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Abstract

Agricultural development status impact individual nutrition through food, health and care practices. Many recent studies are focused on the positive side of the impact pathways. However, in some cases, those interventions may have negative outcomes on nutrition. We explore those potential negative outcomes based on a review of scientific papers and institutional reports as well as expert interviews. We identify six categories of risks related to incomes, prices, types of products, women social status and workload, sanitary environment and inequalities.

Keywords

Agriculture, Nutrition, Risk, Food Security, Impact pathways

Résumé

Les interventions de développement agricole affectent la nutrition des individus via l'alimentation, la santé et les pratiques de soin. Les chemins d'impact sont complexes et sont l'objet de nombreux travaux récents, essentiellement centrés sur les effets positifs. Néanmoins certaines interventions agricoles peuvent avoir, dans certains cas, des effets négatifs sur la nutrition. Cet article propose de les mettre en lumière à partir d'une revue de la littérature scientifique et institutionnelle ainsi que d'entretiens avec des experts. Six catégories de risques sont proposées, relatifs aux revenus, aux prix, à la nature des productions, au statut social et au travail des femmes, à l'environnement sanitaire et aux inégalités.

Mots clefs

Agriculture, Nutrition, Risque, Sécurité alimentaire, Chemins d'impact

JEL: Q18, Q12, I15, O13, O22

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I. Introduction

Following the 2008 food price crisis and the series of articles on maternal and child undernutrition in the medical journal *The Lancet* (2008; 2013), there has been renewed interest in how agriculture affects nutrition. Ruel and Alderman (2013) showed that it is necessary to develop so-called “nutrition-sensitive” interventions, as specific interventions are insufficient. Recent reviews of the literature (Berti *et al.*, 2004; Masset *et al.*, 2012) and numerous operational documents (World Bank, 2007 and 2013; ACF, 2011; FAO, 2012) have endeavoured to identify the effects of agricultural development interventions (ADI) on nutrition, and put forward recommendations to make them nutrition-sensitive. That work has mostly involved the people directly concerned by ADIs, yet they can have effects on other populations, whether they live in a rural or urban environment. In addition, most of the work focused on protein-energy undernutrition responsible for stunting, while other forms of malnutrition, micronutrient deficiencies (vitamin A, zinc, iron, iodine, etc.) or “overnutrition” are very widespread and have serious consequences for individual development. These two forms of malnutrition (by deficiency or excess) also often go hand in hand in the same countries, or even within the same households (Maire *et al.*, 2002). Moreover, little attention was paid to agricultural policies in these studies, yet they are decisive in the evolution of the agrifood system. Lastly, the studies sought the positive effects of interventions, while they may also have negative effects, as the impact pathways are complex and interlocking. Taking a “do no harm” stance, based on the existing literature and interviews with experts, this article proposes to shed some light on the risks that ADIs might entail for nutrition, taking into account all the populations affected, and malnutrition problems, and considering ADIs in the broad sense.

II. Methodology

The few studies documenting negative impacts of ADIs on nutrition are relatively old (e.g. those published by Von Braun and Kennedy in 1986 and 1994). Consequently, articles revealing links between agriculture and certain key variables for nutrition, were also taken into consideration, even though the impact pathway did not extend all the way to nutrition. However, there is no claim to be exhaustive or to judge the relevance of all the references quoted, whose methodological weaknesses have been highlighted, notably by Arimond *et al.* (2011): lack of control groups, reference situations and randomization. This article sets out to inventory potential risks, without assessing their weight, which greatly depends on the intervention contexts.

The range of ADIs is wide and covers as much technical dimensions (development of production basins for example) as it does institutional dimensions (producer capacity building or policy support). In the field, ADIs usually comprise several components combining technical and institutional aspects. Some ADIs correspond more to rural development projects taking on territorial dimensions, while others focus on agricultural products. Here, the ADI perimeter is mainly confined to localized projects (it is the majority of the literature), though agricultural policies are also touched upon. Agriculture is covered in its broad sense (plant and animal production, rural development, natural resource management, etc.), but for easier reading the examples of ADIs are intentionally schematic (irrigation, food crop production, cash crop production, livestock, land, phytosanitary protection, etc.). This presentation partially overlaps with that undertaken by the *Agence Française de Développement*, by major types of intervention, in its 2013-2016 sectorial intervention framework (AFD, 2013).

III. Links between agriculture and nutrition: what impact pathways?

There are several schematic and conceptual representations of the effects of agricultural activities on nutrition (Randolph *et al.*, 2007; Headey *et al.*, 2011; Webb, 2013). They are based on the UNICEF causal model of malnutrition (1990) and on micro and macro-economic links between agricultural production, labour, expenses and food consumption of households and individuals. The different scales (individual, household, community, supply chain, country, world) and the different stakeholders of the agrifood system, are more or less well taken into account: relations are especially represented

for individual scales but rarely for larger scales. The authors emphasize the complexity of those relations.

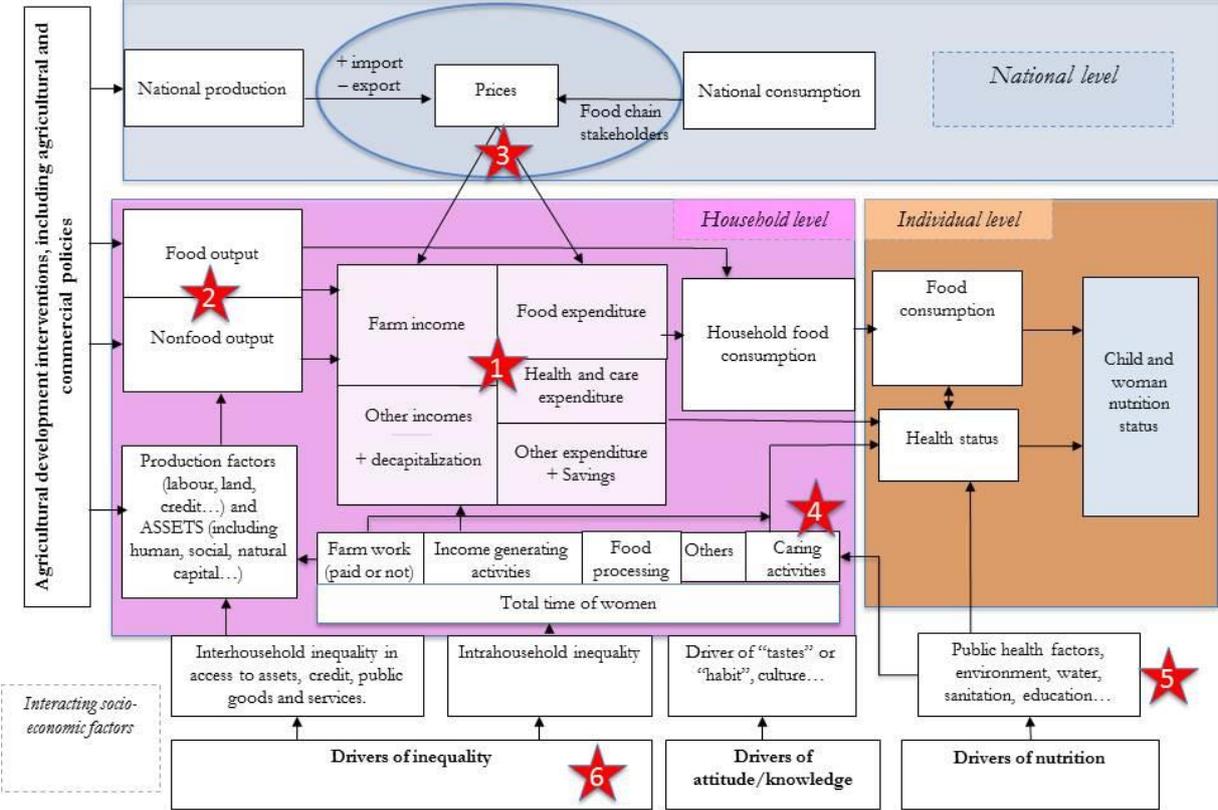


Figure 1: Location of the main risks along the agriculture/nutrition impact pathways

Source : Authors adapted from Headey *et al.*, 2011

Note: the stars indicate the main risks presented in the article

The nutritional status of individuals results from the quality and amount of food intake, and their health status. These two factors are highly dependent on care activities^a, food, and the health environment (natural surroundings, hygiene, health services, etc.). These factors, themselves, depend on structural constraints, especially social rules for resource sharing (e.g. land). The agricultural or livestock production activity may affect nutrition by influencing these different factors and by taking several pathways. Those pathways may be the same for different types of interventions and/or different for a single intervention. For greater clarity, the article takes six risks corresponding to six impact pathways and presents them separately, though they may be interconnected.

IV. The main agricultural risks for nutrition

1. Nutritional risk despite an increase in agricultural income

The rise in income linked to an ADI usually enables households to increase their food expenditure, as well as their health expenses, both of which are positive for nutrition. Some studies have shown that

^a Child care practices encompass food, health care, stimulation and emotional support required for the development of the child. They are ensured by a care provider (usually the mother).

agriculture is a powerful lever in lifting people out of poverty, which is itself correlated to an improvement in nutritional indicators (World Bank, 2007 and 2013). The growth in incomes derived from agriculture generally enable a reduction in malnutrition (Webb and Block, 2012), but it is not automatic. It depends on:

- changes in other sources of income: an increase in the income derived from marketing a product may be counteracted by a drop in other incomes derived from other farming or non-farming activities (Masset *et al.*, 2012).
- food price trends: a rise in agricultural income following an ADI needs to be placed in perspective with the availability and prices of foodstuffs (see also risks 2 and 3).
- income use: extra income may be used for purposes other than buying food, for example.
- the person controlling the income: income controlled by women is used more for food expenditure and has positive impacts on child nutrition (Marek, 1992). Interventions that tend to reduce income controlled by women therefore run the risk of producing negative impacts on nutrition (see risk 4).
- income regularity: a regular income, even small, is used more for food than a larger but less regular income (Von Braun and Kennedy, 1986; IYCN b, 2011). Strong income seasonality prevents households, who buy when prices are highest, from covering their annual needs. This period also corresponds with peaks in the prevalence of water-related illnesses and workload peaks (Devereux and Longhurst, 2010).

The impact of ADIs encouraging commercial crops was studied in the 80s-90s (Fleuret and Fleuret, 1980; Von Braun and Kennedy, 1986 and 1994). They may be negative, from a nutritional viewpoint, when the income derived from converting from a subsistence system to cash crop farming does not compensate for the loss of self-consumed products. For example, the sale of milk, whose consumption reduces the risk of chronic malnutrition, may have a negative impact on the nutrition of dairy farmers, as has been shown in India (Bhagowalia *et al.*, 2012), Rwanda (Pimkina *et al.*, 2013) or Ethiopia (Hoddinott *et al.*, 2013). In addition, specializing in a commercial crop entails an income risk. An adverse event affecting the commercial crop may lead to a drop in household income and potentially a drop in food purchases. For example, in Kenya in 1984, it was found that farming households living in irrigated areas had an income based on commercial rice and had poorer nutritional indicators (stunting) than households not living there with more diversified incomes (Niemeijer and Hoorweg, 1994).

2. Risk of a mismatch in food availabilities

By determining the type of products, ADIs affect the nature and quantity of available foods. They may have negative impacts on energy quantities (too much or not enough) and on available nutrients. This may be the case when agricultural policies encourage specialization to the detriment of the availability and diversity of foodstuffs. For instance, in Southeast Asia, agricultural policy in the second half of the 20th century led to an increase in the availability of cereals, but that was accompanied by a drop in legume production, and a deterioration in the iron consumption and nutritional status of women.

During the green revolution in India, a policy package (fertilizer and seed subsidies, infrastructures, price support, etc.) led to a very large increase in per capita wheat and rice production between 1960 and 1990. That increase in availability helped India escape the famine that had marked the country up to then. Be that as it may, the prevalence of undernutrition among women and children remained among the highest in the world. One hypothesis, albeit difficult to verify due to the multiplicity of causes of malnutrition and wide disparities between regions (Gillespie and Kadiyala, 2012), corresponds to the crop and food specialization brought about by these policies which were centred almost exclusively on cereals. The case of legumes is particularly striking: their availability fell from

23 kg in 1961 to 12 kg/year/inhabitant in 2003 (Dorin and Landy, 2009). Likewise, for Southeast Asia, the calorie supply rose from 2,050 to 2,250 kcal/person between 1970 and 1990, while the iron density in food fell from 6.2 to 5.75 mg/kcal and the prevalence of anaemia (iron deficit) in women rose from 57% to 73% over the same period (Welch and Graham, 1999). The availability of other foodstuffs (animal products, fats, fruits and vegetables) remained well below world averages and their consumption was very unequally distributed (Dorin and Landy, *op.cit.*).

Sometimes the development of commercial products may go hand in hand with: (i) a change in natural ecosystems, the disappearance of wild species – an integral part of local diets (Robson, 1976) (ii) a reduction in resources devoted to subsistence crops (Fleuret and Fleuret, 1980). Such changes lead to simplification of diets and risks of micronutrient deficiencies. The promotion of maize in Mali and Burkina Faso is associated with cotton growing by development companies (distribution of maize seeds, promotion of cereal crop standards, etc.), in order to secure the food supply of cotton farmers. It is thus possible to cover the calorie requirements of certain households (not all), but it has also led to more monotonous diets than in other regions, along with a risk of deficiencies and chronic malnutrition (Dury and Bocoum, 2012).

The introduction of improved varieties often leads, though not always, to a simplification of cropping systems (Bellon and Hellin, 2011) and diets (Johns and Eyzaguirre, 2007). The substitution and reduction in number of accessible traditional varieties may also be accompanied by an erosion of the variety of recipes and dishes consumed. An example involving the industrial white-fleshed banana, which has replaced a local, orange-fleshed banana rich in carotenoids, has been described in Micronesia (Englberger, 2003).

3. Risk of price ratios detrimental to nutrition

ADIs may lead to an increase in the agricultural production of their target products and to a drop in prices for certain food products. However, the link between agricultural prices and food prices tends to slacken with the lengthening of the value chain and with the fact that agriculture accounts for an increasingly small share of food product end-prices.

The effect of a price drop on nutrition depends on the products involved and the nutritional status of consumers. It may be positive in a situation of deficiency-related malnutrition (e.g. consumption of animal products in poor countries), or negative if thresholds are exceeded (e.g. overconsumption of fatty and sugary products). The gain in purchasing power resulting from a drop in prices may lead to more diversified food intake and/or better household access to health care, hence a better nutritional status (Headey, 2013). It should also be noted that the effects differ depending on whether households are urban or rural, hence whether they purchase part or all of their consumption (Ruel *et al.*, 2010), and depending on whether farming households are net buyers or sellers: a drop in food prices may correspond to a drop in income for the latter.

Policies intended to support targeted agricultural products may therefore produce complex effects on nutrition. For example, the focus on cereals, oil palm, sugarcane, or livestock farming has led to a relative drop in their prices, while products that have not benefited from support see their relative prices increase. In India, relative price changes are very pronounced between cereals – having benefited from strong agricultural support – and non-cereal products. The rise in prices of the latter (legumes) might explain the weak improvement in nutritional status, or even its deterioration (Webb *et al.*, 2013), despite an increase in incomes over the last twenty years (Deaton and Drèze, 2009).

Price subsidy policies targeting staple food products may have perverse effects on diets and nutrition. For example, in Tunisia, subsidies for staples (cereal products, oil, sugar) make them highly accessible, but a wide-scale occurrence of excess weight and obesity problems is being seen. It is difficult to blame subsidy policies for the increase in chronic illnesses, as many factors are involved in nutritional transition (urbanization, sedentation, higher living standards, acculturation, etc.) (Beltaifa *et al.*, 2002), but it seems necessary to raise the question of their relevance for public health.

4. Risk of a deteriorating role of women

The abundant literature on the role of women in farming (e.g. Quisumbing and Maluccio, 2000; Kurz and Johnson-Welch, 2007) is often used to show that ADIs that empower women in managing production factors and incomes, or which free up some of their time, help to improve nutrition. Conversely, a reduction in decision-making power or an increase in workload carry risks for nutrition. Few references enable the size of those risks to be measured, but the fact that they are reported many times indicates that particular attention needs to be paid to them.

- **Increased marginalization of women in decision-making**

As certain commercial crops are often in the hands of men, ADIs that encourage them may lead to women being marginalized in decisions relative to production and income use, and may therefore entail risks for nutrition. Agricultural extension projects are often targeted at men and tend to side-line women, who are penalized due to a lack of sufficient capacities (education, access to credit, etc.). For example, the introduction of irrigated rice growing unbalanced gender relations in favour of men in the 20th century in Senegambia (Carney and Watts, 1991). The exclusion of women from management of the fields and crops for which they were responsible, while remaining responsible for children and food, carried risks for family nutrition. In the East of Zambia, the adoption of hybrid maize was accompanied by a reduction in the power of women to make production decisions, and by a nutritional risk (Kumar et Siandwazi, 1994). However, the fact that commercial crops are managed more by men does not systematically mean that the decision-making power of women is reduced. The introduction of irrigated rice growing in northern Cameroon, for example, obliged women to work in plots managed by their husbands, but they were able to negotiate an income at a rate based on the opportunity cost of their labour (Jones, 1986).

- **Increased workload for women**

Some ADIs entail a much greater workload for women, to the detriment of the time devoted to child care, breast feeding and food preparation: faster preparation methods, less nutritional meals, or even fewer meals (Kennedy, 1994; Masset *et al.*, *op. cit.*, Jones *et al.*, 2012). For example, vegetable-based meals that can provide vitamin A often take time to prepare (Popkin and Solon, 1976). For example, in Burkina Faso, in the large hydro-agricultural schemes of the Sourou region, female labour is one of the factors that explains why wasting is more frequent in households depending on those schemes than in other households (see also risk 5). In the Bagré region, women practising market gardening – a primarily female activity – have one hour and thirty minutes less to take care of their children and 2 hours less to rest than those not involved in market gardening (Parent *et al.*, 2002).

The workload of mothers is also a risk for their own health and nutrition, and those of their children, particularly during pregnancy or breast feeding. For example, Lima *et al.* (1999) showed that an excessive agricultural workload throughout pregnancy had a direct impact on infant birth weights.

Mechanization can have ambivalent effects on work sharing within households and on nutrition: a positive impact by lessening the workload of farmers, notably women (FAO, 2012), but also sometimes a deepening of gender inequalities within the household. On some cotton farms in Mali, without any strong land tenure constraints, motorization led to an increase in the area farmed, and consequently to the amount of labour for sowing, weeding, crop thinning and harvesting, largely provided by women (Girard and Dugué, 2009).

However, female labour very obviously also has some positive effects in terms of autonomy (Ukwuani and Suchindran, 2003; Arimond *et al.*, *op.cit.*, Leroy and Frongillo, 2007). What matters is that a balance is found so that women's involvement in ADIs does not result in a workload that is harmful to their health and to that of their children. A balance must also be found between ADIs and other productive activities. When women have little control over the income of a farm, care has to be taken

to ensure they have enough time for their productive activities ensuring them an income or their own crops.

5. Health risks and environmental degradation

Some farming practices may entail risks for the environment (air, water, soil) and/or the health quality of foods, thereby affecting the health of individuals and their nutritional status.

- **Risks of zoonoses associated with livestock farming**

While livestock farming is a strategy for alleviating poverty and malnutrition (quality foodstuffs, income from the sale of animal products or animal rental, manure and draught power, savings, social status afforded by the ownership of animals, etc.), it may also generate risks for nutrition (Randolph *et al.*, 2007). Diarrhoeal diseases, which are closely associated with malnutrition, are linked in half the cases to animal pathogens or foodstuffs of animal origin in poor countries (Grace, 2011). In addition, given population growth and increased demand from the urban population, there is a tendency for the number of livestock animals to increase, especially monogastric animals which are more at risk of transmitting pathogens in countries without operational veterinary services. The gradual intensification of animal production is also accompanied by a longer and more complex food chain, and an increased risk of gastro-intestinal zoonoses responsible for diarrhoea (ILRI, 2012).

- **Risks linked to aflatoxin in maize-groundnut systems**

In tropical zones, where the diet is largely maize and groundnut dependent, chronic exposure of the population to aflatoxin is massive. It involves 85 to 100% of children in African countries of the Gulf of Guinea (Khlanguiset *et al.*, 2011). Many studies have shown a link between chronic malnutrition and the exposure of unborn children to aflatoxin, or subsequently through breast feeding or weaning foods. The biochemical mechanism involved remains to be identified, but the strong and regular links observed between the level of exposure to aflatoxins and the prevalence of chronic malnutrition argues in favour of a direct causality (Gong *et al.*, 2003 and 2004). Contamination occurs right from the field, before the grains mature, amplified by drought and heat, then after grain ripening, favoured by moisture in the fields, and during drying, storage and transport (Zakhia-Rozis and Schorr-Galindo, 2013).

- **Risks associated with exposure to pesticides**

The risks of pesticide use for the health of those applying them are known in the short term and suspected over the medium and long terms (INSERM, 2013). Those health risks affect nutrition. They are particularly significant in developing countries where, even if the use of pesticides is low (25% of world consumption, 4% for Africa), they account for 99% of deaths due to poisoning (75% for Africa) (Thiam and Sagna, 2009). In Africa, the regions most affected by the impacts of pesticide applications are the zones with large farms, irrigated zones and cash crop areas, where pollution can contaminate the environment and the food chain (Thiam and Sagna, *op. cit.*).

- **Risks associated with irrigation**

Irrigation is a way of improving productivity, alleviating poverty in rural zones (Mc Cartney *et al.*, 2007) and breaking away from the seasonality of hunger (Devereux and Longhurst, *op. cit.*). However, it may also be propitious to the development of water-borne diseases, such as schistosomiasis and malaria (Mc Vartney *et al.*, *op. cit.*), major scourges in Africa. It may also be conducive to the spread of zoonoses such as Rift Valley Fever (FAO-WHO, 2008). The existence of surface water near villages may also lead to a deterioration of drinking water quality and a multiplication of diarrhoeal diseases (Van der Hoek *et al.*, 2001). Such links are not systematic: despite a high density of *Anopheles* mosquitoes throughout the year associated with irrigation, the prevalence of malaria in people living near irrigated zones is often less than in control groups, for immunological and

socio-economic reasons (WHO, 2005).

- **Market gardening and diarrhoeal diseases in urban areas**

Urban agriculture, which is booming and which is practised in a polluted environment, generates health risks for producers and consumers. However, studies often consider that the benefits of the activity (income and supplies for towns, development of urban space, a better living environment and conditions) outweigh the risks entailed. Waste water use by urban agriculture has particularly attracted the attention of numerous studies. This practice offers the merits of using water rich in nutrients and available throughout the year for several cropping cycles, while helping to make use of urban waste. However, it greatly exposes the populations to pathogens (Blumenthal and Peasey, 2002) and to chemicals (heavy metals, hydrocarbons and pesticides) which entail health risks.

6. Risk of worsening inequalities

The risks described here refer to partial or total exclusions, created or amplified by ADIs. They concern producers not directly targeted by an intervention and who lose some or all of their access to certain resources (land, forest, water, work or sale opportunities, etc.). They may concern an entire category of the population, often the most socially and politically fragile: for example rural versus urban, nomadic versus sedentary, employees versus owners, poor households versus wealthy households.

- **Land inequalities**

In the 80s-90s, many authors described the negative effects of agricultural policies on land inequalities, in favour of large farms to the detriment of smallholders. For example, in Malawi, the size of farms was reduced and farmers who were net purchasers had to work on other farms, usually at the tiding-over period. As many small farms were also managed by women, it fell to them to work on the farms of others and young children, entrusted to their older brothers and sisters, had to wait until the mother returned to eat (Millard *et al.*, 1990). The current phenomenon of land grabbing seen in developing countries may offer economic opportunities for some, but results in greater poverty, food insecurity and potential malnutrition for others (Ansoms, 2013).

- **Unequal negotiating powers for contracts**

Agricultural investments by foreign investors or local elites, which lead to contracts with smallholders, are a strong trend in the future of farming (Karsenty and Ongolo, 2012). There is a debate under way as to the effects on the wellbeing indicators of farming households, but the power relationships are very unbalanced between enterprises and farmers and, in that sense, there exists a risk for farming families under contract.

- **Inequalities linked to salaried work**

A national survey in South Africa revealed that it was on commercial farms that chronic malnutrition in children was the most prevalent in the country (Labadarios, 2000). In the United States (Nichols *et al.*, 2014) and Turkey (Simseka and Korukb, 2011), the nutritional status among the children of seasonal agricultural workers is less good than in the rest of the population. In Chile, fruit and vegetable exports, and the standardization accompanying them, has led to a structural modification in the wage earners in this sector (Bain, 2010). Some relatively protected wage earners under permanent contract work alongside unprotected seasonal wage earners (mostly women) without contracts. The export policy adopted by Chile has been accompanied by a deterioration in working conditions for most wage earners. The development of hired labour-intensive farming therefore potentially increases the risks of malnutrition.

- **Inequalities linked to targeting**

The question of targeting interventions is a recurrent debate in agricultural development: should “average” farmers with capacities, capital, etc. be targeted or should the poorest farmers be targeted? It is not a question here of choosing but of considering whether there exists a risk of worsening inequalities when agricultural interventions benefit the largest producers to the detriment of the most vulnerable (FAO, 2012). For example, in Malawi, the auctioning system introduced for tobacco led to a lower price being paid to small farmers than to large producers, who were the only ones allowed to sell directly via that system (Millard *et al.*, *op. cit.*). The example of the green revolution in Uganda also showed that small farmers did not have the means of using new technologies and were unable to take advantage, like the others, of the economic gains generated and of the improvement to their food and nutritional security (Munyonyo, 1998).

V. Conclusions

This review of the literature shows that certain agricultural interventions that are successful for certain aspects (production, income, etc.) may have unexpected negative effects on nutrition. The relations between agriculture and nutrition are eminently complex, the risks vary depending on the nature and context of the intervention and no recommendation can be made in absolute terms. Nevertheless, a few principles of caution can be applied: (i) identify and keep track of nutritional risks throughout the life span of the intervention; (ii) promote diversification to prevent risks linked to specialization of farming systems and incomes; (iii) encourage practices with low labour requirements and activities enabling women to increase their autonomy; (iv) set in place good practices known to enable a reduction in health risks; (v) anticipate potential exclusion effects of interventions, and pay specific attention to vulnerable groups. Overall, by ensuring coordination between sectors when designing and implementing interventions, it is possible to identify and manage some aspects that the agricultural sector can hardly tackle alone. Over and above these operational recommendations, this article has helped to identify several research leads. It seems important to give further thought to defining nutrition-sensitive agricultural policies. It is not easy to design agricultural and agrifood policies supporting the diversity of foodstuffs, since those policies have usually targeted priority products or supply chains. It is also important to update explicit empirical studies on links between agriculture and nutrition. It was not possible to identify any more recent empirical work directly showing negative impacts on nutrition. Intermediate variables were used (income, status of women, food diversity, health, etc.), but the full impact pathways have not been developed. The few recent studies of this type tend to concentrate on localized projects and on positive effects, particularly of small-scale livestock farming or family gardens. It is therefore necessary to (i) reposition the question of the links between agriculture and nutrition in the current context, taking into account the different forms of agriculture, the dual nutritional burden (excess weight and undernutrition), the lengthening of the supply chains, the role played by private processing and distribution macro-stakeholders, etc., and (ii) extend deliberations to the scale of agricultural and food policies. Lastly, the most recent studies were found in the medical and dietary literature, indicating a field of scientific production that agricultural economists should be paying greater attention to.

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