops, resulting in lower species diversity in farming⁽²⁴⁾. Over the past 50 years, agricultural modernisation around the world has contributed to narrowing global production patterns with a focus on a limited number of major crop plants⁽²⁵⁾. This also has implications for dietary diversity. Whereas prices for starchy staple foods decreased, more nutritious foods (such as pulses, vegetables, fruits and animal products) became relatively less affordable⁽²³⁾. Nowadays, about 60 % of all the energy consumed worldwide is provided by only three cereal species, namely wheat, rice and maize. In addition, plant breeders' strong attention to yield was at the expense of nutritional traits, resulting in lower micronutrient contents in high-yielding cereal varieties⁽²⁶⁾. Against this background it is unsurprising that micronutrient malnutrition is still widespread, even in countries where food energy deficiency is not a big issue anymore.

Critics of the Green Revolution also stress the negative environmental consequences resulting from the higher use of chemical fertilisers and pesticides⁽²⁷⁾. The overuse of agrochemicals in some regions has unquestionably contributed to environmental problems, such as water pollution, biodiversity loss and nitrous oxide emissions. Conversely, the yield increases on the given farmland have helped to save natural ecosystems, including tropical forestland, from being converted to agriculture⁽²⁸⁾.

Recent technological developments

Technological developments continue. Lessons learnt from the Green Revolution were integrated into more recent research and development programmes. Research on improved agronomy, soil conservation and other natural resource management techniques has gained in importance. In plant-breeding programmes, the range of crops and crop traits that scientists work on was broadened. Breeders today put much more emphasis on combining high yields with improved tolerance to pests, diseases, and adverse climate and soil conditions. Genetic engineering and genome editing in particular help to develop highly productive crops that require lower amounts of pesticides, fertiliser and water⁽¹⁹⁾. Similarly, breeders work on developing crop varieties with higher amounts of micronutrients, an approach that is commonly referred to as biofortification^(29–31).

While such new technologies could contribute substantially to sustainable nutrition and health^(32–34), acceptance levels in the wider public are relatively low. Especially in Europe, there is a deep-rooted notion that new agricultural technologies have no important role to play anymore for improving global food security and nutrition. In spite of their unblemished safety record, genetically modified organisms are rather feared to be harmful for human health and the environment. Through non-governmental organizations networks, public media, international agreements and other channels such public

fears and attitudes have spilled over from Europe to the rest of the world⁽³⁵⁾. The globalising protest movement against genetically modified organisms has clearly slowed down international technological developments in agriculture⁽¹⁹⁾. This other facet of globalisation is worrying, because feeding a growing world population with a limited natural resource base remains challenging⁽³⁶⁾. Sustainable nutrition for all will not be possible without responsibly developing and using new agricultural technologies.

Globalising patterns of food purchase and consumption

Nutrition transition

Income growth entails changing diets. Poor people usually derive a large share of their energy from staple foods. When living standards rise, diets are being diversified: higher-value and more nutritious foods such as fruits, vegetables and animal products are gaining in importance. This type of dietary shift is nutritionally desirable. However, another type of dietary shift often occurs in parallel. Economic development, urbanisation and globalisation contribute to evolving lifestyles, involving changing consumer preferences, purchase habits, food environments, and a shift towards Western-style diets^(8,9). Traditional food components are increasingly replaced by processed foods and convenience products that tend to be low in fibre but high in fat, sugar and salt contents^(16,17,37). This shift is nutritionally less desirable. High fat and sugar intakes combined with decreasing levels of physical activity during work and leisure time entail rising rates of overweight and obesity and a resulting surge in non-communicable diseases^(17,38).

The nutrition transition, with rising rates of obesity and non-communicable diseases, can be observed in all parts of the world. In developed countries, it started much earlier and unfolded gradually over a period of several decades. In many developing countries, the nutrition transition is now observed at accelerated pace. Overnutrition is rapidly rising at a time when undernutrition is still prevalent in the same countries, and sometimes even in the same households^(39,40). These overlapping forms of malnutrition make the design of suitable nutrition policies much more complex. In some developing countries, overweight and obesity rates are already at par with those in developed countries⁽⁴¹⁾. Even in Africa, obesity is rising rapidly, including in relatively poor population segments⁽⁴²⁾. In poor countries, health systems are often not yet prepared to properly deal with non-communicable diseases.

Supermarket revolution

Food retailing in most developing countries is still dominated by wet markets and traditional shops and grocery outlets. However, with economic growth, trade liberalisation and rising foreign direct investment, the retail sector in many developing countries is modernising rapidly. Supply-side factors, coupled with an increase in demand for readily available foods of high quality among the rising urban middle-classes, have contributed to a

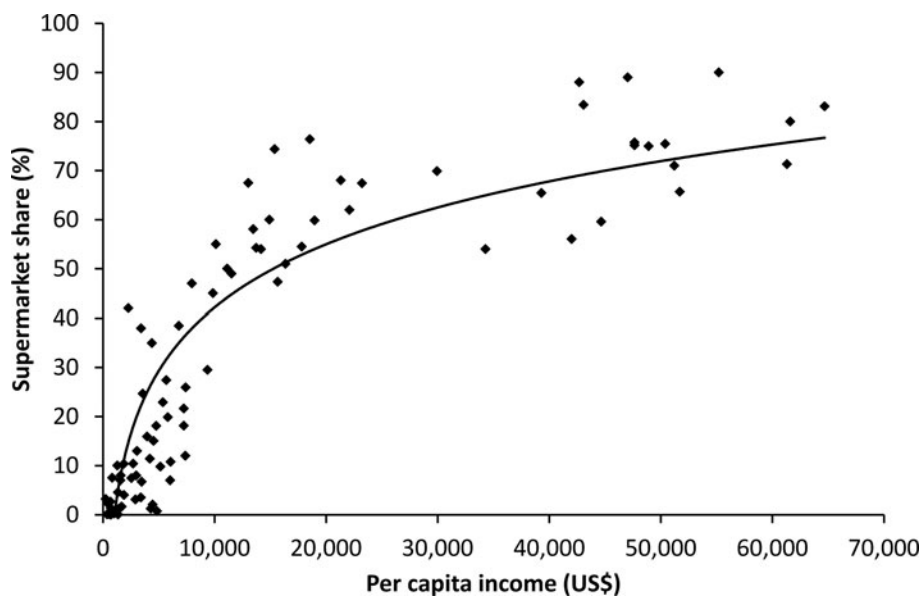


Fig. 1. Relationship between average per capita income in a country and the share of supermarkets in food retailing. Source: Compiled by author with data from^(53,76).

large-scale expansion of supermarkets and hypermarkets^(9,43). The expansion of supermarkets has been of such a scale that the phenomenon is often referred to as a supermarket revolution^(11,43). This supermarket revolution is likely to continue in developing countries; the share of supermarkets in food retailing is closely correlated with average per capita incomes (Fig. 1).

The rise of supermarkets, at the expense of more traditional grocery outlets, is associated with many changes, not only in terms of the place of purchase, but also with respect to food prices, types of foods offered, levels of processing, shopping atmosphere and the way procurement systems are organised^(15,17,44,45). This may have far-reaching implications for consumers and producers, some of which are analysed below.

Supermarkets and obesity

Compared with traditional retail formats, supermarkets tend to have a wider variety of processed and highly processed foods and drinks, often in larger packaging sizes and combined with special promotional campaigns^(15,37,46). Hence, one important question is whether the expansion of supermarkets contributes directly to rising overweight and obesity in developing countries. Several studies suggest that the spread of supermarkets leads to dietary changes for urban consumers in developing countries. Most of this work shows that supermarket purchase is associated with increased consumption of energy-dense, processed foods^(37,45,47,48), although in one case supermarkets were found to improve dietary quality⁽⁴⁹⁾. Research on the impact of supermarkets on consumer nutritional status in developing countries is rare. Studies in the USA show that access to supermarkets is nowadays often associated with lower obesity⁽⁵⁰⁾, but the situation in developing countries is different.

We have addressed the question of supermarket impacts on consumer food choices and nutritional status in recent studies in Kenya^(51,52). Kenya is an interesting country for this type of research. It has recently witnessed a rapid spread of supermarkets that now account for about 10% of national grocery sales⁽⁵³⁾. This retail share of supermarkets in Kenya is lower than in many middle-income countries, but it is already higher than in most other low-income countries in sub-Saharan Africa and Asia. Hence, trends observed in Kenya may be helpful to predict future developments in other poor regions.

For the studies, we conducted a survey of 453 randomly selected households in small towns of central Kenya, some of which had a supermarket, while others had not. This provided a quasi-experimental setting, which we exploited for the analysis. Data on socio-economic characteristics, including food consumption quantities, expenditures and place of purchase, were collected at the household level⁽⁵²⁾. In addition, we collected individual-level data from household members, including anthropometric measures. In total, we took individual data from 615 adults and 216 children and adolescents⁽⁵¹⁾.

While 41% of the adults in the sample are either overweight or obese, only 10% of the children and adolescents fall into this category. Conversely, 21% of the children are stunted (too short for their age), pointing at widespread undernutrition⁽⁵¹⁾. Table 1 compares nutrition variables between individuals from households that buy and do not buy in supermarkets. Adults in supermarket-buying households have a higher BMI and are more likely to be overweight or obese. They also consume more energy, and a greater share of their energy comes from processed foods. For children and adolescents, the patterns are different. There is only a very

Table 1. Consumer nutrition with and without supermarket purchase in Kenya

Variable	Household buys in supermarkets	Household does not buy in supermarkets
Adults		
BMI	25.22 [†] (4.73)	24.43 (4.98)
Overweight or obese (share)	0.45 [†] (0.50)	0.36 (0.48)
Underweight (share)	0.04 (0.19)	0.04 (0.20)
Energy consumption per day (kcal)	3500.70 ^{**} (1230.79)	3143.32 (1426.80)
Share of energy from processed foods	0.51 ^{***} (0.11)	0.44 (0.20)
Number of observations	357	258
Children/adolescents		
BMI-for-age Z-score (BAZ)	-0.26 (1.09)	-0.36 (0.90)
Overweight or obese (share)	0.10 (0.30)	0.09 (0.30)
Height-for-age Z-score (HAZ)	-0.76 ^{***} (1.09)	-1.35 (1.43)
Stunted (share)	0.14 (0.34)	0.28 ^{**} (0.45)
Energy consumption per day (kcal)	2531.67 (959.88)	2310.54 (1428.13)
Share of energy from processed foods	0.52 ^{***} (0.10)	0.44 (0.22)
Number of observations	110	106

Mean values are shown with standard deviations in parentheses. Adult underweight, overweight and obesity are defined as BMI < 18.5, BMI ≥ 25 and BMI ≥ 30, respectively. Child/adolescent overweight and stunting are defined as BAZ ≥ 1 and HAZ < -2, respectively. Mean value is significantly higher than that of the other group: [†]*P* < 0.1; ^{**}*P* < 0.05; ^{***}*P* < 0.01. Source: Adapted from⁽⁵¹⁾.

small difference in BMI-for-age Z-scores. Yet, we observe considerably higher height-for-age Z-scores among children from households that buy in supermarkets, and a lower prevalence of stunting.

The mean differences in **Table 1** are a first indication that buying food in supermarkets may affect nutritional status of consumers in Kenya. Yet, these results cannot be interpreted as causal, because of possible confounding factors and the fact that food consumers decide themselves whether or not to buy in supermarkets. This decision may be correlated with other observed and unobserved characteristics that could influence nutritional status through various pathways, thus leading to what is called self-selection bias in the impact evaluation literature. To control for confounding factors and possible self-selection bias, we estimated various regression models with instrumental variables^(51,52).

The estimation results suggest that supermarkets contribute indeed to rising waistlines among adult consumers in Kenya. Buying in supermarkets increases BMI by 1.7 and the probability of being overweight or obese by thirteen percentage points⁽⁵¹⁾. However, the same effects are not observed for children and adolescents. Supermarket purchase does not affect BMI-for-age Z-scores significantly. Instead, supermarket purchase has a positive and significant effect on height-for-age Z-scores. Buying in supermarkets increases height-for-age Z-scores by 0.63 and decreases the probability of severe stunting by twenty-three percentage points⁽⁵¹⁾. This is evidence that supermarkets contribute to reducing problems of undernutrition among children and adolescents in Kenya.

We also estimated additional models to better understand impact pathways. Average food prices expressed per calorie are lower for households that buy a larger share of their food in supermarkets⁽⁵²⁾. This price incentive contributes to higher total energy consumption. We also observed a shift in the types of foods consumed.

Since the small-town supermarkets in Kenya primarily sell processed items, the share of processed foods in total food expenditure increases with supermarket purchase⁽⁵²⁾. Likewise, the energy share of processed foods increases. Yet, this does not automatically mean lower dietary quality. The consumption increase is stronger for lightly processed than for strongly processed foods. Further, we found that supermarket purchase leads to a larger number of food items consumed, pointing at higher dietary diversity⁽⁵²⁾.

I am aware of only two other studies that have estimated the effects of purchasing in supermarkets on people's nutritional status, one referring to Guatemala and the other to Indonesia^(47,54). Consistent with our results from Kenya, the Guatemala study found that buying food in supermarkets contributes to higher BMI and overweight among adults⁽⁴⁷⁾. Effects for children were not analysed in Guatemala. The study in Indonesia found no significant effects of supermarket purchase on adult BMI and child BMI-for-age Z-scores (effects on child height-for-age Z-scores and stunting were not analysed). Only for children from relatively rich households in Indonesia, supermarket purchase was found to increase the probability of overweight and obesity⁽⁵⁴⁾.

Supermarkets and child undernutrition

Our results from Kenya show that buying in supermarkets increases BMI and the probability of being overweight or obese among adults, but not among children. Rather, supermarket purchase reduces child undernutrition and has a positive impact on body height⁽⁵¹⁾. For both adults and children, impacts occur through the same mechanisms, namely higher energy consumption and a higher share of energy from processed foods. The fact that the same mechanisms lead to nutritional outcomes that differ by age cohort is interesting. For adults who have already reached their final body height,

increasing energy consumption can only lead to higher BMI. For children and adolescents, the situation is different, because higher energy consumption can also lead to gains in height. It should be mentioned that, beyond energy, certain micronutrients also play an important role for child growth⁽²⁾. While not analysed in detail, dietary changes through buying in supermarkets may potentially be associated with higher micronutrient consumption. This could be true especially for children from poor households who otherwise have relatively low dietary diversity.

The impact of supermarkets on urban consumers will much depend on people's initial nutritional status. In Kenya, we observe relatively high overweight rates among adults, while stunting is a more widespread problem among children and adolescents. The same pattern is observed in many developing countries^(40,55). Reducing child stunting and controlling the global obesity pandemic are both important public health objectives. The results from Kenya, Guatemala and Indonesia suggest that the supermarket revolution is not just a business response to the rapid nutrition transition in developing countries, but that supermarkets also contribute to changing food consumption habits and nutritional outcomes. Yet, the results also suggest that the types of outcomes can be diverse.

The finding from Kenya that the nutrition transition in general and the supermarket revolution in particular may contribute to reduced child stunting challenges some widely held beliefs. Several authors have pointed out that the observed shift towards processed foods may contribute to higher child weight but not to improved child growth, which could also be one reason why child underweight declined more rapidly than child stunting during the past 20 years^(2,56,57). The underlying assumption is that processed foods purchased in supermarkets are high in energy and low in micronutrient contents. However, the results from Kenya suggest that this is not always true. Depending on poor people's traditional diets, supermarkets may contribute to improved dietary quality in certain situations. To gain a broader understanding, we compiled country-level panel data from a large number of developing countries and ran additional cross-country regressions. This cross-country analysis suggests that the share of supermarkets in national food retailing is negatively associated with both child underweight and child stunting⁽⁵⁸⁾, which supports the micro-level evidence from Kenya.

Globalising agrifood systems and smallholder farmers

Globalising agrifood systems also affect farm enterprises and farm households. This is particularly relevant in developing countries, where rural households make up a large proportion of the poor and hungry people. About 80 % of all undernourished people worldwide depend primarily on the small farm sector as a source of income and employment⁽⁵⁹⁾. Many smallholders are subsistence-oriented, meaning that they consume a large share of what they produce. Modernising value

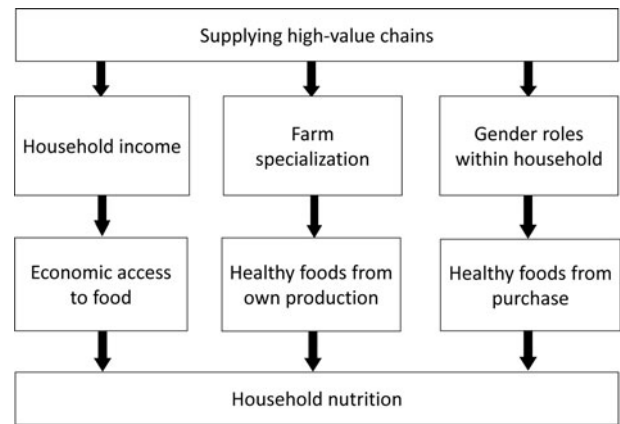


Fig. 2. Supplying emerging high-value chains and nutrition effects in smallholder farm households (possible impact pathways). Source: Adapted from⁽⁶⁹⁾.

chains tend to decrease subsistence levels. When market access improves, for instance through better infrastructure and trading opportunities, farms are often becoming more specialised and commercially oriented. While farm specialisation reduces the diversity of foods available in the household from own production, this effect is usually outweighed by higher food diversity that can be purchased from the market. Recent research with data from small farm households in different developing countries showed that market access is more important for dietary quality than on-farm production diversity⁽⁶⁰⁾.

There are other aspects worth considering for farm households in developing countries. Modernising food systems and emerging value chains for upscale export and domestic supermarkets often involve certification and contractual arrangements between farmers and agribusiness companies. This may have positive or negative effects for smallholders. Positive effects may come from higher and more stable prices, as well as better access to modern inputs and technologies^(61–63). Conversely, negative effects may occur when too stringent quality standards prevent smallholders from participating in emerging chains for high-value products^(11,64). To reduce transaction costs, agribusiness companies sometimes prefer to source from medium and large farms. This could lead to further marginalisation of smallholders. Several recent studies have analysed the impacts of globalising agrifood systems on smallholder farmers in developing countries^(11,14,61–64). Most of these studies conclude that emerging value chains contribute to income growth and employment generation in the small farm sector. However, nutrition effects have rarely been analysed^(16,18).

Supermarkets and smallholder nutrition

Supplying supermarkets or other emerging high-value chains may affect farm household nutrition through various pathways, as shown in Fig. 2. A first pathway is through household income. If farmers decide to supply high-value chains instead of producing for traditional markets or subsistence they do so because they expect higher profits and incomes. Higher incomes will raise



living standards and improve economic access to food. A second pathway relates to possible specialisation effects. Supplying high-value chains may lead to specialisation on certain commodities, which could narrow down the diversity of foods available for home consumption. Conversely, if farmers specialise on nutritious foods such as vegetables or dairy, positive effects for dietary quality are also possible. A third pathway relates to gender roles within the household. Participation in high-value chains may involve higher levels of commercialisation. Research has shown that men often take greater control of agricultural income with rising levels of commercialisation^(65,66). Men also tend to spend less than women on dietary quality^(67,68). All these factors may influence nutritional outcomes in positive or negative directions.

To analyse nutrition effects of supplying supermarkets empirically, we carried out a survey of 384 smallholder farmers in central Kenya⁽⁶⁹⁾. Some of these farmers produce vegetables for supermarkets under contract, while others sell their vegetables in traditional markets. The average size of farms in the sample is below one hectare. In addition to vegetables, households produce staple crops, such as maize, bananas and beans, and cash crops such as tea and coffee. Many are also involved in small-scale livestock husbandry. Using a structured questionnaire, we collected data on household agricultural activities and the broader socioeconomic context. The questionnaire also included a 7-d food consumption recall and a module on gender roles within the household. Food quantities from the recall were converted to per capita consumption levels of various nutrients⁽⁶⁹⁾.

Using regression models and instrumental variables to control for confounding factors and possible self-selection bias, we estimated the net impact of participating in supermarket channels on per capita consumption of energy and various micronutrients. In particular, we focused on iron, zinc and vitamin A, because deficiencies in these micronutrients are widespread among the rural poor in developing countries⁽²⁾. Supermarket participation has a positive and significant net effect on all nutritional indicators. Participation increases energy, iron and zinc consumption by 15–20 %⁽⁶⁹⁾. The positive impact on vitamin A consumption is even higher⁽⁶⁹⁾. These results suggest that the growing role of supermarkets has a positive effect on farm household nutrition in Kenya.

Further analysis confirmed that all three pathways discussed in connection with Fig. 2 play an important role⁽⁶⁹⁾. Supplying vegetables to supermarkets has a positive effect on farm income and thus improves households' economic access to food. The marketing contracts with supermarkets provide incentives to farmers to specialise more on vegetables all year round. Some of the vegetables that do not meet the supermarkets' quality standards are consumed at home, which also explains the strong increase in vitamin A consumption. For rural households in Kenya, with relatively low consumption of animal products, green leafy vegetables are the most important source of vitamin A (this partial effect might be different in other contexts where contracted farmers specialise on the production of non-food products). However, the supermarket contracts have

contributed to men taking over control of farm revenues that were previously controlled by women, and this change in gender roles has a negative partial effect on dietary quality⁽⁶⁹⁾. Hence, while the overall effect of supermarket participation on farm household nutrition is positive, it could even be more positive when the loss of female control of sales revenues could be prevented.

Very few other studies have empirically analysed effects of supplying supermarkets, horticultural export channels, or other emerging high-value chains on farm household nutrition. One recent study found that sustainability certification of coffee cooperatives has helped to improve dietary quality among smallholder farmers in Uganda⁽⁷⁰⁾. Another study found that farmer participation in certified vegetable export channels has contributed to higher food consumption levels in Kenya⁽⁷¹⁾. It was also shown that globalising value chains for labour-intensive agricultural products can create new employment opportunities, especially for female workers, which might also improve rural household welfare and economic access to food^(18,61,72,73). However, such employment-related nutrition effects have not been analysed until now.

Strengthening women's roles

It is a common observation that male household members take greater control of agricultural income when the farm enterprise is shifting from subsistence orientation to higher degrees of commercialisation^(65,66,68,69). This type of shift in gender roles within the farm household is undesirable from a nutrition, health and broader development perspective. However, concluding that small farms should not commercialise and stay subsistence-oriented instead would be wrong. Closer market integration, adoption of innovations and participation in the economy's division of labour are important steps out of poverty for smallholder farmers. Also from a broader perspective, sustainable food security for a growing and increasingly urban population cannot be achieved when the majority of farms in a country are subsistence-oriented. Hence, avenues need to be found how the commercialisation of smallholder farms can be fostered without a decrease in women's status.

Gender-sensitive approaches in programmes that try to link smallholders to markets and high-value chains are an important step in this direction. Such approaches involve gender awareness building, training programmes targeted at females and better tailoring of relevant rural services to the needs and conditions of women farmers. Several development initiatives already pursue such gender-sensitive approaches. For instance, certain sustainability standards, such as Fairtrade, consider the promotion of gender equity as an important element in the process of smallholder certification⁽⁷⁴⁾.

In a recent study, we analysed the effects of Fairtrade and other sustainability standards on gender roles and nutrition among smallholder coffee farmers in Uganda⁽⁷⁰⁾. Using a similar approach as described earlier for farmers in Kenya, we surveyed 419 coffee-producing households in Central Uganda, some of them with and

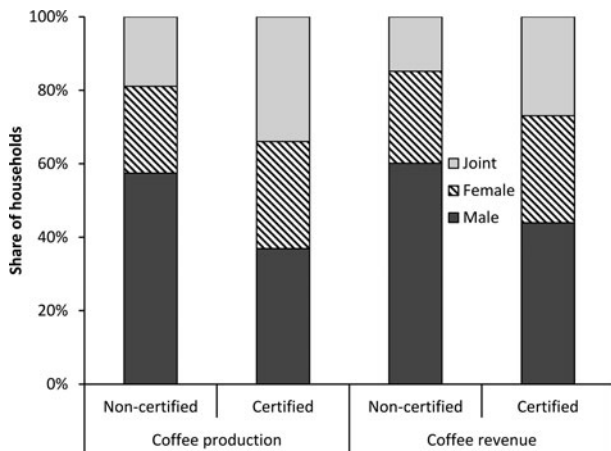


Fig. 3. Male and female control of coffee production and revenue in Ugandan farm households with and without sustainability certification. Source: Adapted from⁽⁷⁰⁾.

others without sustainability certificates. The results show that sustainability standards improve household income and nutrition, as certified households have better access to high-value export markets. Certified cooperatives offered special female training sessions. Some of the cooperatives also advised husband and wife to be present for the payouts of sales revenues. As a result, women in households with sustainability certification had significantly more control of coffee production and revenues than their counterparts in non-certified households (Fig. 3). Other research confirms that modern supply chain developments can contribute to female empowerment in rural areas of developing countries when gender-sensitive approaches are pursued^(68,75).

Conclusion

Global agrifood systems are undergoing a rapid transformation. Technological change, trade liberalisation, foreign direct investment, urbanisation and rising middle-classes in developing countries, and globalising preferences and lifestyles are all factors that contribute to profound shifts in the way food is produced, processed, distributed and consumed. This review has shown that these changes can affect nutrition in various ways. However, a simple conclusion whether globalising agrifood systems are positive or negative for sustainable nutrition is not possible. A more nuanced perspective is needed because different facets of globalisation can have different nutritional implications. Furthermore, sustainable nutrition requires looking at all three forms of malnutrition, namely undernutrition, micronutrient deficiencies and overnutrition.

Given global population and income growth and a limited natural resource base, productivity-increasing agricultural technology will have an important role to play for food security also in the future. Likewise, international agricultural and food trade is important to harness comparative advantages in different locations and

use scarce resources efficiently. Hence, a focus on regional and low-tech food production, as has become popular among certain rich-country consumers, should not be misunderstood as the new paradigm for sustainable food systems, as this would hurt poor people in developing countries the most. Nevertheless, future food policies and technological approaches need to place more emphasis on promoting dietary diversity and agricultural production patterns that reduce environmental problems.

Globalising agrifood systems also involve changing supply-chain structures through modernising retail, new food safety and food quality standards, and higher levels of vertical and international integration. The evidence suggests that emerging high-value chains in developing countries can contribute to income growth in the farm sector and improved access to food for rural and urban populations. Policy support may be needed in some situations to ensure gender equity and reduce market entry barriers for smallholder farmers. However, there is also evidence that the retail revolution in developing countries, with its growing role of supermarkets and processed foods, may contribute to overweight and obesity, especially among urban consumers. Except for the few empirical studies reviewed here, the multi-faceted nutritional implications of modernising food systems in developing countries are not yet sufficiently understood. More research is needed to provide a sound knowledge base for policymaking aimed at promoting sustainable nutrition.

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Authorship

M. Q. was responsible for all aspects of writing this review article.

Conflicts of Interest

None.

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