Pre-print

Accepted by World Food Policy with minor corrections, May 5 2015

The negative side of the Agricultural–Nutrition impact pathways: a literature review.

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Abstract

Agricultural development interventions and policies have an impact on the nutrition of individuals through changes in food availability, in food diversity, in food prices and changes in farmers' income. Less straightforward, they also entail many changes in health environment and in time availability for care activities. They finally have impacts on the balance of power both at the intra-household, community and global levels. The impact pathways are complex and interlinked and many recent studies have primarily focused on their positive effects. However, some agricultural interventions might have a negative impact on nutrition in certain cases. This article sets out to identify them, through a review of the scientific and institutional literature, along with expert interviews. Six risk categories are proposed, relative to incomes, prices, types of products, women's social status and workload, the health environment and inequalities. This review underlines the necessity to have an *ex ante* analysis of the nutrition impacts of any food or agricultural policy or intervention with "do not harm approach" regarding to the nutrition outcomes. It gives clues to identify and mitigate the main negative outcome and advocate for more applied and well document research on that topic.

Keywords : nutrition, agriculture, pathways, impact, development

1. Introduction

Following the 2008 food price crisis and the series of articles on maternal and child undernutrition published in *The Lancet* in 2008 and in 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 (such as those of Masset et al. 2012) have endeavoured to identify the effects of agricultural development interventions (ADI) on nutrition, and put forward recommendations to make them nutrition-sensitive. It is interesting to underline the fact that these studies sought the positive effects of interventions, while agricultural interventions may also have negative effects, as the impact pathways are complex and interlocking.

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Taking a “do no harm” lens, 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. The article sets out to inventory potential risks, without assessing neither the reality of the threats nor their relative weight, which greatly depends on the intervention contexts. It proposes conceptual guidelines for agricultural policy or projects designers to assess *ex ante* likely impacts and to mitigate the possible drawbacks of their actions.

The followed methodology of data collection and analysis is detailed in section II. Section III illustrates the synthesis of the six main different pathways we identified and their complex interconnections. We present each of these pathways in section IV.

II. Methodology

Starting from the different recent reports (Webb 2013; World Bank 2007, 2013; du Vachat 2013), conference presentations (Headey 2013; Hoddinott 2011), books (Fan and Pandya-Lorch 2012) and scientific papers (Masset et al. 2012; Ruel, Alderman, and Maternal and Child Nutrition Study Group 2013; Berti, Krasevec, and FitzGerald 2004) concerning the effect of agriculture on nutrition, we followed a backward snowball methodology, identifying each paper or author, who was quoted about a possible negative causality. In addition, we interviewed fifteen colleagues, from different backgrounds : history, human nutrition and epidemiology, agricultural economics or agronomy from FAO, ACF, IRD and Cirad about their knowledge of existing literature or empirical evidences concerning a possible negative effect of certain types of projects or policies on nutrition.

Altogether, we gathered 171 different documents, in English and in French, all written between 1980 and 2013. It appears that studies documenting specifically the negative impacts of ADIs on nutrition were scarce and relatively old (e.g. those published by Von Braun and Kennedy (1986); (1994)). Consequently, articles revealing links between agriculture and certain key variables for nutrition, were also taken into consideration, even though the impact pathways did not extend all the way to nutrition. In the end, we use here 8282different references. There is no claim to be exhaustive and when the same idea is found in different papers, we do not quote all of them. We know the methodological weaknesses of most of these papers which have been already highlighted, notably by Arimond *et al.* (2011): lack of control groups, reference situations and randomization. We ought to underline the fact that, “in one case, one observer has report in a written form a specific risk”. With the existing material, it is impossible to draw conclusions regarding the probability of the occurrence of the identified risk nor of their severity. The message here is qualitative for practitioners : to have a guidelines in their impact assessments ; and for scholars : a claim for conducting more serious research on this issue.

The existing work has mostly dealt with 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 such as micronutrient deficiencies (vitamin A, zinc, iron, iodine, etc.) or “overnutrition” are a major issue. 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). 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 regional dimensions, while others focus on agricultural products. Here, the ADI perimeter is mainly confined to localized projects since it is the majority of the literature. 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, plant health, etc.). This presentation partially overlaps with that undertaken by the *French Development Agency*, 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, Chiu, and Kadiyala 2011, 5). The different stakeholders of the agrifood system, are more or less well taken into account according to the different authors: relations are especially represented for individual scales but rarely at larger scales. Most authors emphasize the complexity of those relations. However, most of these representations are based on the UNICEF causal model of malnutrition (1990). In that sense, the starting point is the "individual" and its health/nutrition status. The different causes/factors affecting its nutrition are organized in different levels from household, community, supply chain, country, world…. These specific models disentangle the drivers linked to food, food systems and agriculture. That is on the basis proposed by (Headey, Chiu, and Kadiyala 2011, 5) that we propose our own model : the nutritional status of individuals (on the right hand on figure 1) results from the quality and amount of food intake, and their health status. These two factors are highly dependent on two drivers at the level of the household : most of the care time[2] and household food consumption, and on many drivers at the level of the general health environment (natural surroundings, hygiene, health services, etc.) that are not on the scope of this study.

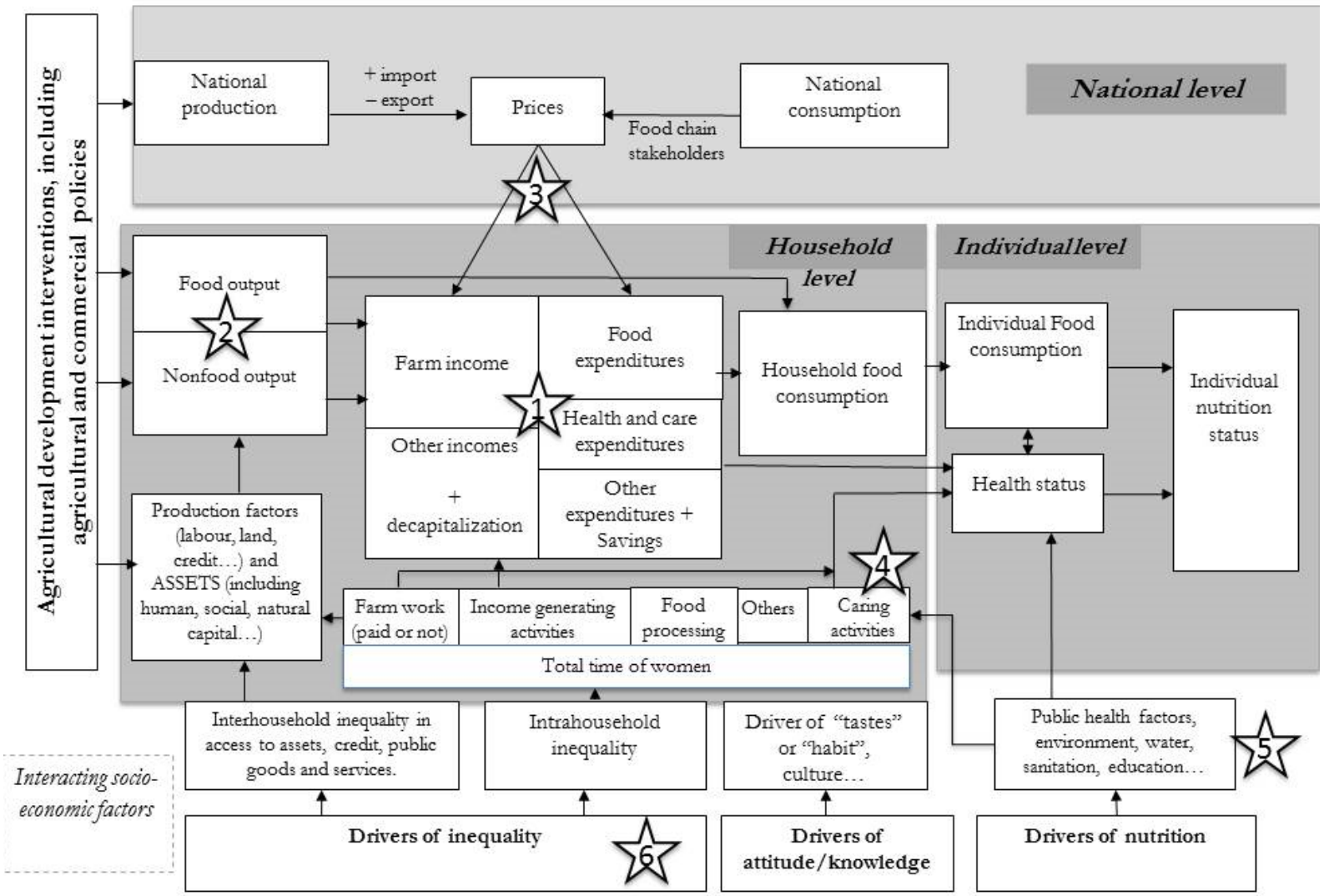
The important factors at the level of the household depend on variables that are analysed in classical agricultural household and food consumption micro-economic literature : i e during one period of time the household has to decide to spend its money and affect its time in a specific way according to its "preferences" and resources (income, savings). In the model we propose, we represent a simplified budget of a household (central rectangle) to illustrate the choice between food expenditures, health and care expenditures, and other expenditures. Of course, one can imagine a more detailed model where the household affects its money between beans or meat, cereals, beers or cigarettes, school or shampoo, smartphone or radio, etc. the list can be infinite and worth to be discussed. By drawing a different arrow from the production of food to the household food consumption box, we stress the possibility of selfconsumption in the household. We also chose to disaggregate the time of women who are the main caregivers and whose health depends on their activities. Most of women have to deal with different kind of income generating activities as well as "home" activities such as food and meal processing. They have also to take care of themselves and of their children. Last, but not least, in most agricultural families, they have to work on the family farm with no immediate wage, but in advance of a share of the harvest. The nature (money, products) and amount of this share depends on the local social rules of sharing in-between the families. And, as we are dealing with agriculture activity, the harvest as well as this share are highly risky.

At the left side in the household level' box, we drew two boxes concerning the production side of the agricultural households (though this figure does not represent only farmers ; for non-farmers one just has to imagine that these two boxes are empty). These boxes represent the production factors and assets, taken in a broad sense (labour, land, financial capital, but also human, and social, natural capital) and the farm outputs, subdivided into two categories : food and non-food.

Surrounding these two individual and household levels, on the top of the figure the agri-food market at a "national" level is represented in a very schematic way, while at the bottom, the socio-economic /cultural drivers are also represented. At the left side of the Figure, the different food and agricultural policies and interventions are finally represented.

We will now start from this left side and propose different pathways through which these interventions may affect, actually in a positive or negative way, the nutrition outcome of the individual. One has to underline the fact that pathways may be the same for different types of interventions and/or different for a single intervention.

[2] 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).



Note: the stars indicate the main risks presented in the article. Source : Authors adapted from Headey *et al,* 2011

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

IV. The main agricultural risks for nutrition

The topic of this paper is to identify potential risks of agriculture interventions or policies. Using the schematic figure we just explained and the different pathways from agriculture toward nutrition of individuals, we chose to present six family of risks corresponding to six impact pathways and to present them separately, though they are interconnected. Each risk/pathways is represented by a star in Figure 1 that corresponds to the numbering of the title.

1. Nutritional risk despite an increase in real incomes (relative to prices) : the level of the households, including farm and non-farm household.

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 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 real incomes (relative to price) derived from agriculture generally enables a reduction in malnutrition (Webb and Block 2012), but it is not automatic. It depends on:

(i) modalities of change 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).

(ii) modalities of change in source of food access : The impact of ADIs encouraging commercial crops was studied in the 80s-90s (Fleuret and Fleuret 1980) (Von Braun and Kennedy 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 sources of incomes (Niemeijer and Hoorweg 1994).

(iii) income uses: for example extra income may be used for purposes other than buying food. In some countries and under different circumstances it has been shown that income elasticity of food consumption, or calorie consumption or nutriment intake might be null or even negative in certain cases. For example, (Skoufias et al. 2009) found in Mexico, that "for the poorest households, the deficiency of total energy, protein, and zinc is not accompanied by a positive income elasticity".

(iv) 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 (even if the men get more income) therefore run the risk of producing negative impacts on nutrition (see risk 4).

(v) change in income regularity: a regular income, even small one, is used more for food than a larger but less regular one (Von Braun and Kennedy 1986; IYCN b 2011). Strong income seasonality prevents households, who buy when prices are highest, from covering their annual needs. The period of higher prices also corresponds with peaks in the prevalence of water-related illnesses and workload peaks (Devereux and Longhurst 2010).

Altogether, the ADIs whose main objective is to raise income of the poor/farmers might not always end with improvement in nutrition. One has to be aware that additional income might be gained at the expenses of other sources of income (non-agricultural income) or resources (food) which might not be properly replaced. And that the use of additional income is not always directed to food expenditures nor adequate food, nor for the ones whose who are in deficit.

2. Risk of a mismatch in food availabilities and diversity : macro and "meso" (market chain, regional development) levels.

By focusing on certain specific 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 at the expense of the availability and diversity of foodstuffs.

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 (Gillespsie 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). Francesco Burchi, Jessica Fanzo and Emile Frison (2011 : 362) insist on that opinion "this push to concentrate on a few staple crops may be a contributory factor to the simplified diets, the continued undernutrition in South Asia and widespread hunger". Even Hazell (2009 : 12), who is a strong supporter of the green revolution, admits "However, since deficiencies in iron and the B vitamins are common amongst the poor the increases in micronutrient–rich foods must not always have been high enough to offset the decline from cereals" consumption that has followed the green revolution. Finally, 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 2009).

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 was associated with cotton supported by development companies though the distribution of maize seeds, promotion of cereal crop standards, 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 can 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 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 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, changes in lifestyle, higher living standards, etc.) (Beltaifa et al. 2002), but it seems necessary to raise the question of their relevance for public health.

The three previous pathways are dealing with the left and upper part of Figure 1, i e the production/ income/price sides of the figure, both at household, market and macro-economic levels. Hence, one has to look at infra household level, at socio-cultural framing, at the health environment and finally at the specific effect of inequalities.

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 carries risks for nutrition. Few references enable to gauge the size of those risks, but the fact that they are reported many times indicates that a 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 production 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 previously in charge of, while remaining responsible for children and food, carried risks for family nutrition. In East 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 mainly managed more by men does not systematically mean that the decision-making power of women is reduced. The introduction of irrigated rice production 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 (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 needed for sowing, weeding, crop thinning and harvesting, largely provided by women (Girard and Dugué 2009).

However, very obviously female labour 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 agricultural, other productive and care activities. When women have little control over the income of a farm, care has to be taken to guarantee 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, biodiversity) term 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 (Khlangwiset 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 crop mature, amplified by drought and heat, then after 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% in 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 (Thima 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, 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, Ferguson, and Khaila 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 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, with economic growth and development (Dorward, 2013). No recommendation can be made in absolute terms. Nevertheless, a few precautionary principles can be applied: (i) identify and keep track of nutritional risks at the adi design stage and 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 gaps. 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 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 (see Wiggins and Keats, 2013), the double malnutrition burden (excess weight and undernutrition), the lengthening of the supply chains (see Hawkes and Ruel, 2012), 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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