Original Study

The Sikasso paradox: why does higher production fail to feed farmers' children?

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Foreword

This paper was originally published in 2012 in French (Doi: 10.1684/agr.2012.0584). As many scholars asked the authors if an English version was available, the editors of Cahiers Agricultures agreed to publish in 2021 a translation of the original paper. Nine years later, Mali has certainly changed, but the core of the ideas presented here – the relative disconnection between level of agricultural output and chronic undernutrition of children, the lack of time of women engaged in agricultural production, the low dietary diversity of rural dwellers in southern Mali – may not have changed very much. Results of other studies (such as Lourme Ruiz et al, 2016 [Doi: 10.1051/cagri/2016038] & 2021 [Doi: 10.1007/s12571-020-01137-5] among others) in nearby and similar regions of cotton-maize production in Western Burkina Faso tend to confirm that this one is still relevant and worth translating. The 2012 version is presented here without changes or additions. It has been translated in the most respectful way by Anya Cockle, an independent professional translator who is thanked for her efficiency by the authors.

Résumé

Réduire la pauvreté et améliorer la production alimentaire sont des recommandations usuelles pour améliorer la sécurité alimentaire et nutritionnelle. Mais les relations entre pauvreté, production agricole et sécurité alimentaire sont complexes et peu explicitées. La région de Sikasso au Mali illustre une situation paradoxale où la production agricole importante est concomitante à une malnutrition infantile étendue. La comparaison de cette région aux autres régions maliennes permet de cerner les déterminants spécifiques des mauvais indicateurs nutritionnels observés chez les enfants. Leur retard de croissance, qui est plus important dans cette région, est lié à une alimentation moins diversifiée et probablement à un manque de soins, conséquence d'une surcharge de travail agricole.

Mots clés : Sous-alimentation ; pauvreté ; agriculture ; sécurité alimentaire des ménages ; soins de santé.

Abstract

Reducing poverty and increasing food production are usual recommendations for improving food and nutrition security. However, the linkages between poverty, agricultural production and food security are complex and still poorly understood. The Sikasso region in Mali exemplifies a paradoxical situation where high agricultural production is concomitant with widespread child malnutrition. Comparing this region with other Malian regions helps to circumscribe the specific determinants of poor child nutrition indicators. Child stunting, which is higher in the region, is linked to low dietary diversity and probably to a lack of childcare resulting from extensive working hours in the fields.

Keywords: Undernutrition; poverty; agriculture; household food security; health care.

Introduction

Agriculture, health and nutrition impact each other. Agriculture has an effect on the health and nutrition of the members of the agricultural production unit *via* the foodstuffs produced, their quantity, diversity, accessibility, safety, and nutritional composition when the farming households largely feed themselves on their own produce. It also affects access to edible goods when the farm produce is sold. The level of income derived from selling produce and its distribution among the members of the household determine the quality of the diet of household members. Agriculture also affects health and nutrition *via* its effects on the environment and on the type of labour involved. On the other hand, health and nutrition have an effect on agriculture by affecting the working capacity (the reproduction of labour power according to Marxist terminology) of the more or less well-nourished labourers. Haddad (2000) and more recently Hawkes & Ruel (2006) describe these relationships between agriculture and health/nutrition in setting up agricultural and health policies, and call for taking them better into account. Recently, several authors (Deaton & Drèze, 2009; Gillespie & Kadiyala, 2012) reflected upon the unexpected economic growth results of the last two decades in particular concerning the Indian case: even though agricultural production has been rising and poverty decreasing, the prevalence of malnutrition has remained surprisingly high.

The region of Sikasso in the south of Mali exemplifies how difficult it can be to identify a simple relationship between agricultural production and food and nutrition security. The region is an area of high agricultural production but it nonetheless exhibits a regular and very high prevalence of child malnutrition (Tefft *et al.*, 2000) (CPS/MS and DNSI/MEIC, 2002, 2007).

How can it be that an agricultural region deemed to be the most prosperous of the country can at the same time be the national champion in child malnutrition rates? This issue has been probed several times from different angles. The earliest investigation we found concerned the 'agriculture / child malnutrition' paradox and were undertaken by nutritionists (Bouvier *et al.,* 1995). Another team, comprising both nutritionists and agricultural economists, also examined the problem (Tefft *et al.,* 2000; Tefft & Kelly, 2003). The first authors focused on the relationships between child malnutrition and the socio-economic characteristics of 491 households in the Sikasso region. They showed that wasting was weakly correlated with socio-economic determinants, and stunting more strongly so. In particular, the socio-professional category (associated with farming activity), level of education of the parents (in particular of the father), fewer assets, low family income, and poor access to water and electricity were positively associated with stunted growth in children. The study did not compare Sikasso with the other regions.

The other research team compared the rice-producing region of Mali (Segou region), an area of dry cereal production (sorghum and pearl millet, Mopti region) and an area of rainfed cotton production (Sikasso region). Results underlined the role of the parents' education level and income (in particular of the mother above a certain threshold) on stunting. They also pointed to the specific role of the organisation of the family household. The authors identified one particular trait of the Sikasso region not found elsewhere: fathers of young children spend much less than older men of the

family. Production units are larger and not headed by fathers of young children, who have less control over production means and income than in other regions. The authors insisted on this concentration of the agricultural income and on the problem deriving from this situation: farm heads spend in priority to cover production costs, taxes, maintenance of dwellings, and social festivities, and not the health and nutrition of the young children of dependent family units.

The data collected by surveying the households of the region thus revealed a link between the level of education of the parents, their standard of living, their type of activity, and the children's stunting. The particular structure of the households (their very large size) and the lack of rights of the parents of young children therein seemed to explain the specificity of the region.

Mesplé-Somps et al. (2008) and Delarue et al. (2009) focused on another aspect of the paradox: the relative poverty of cotton growers compared with other farmers. They analysed the national statistics derived from the Malian national poverty evaluation survey (Enquête Malienne d'Evaluation de la Pauvreté EMEP 2001) carried out in 2001. Although their calculated poverty line somewhat abated the level of poverty, their results – less negative than the official statistics (see below the paragraph on child stunting) – did not totally contradict the existence of a paradox: the region of Sikasso in 2001 "is among the three poorest regions of Mali" and "the absence of conclusive proof of a significantly greater well-being associated with agricultural production in the cotton-growing zone is still a kind of paradox". In the end, they concluded that the causes of this situation had not been analysed and would be worth investigating.

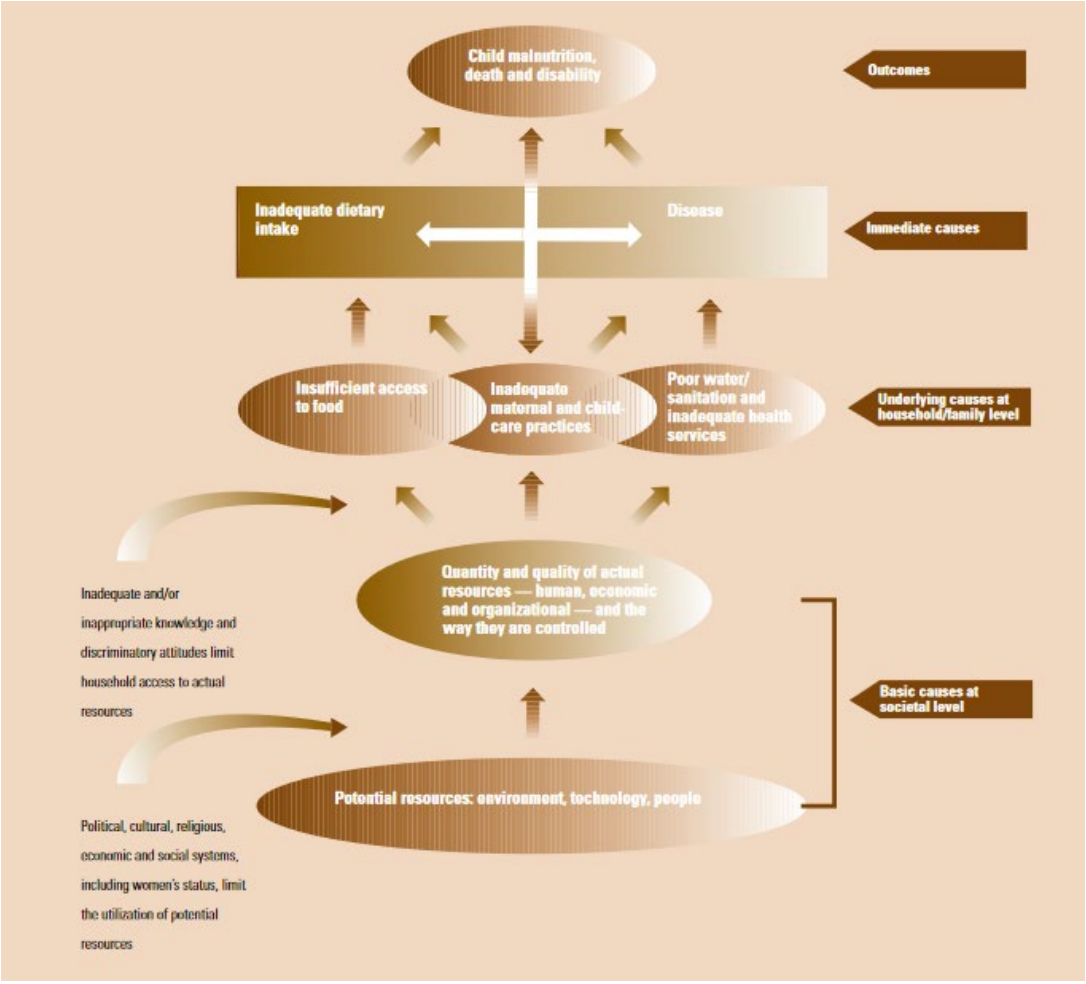

Figure 1. Causes of child malnutrition (Unicef, 1998).

A recent report by the International Monetary Fund (IMF, 2011) again confirmed the double paradox of 1) high agricultural production and high poverty and 2) high agricultural production and malnutrition, and suggested it is linked to "the cultural habit of hoarding" with no further justification. According to the authors of this report, in this region households prefer to put money aside and/or buy durable goods and/or invest in productive activities rather than spend their income on food.

In fine, we have an idea of the relationships between different variables, but we do not know precisely the causal relationships that are at work. Moreover, we know little of the specific role of diet (compared with that of health) in explaining the high rates of malnutrition. Similarly, the link – paradoxical in this case – between agricultural production and child nutrition remains unclear.

The aim of this paper is to organise conceptually and evaluate the different possible explanatory causes of this paradox. For this, we will base ourselves on the conceptual framework of the causes of child malnutrition (Figure 1), which distinguishes three levels of causes: immediate causes (disease and inadequate dietary intake), underlying causes at the household or family level (insufficient access to food, inadequate maternal and childcare practices, and inadequate water/sanitation and health services) and basic causes at societal level (quantity and quality of actual resources and the way they are controlled, and potential resources). For each level, we will use statistical indicators from our own analyses of the EMEP 2001 survey data or from other national surveys produced by the central statistics services or other specialised services (agriculture, health, livestock farming). We will carry out a comparative analysis of the different regions and identify gaps in the information. In the first part, we will note that the paradox is confirmed, and in the three following sections we will strive to unravel its immediate, underlying and basic causes.

Methods and data used

Selection of indicators

The indicators of the causes of malnutrition were analysed for each administrative region and compared with the situation in the Sikasso region. Data of two types were used: national statistics from reports and/or websites of the Malian statistics services, and the EMEP 2001 survey data. This survey is more than a decade old, but it is representative at the national and regional levels and uses a recognised methodology to identify consumption items and evaluate their corresponding budgets; besides, its data were validated and analysed as part of a PhD dissertation (Bocoum, 2011). The anthropometric data were extracted from the 2006 WFP/UNICEF survey, and from population and health surveys carried out in 2001 (CPS/MS and DNSI/MEIC, 2002) and 2006 (CPS/MS and DNSI/MEIC, 2007). Agriculture data were obtained from the 2000 statistical yearbook (DNSI/MPAT, 2001). We also used the results of the surveys conducted as part of the 2004 general agriculture census (*Recensement Général de l'Agriculture*) and those concerning agricultural production from other years (production data from a single year are never representative because the productivity of rainfed crops depends on climatic conditions).

The paradox concerns the rural population. In national reports, the only available figures are means per region (rural and urban areas pooled). In our calculations based on the EMEP 2001 data, we used the data concerning 3,121 rural households representative of the rural Malian population.

Indicators were selected on the basis of the data available, a review of the literature on the topic, and our interpretation of the UNICEF causal model (Figure 1).

The consequences of malnutrition on the anthropometric development of children are assessed by several standardised indicators, in particular child wasting and stunting. Wasting is measured using the weight-for-height index and is a symptom of current undernutrition. Stunting is measured using the height-for-age index and reflects nutritional history (WHO, 1995). In brief, wasting indicates acute temporary undernutrition

such as seen during an illness period or during the lean season, whereas stunting reflects chronic undernutrition due to recurring periods of food scarcity or disease. These indices are compared with the distribution observed in a 'reference' population of well-nourished and healthy children, who experience "unconstrained growth". The approach is of a normative type: when the anthropometric index of a child is below the mean of the reference population, if it departs from it by more than twice the standard deviation of the reference population then the child is said to be 'moderately' undernourished; if it departs from it by more than three times the standard deviation, then the child's undernutrition is considered 'severe'.

Regarding the immediate causes of child malnutrition, we retained three indicators of food intake (Table 1) - including two reflecting food intake quality - and one indicator of disease (Table 2), all derived from our analyses of the EMEP 2001 data. The first indicator is highly synthetic: it is the calorie intake, calculated by weighing the food items consumed at home and estimating the intake outside the home over a total of 4 weeks distributed over the year (Bocoum *et al.*, 2012). We also estimated the dietary diversity score, which reflects the quality of the diet. It corresponds to the number of food groups represented in the diet consumed by the households. These groups are those proposed by Kennedy *et al.* (2011): (1) cereals, (2) potato, cassava and other roots and tubers, plantain, (3) vegetables and fresh leaves, (4) fruits, (5) meat, (6) eggs, (7) fish, (8) legumes, nuts and seeds, (9) milk and milk products, (10) oils and fats, (11) sweets, (12) condiments, tea, coffee, spices. The proportion of cereals in the calorie intake is also recorded (another indicator of diet diversity). Regarding the disease factor in the cause-effect model, we extracted the number of sick people in each household.

As regards the underlying causes, we distinguished the factors of insufficient access to food, care factors and health and sanitation factors. For food access factors, given the high rate of on-farm consumption (see Table 3), we used production factors (poverty will be considered when examining basic causes): production of meat, oil and protein seed crops (peanut, cowpea), fruits and vegetables. Care factors were assessed, for want of better indicators, by the percentage of men and women at work, women's involvement in agricultural, fishing and animal husbandry activities, and the percentage of children in households (Table 4). A single indicator, access to safe drinking water, represented the state of water and sanitation services (Table 5).

Basic causes were classified into three subcategories: the 'human' capital, the economic capital (income and possessions), and social capital.

The human capital reflects part of the capacity to integrate dietary recommendations in dietary and health and sanitary practices. It depends on formal education as well as specific training, but the only information available to us was the level of education of adults (Table 6).

The economic capital reflects economic wealth or poverty: income (here estimated through the sum total of the everyday expenditures of households) and possessions (including productive assets in the case of independent farming households, and savings). Household expenditure – an estimate of household income – is a first indicator of the average level of income. It was calculated in real value and then deflated according to prices (with Bamako as reference) (Table 7). The total expenditures we used in our calculations on the EMEP 2001 data take into account the expenses actually incurred as well as the quantity of food grown and consumed on the farm. These quantities were translated into values on the basis of unit values (expenditures-to-quantities) of the food items purchased. We used median unit values for each region. These unit values are fairly close to the available actual prices (Bocoum, 2011). Expenditures incurred to acquire long-term assets were excluded for lack of information allowing us to adequately take into account the duration of these assets' useful life.

The poverty line was estimated from household expenditures using the method of the cost of basic needs. The poverty line corresponds to the level of expenditures under which the individuals making up the household are considered to be living in poverty. The methods used for calculating poverty lines are in themselves the focus of a specialised

body of literature and will not be treated here[1]. The prevalence of poverty, a second indicator of poverty, corresponds to the percentage of people who live in a household whose expenditures per capita lie below the poverty line.

The possessions (Table 8) of individuals and households is difficult to estimate because surveys concerning this particular aspect are both few and unreliable. We used the 2004 general agriculture census to work out the surface area cultivated per person as well as the mean number of heads of livestock owned. We were also able to extract from the EMEP 2001 data about the farming equipment, which partly reflects the wealth of farming households.

Social capital was estimated by the way 'food solidarity' took place. The EMEP survey makes it possible to count the number of food dishes sent to other households or received, as well as the number of people invited in to eat with household members (Table 9). Expressed in number of portions per person, we believe that this indicator partly reflects the social network of households.

Quality and reliability of the data

The issue of the reliability of statistical data is frequently raised. Public statistics services in Mali (Ministries and specialised services regarding health, agriculture, territorial development and finance) have little technical and financial resources at their disposal, in particular since the structural adjustment period. There has been a general decrease in the quality of reports since the 1990s, both in contents and presentation. Moreover, with statistics becoming an issue for the legitimisation of international institutions, a proliferation of figures and statistical surveys can be observed (Dury & Fouilleux, 2011). The positive outcome of this situation for the poverty and health sectors in particular is that the methodologies used to collect the data are discussed and validated at the international level and are based on standardised survey methods. Those involved are in particular the World Bank (which financed and technically supported the EMEP 2001 survey), WHO and UNICEF.

As regards the farming sector, there is in Mali a long history of thorough data collection in the regions producing cotton and rice, linked to the presence of State companies or agencies (*Compagnie Malienne du Développement des Textiles* and *Office du Niger*). Such data mainly concern cotton and rice. Moreover, since the 1970s, agricultural statisticians have also recorded cereal production with a view to prevent and manage food crises. Figures concerning cotton, rice and cereals are regularly published. Like all figures, they are not indisputable, but since they are the object of discussions between national and international actors of food and agricultural security, they are in effect validated. The trends observed, at least in the case of cereals, are consistent with what is seen in other countries (Udher *et al.*, 2011). Given these institutional discussions and comparisons with nearby countries, we believe that these statistical figures are sufficiently reliable for our level of analysis. As regards other agricultural and animal productions, on the other hand, the statistics are more patchy, have been less used and less discussed, and appear much less reliable.

In brief, all the data presented here (with the exception of non-cereal agricultural production and animal production data) are fairly in line with known data from Western Africa and allow comparisons of means between different regions and an analysis of the results.

Results

The enduring paradox

Cereal production is high in the Sikasso region

Cereal production is higher in the Sikasso region than in most other regions of Mali. It reached 441 kg per capita over the year 2000 (Table 2) and 489 kg/person/year in 2008. At the national level, cereal production was of 266 and 324 kg/person/year respectively in the same two years.

[1] For additional information on the different methods used to calculate the poverty line in this particular Malian case and on other more international references, see Bocoum *et al.* (2012) and Mesplé-Somps *et al.* (2008).

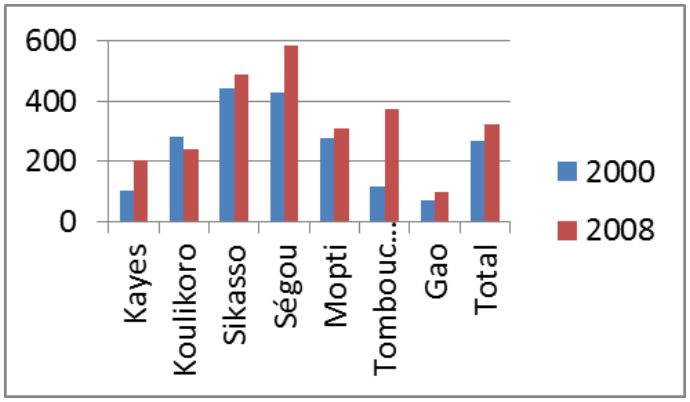

Figure 2. Mean cereal production per region(kg/person/year).
Source**:** DNSI/MPAT (2001) and INS/MEF (2010)

Stunting is widespread among children

In the three most recent national surveys (carried out in 2001, 2005 and 2006), the region of Sikasso stands out with a particularly high and stable prevalence of stunting among children below 5 years of age. According to the data obtained by the Demography and Health Survey of Mali (*Enquête Démographique et de Santé du Mali* EDSM-IV 2006; CPS/MS *et al.,* 2007), 45.2% of the children of the Sikasso region were suffering from stunted growth in 2006. This figure had reached 47.5% in 2001 (CPS/MS *et al.*, 2002). Data from surveys carried out by UNICEF and WFP in 2005 in rural areas reveal an incidence of 46% in the Sikasso region, the highest rate in the country (Figure 3). Severe stunting is also present, but without equalling the highest national rate.

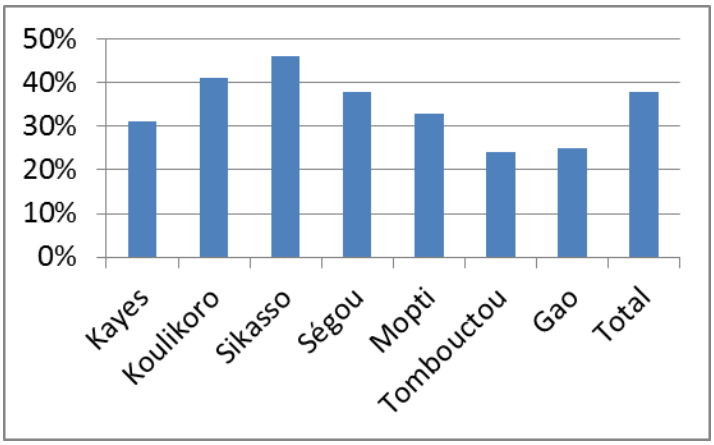

Figure 3. Stunting in children 6-59 months oldin December 2005.
Source: WFP/UNICEF, 2006 (survey in rural areas)

On the other hand, according to the same sources, the prevalence of child wasting is fairly similar in the Sikasso region and in other regions of the country. In rural areas in 2005 (WFP/UNICEF, 2006), the general rate of child wasting reached 11%, both country-wide and in the region.

The rate of child malnutrition as assessed through the prevalence of stunting is thus at the same time very high (almost half the children are concerned) and higher than in the other regions, whereas the prevalence of child wasting is not particularly different in the Sikasso region. These anthropometric results show that the children of the region are *structurally* confronted with nutritional problems, and more often so than the children of other regions, while the short-term problems experienced are of the same magnitude as elsewhere.

The immediate causes: inadequate food intake rather than poor health

Table 1. Food intake indicators.

	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
Calorie intake (kcal/pers/day)	2145	1971	2071	2534***	2613***	2339*	1691***	2245
Dietary Diversity Score	6.8***	6.1	5.9	7.7***	6.2	7.3***	6.3*	6.6
Percentage of calorie intake of cereals	76%	86%	89%	86%	88%	84%	88%	85%

One-tailed comparison of means test in relation to Sikasso (mean greater or lower than that of Sikasso): *p<0.05, **p<0.01, *** p<0.001
Source: EMEP 2001 (2001), our calculations on rural household data.

The immediate causes involved can be an inadequate food intake and/or disease. Table 1 shows that the indicators of food intake are among the worst when compared with other regions. Mean calorie intake was 2071 kcal/day/person in the Sikasso region in 2001 whereas it was 2245 kcal/day/person for the country as a whole over the same period. In rural areas, mean calorie intake in Sikasso was significantly lower than the Ségou, Mopti and Tombouctou means. The dietary diversity score is significantly lower than in most other regions (except Koulikoro and Mopti). Households of the Sikasso region consumed 5.9 food groups out of 12, whereas this score was 6.6 at the national level. The percentage of calorie intake of cereals is very high (89%) - in line with the food intake uniformity suggested by the analysis of the dietary diversity scores.

Table 2. Disease.

	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
Sickness rate in households (%)	16**	12	13	13	16*	25***	28***	15

See Table 1, test of comparison of means with Sikasso *p<0.05, **p<0.01, *** p<0.001
Source: EMEP 2001 (2001) our calculations on rural household data.

The sickness rate in Bamako is equivalent to that in Ségou and Koulikoro and is among the lowest in the country. Analysis of the EMEP 2001 data showed that in the Sikasso region 13% of the members of rural households on average had been sick in the course of the month prior to the visit of the surveyors, *versus* 16% in Mopti and 25% in Tombouctou.

The main immediate cause seems therefore to be sought for in the children's diet, its poor calorie content and its lack of diversity. Variables are given per household and expressed as mean per person, and we could find no indication in the data as to how food is distributed within households. However, since the mean figures are lower than elsewhere in the country, if we assume that children are not exceptionally favoured in the household food distribution there is no reason to suspect that the actual food intake of children is not lower in Sikasso than elsewhere.

The underlying causes

Three possible underlying causes are to be investigated (Figure 1). Are the inadequate quantity and quality of the diet due to insufficient access to food and/or to inadequate childcare practices? Is the environment satisfactory in terms of water/sanitation facilities and health services?

Table 3. Indicators of access to certain food items (on-farm consumption and production).

		Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
On-farm consumption rate of rural household in % of food expenditures (1)	Mean	54	64	83	60	65	27	26	61
	Standard deviation	33	33	19	29	29	23	15	32
Slaughtered cattle and goats (kg/person/year) (2)		4.0	2.6	4.3	2.0	2.0	2.1	2.2	5.0
Peanut production (kg/person/year) (3)		63	31	27	18	10			24
Cowpea production (kg/person/year) (4)		5	10	4	10	8			6
Area planted with fruit trees (m²/person) (5)		19	33	199	16	4			45
Vegetable production (kg/person/year) (6)		10	37	14	170	53	15	14	49

Sources: (1) EMEP 2001 (2001), our calculations on rural household data. (2) http://www.maliagriculture.org/camp_agr/p_animale/pro_viande.html production forecast for the 2005/2006 season. (3) Ministry for Agriculture. Website consulted on 15 February 2012. http://www.maliagriculture.org/camp_agr/. (4) INS/MEF 2010 Annuaire statistique du Mali 2008 ; (5) http://www.maliagriculture.org/camp_agr/cult_fruit.html.(6)http://www.maliagriculture.org/camp_agr/cult_marai.html

Access to food: a lack of diversity in food production

Production is not always a 'good' indicator of access to food, but since on-farm consumption is high (between 50% and 80% in rural areas depending on the regions; see Table 3), we consider that it gives an idea of the food intake potential. Given that part of this production is sold, another part is kept for sowing the following season, and a third is lost, and moreover that distribution between and within households is not uniform, this variable represents the upper limit of food intake by rural households.

Peanut is one of the basic components of the diet and an important source of lipids. Its production in 2004-2005 averaged roughly 30 kg/person in the Sikasso region. On the basis of the production data for 2008 (not presented, INS/MEF, 2010), we calculated that a mean of 38 kg of peanuts were consumed per person and per year. This is greater than what is consumed in the northern regions (Gao, Kidal and Tombouctou) and similar to the figure found for the adjacent region of Koulikoro, but only half of the figure for the Kayes region. As regards cowpea, a source of plant protein, the mean production per inhabitant in the Sikasso region is fairly low at roughly 4 kg/person/year, similar to the drier regions of Kayes and Mopti (5 and 8 kg/person/year, respectively) and lower than in the neighbouring regions of Ségou and Koulikoro (10 kg/person/year).

Regarding vegetables and fruits, source of vitamins and micronutrients, results are contrasted: Sikasso is by far the region with the greatest surface area of fruit trees, but is below practically all the other regions in vegetable production. This is coherent with the fact that the region is poorly equipped for irrigation and that its main cash crop is cotton.

Animal production can only be assessed through two rough indicators: numbers slaughtered and numbers owned. According to the first, Sikasso is

ahead of the other regions, Bamako excepted, but it is difficult to ascertain whether this result reflects a different way of collecting the data or actually a higher production. The figure remains very low nonetheless (4.3 kg/person/year).

Agricultural production in the Sikasso region as compared to the other regions of Mali is not as exceptional as conveyed by the first impression once the number of inhabitants is taken into account. It is actually fairly close to the average in animal production and most plant productions considered (peanuts, cowpea). There are two notable exceptions to this: the cereal production (which is also among the most closely monitored food crops) and the area planted with fruit trees (but no actual production data could be found). On the other hand, vegetable production seems very low in Sikasso, but one must bear in mind that cultivation is well developed in the low-lying swampy areas of this region (Amadhi & Teme, 1998) and that the figures available concerning this particular activity are both rare and unreliable. Production in these areas does take place (in particular potato), but is mostly sold and not included in the diet of the region's households. Overall, due to the questionable quality of the data, this section concerning non-cereal production is the least robust; this underlines the lack of reliable information.

Not enough time for childcare?

We could find little information to assess the quality of childcare practices. However, the EDSM-IV survey (CPS/MS *et al.,* 2007) does provide statistics concerning women's occupational activities. The activity rate of women in Sikasso and Kayes (where 80% of women work) is higher than in all the other regions (the national rate is 61%). Similarly, the men's activity rate is higher in the Sikasso region (67%) but not much than elsewhere and is close to the countrywide mean (64%).

Table 4. Indicators of childcare practices.

	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
% of working women (2)	84	67	80	55	43	38	18	61
% of working men (2)	57	55	67	60	67	78	66	64
Mean adult activity rate (%)	70	61	74	58	55	58	42	62
% of active women active in agriculture, livestock husbandry and/or fishing (2)	48	62	70	39	23	2	4	48
% of children under 15 in the household (1)	44*	47	47	44**	43**	43**	46	45
% of children under 5 in the household (1)	15*	16	17	16	16	18	18	16

See Table 1, test for the comparison of means with the mean of Sikasso, *p<0.05, **p<0.01, *** p<0.001
Sources: (1) EMEP 2001 (2001), our calculations on rural household data. (2) EDSM-IV, 2006 (CPS/MS *et al.*, 2007)

The number of children in the household divided by the total number of people in the household can also give an idea of the childcare load per adult and the care each child can be given (in time). The proportion of children under 15 is significantly greater in Sikasso than in most other regions (47% in Sikasso, 43% in Mopti for example), but the proportion of children under 5 is not significantly different from that elsewhere (17% in the Bamako region). This being said, it has been shown that young children looked after by preadolescents often have a poorer nutritional status than young children looked after by adults (Ukwuani & Suchindran, 2003).

Water/sanitation facilities and health services

This section is underdeveloped because disease is not the greatest, regionally distinctive, immediate cause. A single indicator is taken into account here: 73% of rural households have access to safe drinking water in the Sikasso region. Only in the Ségou region is access to safe drinking water more widespread (Table 5). It may be surprising that a broader access to safe water does not come hand in hand with better performances in terms of nutrition (in particular wasting), but we have no additional element available to push our analysis further on this particular point.

Table 5. Rural households with access to safe drinking water.

	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Overall
Mean	0.68*	0.60***	0.73	0.78*	0.51***	0.67*	0.35***	0.66
Standard deviation	0.47	0.49	0.45	0.41	0.50	0.47	0.48	0.47

% of households with access to safe drinking water.
Source: EMEP 2001 (2001), our calculations on rural household data.

Basic causes

Level of education

The educational attainment of adult women in the Sikasso region is very low but somewhat higher than elsewhere in Mali. The mean duration of school attendance for the woman with the greatest educational achievement in each household is 1.3 years, *versus* less than a year countrywide. Similarly, the level of education of household members in general is greater in Sikasso: 16% of household members have attended school *versus* 13% in Mali as a whole (Table 6).

Table 6. Level of education.

		Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
% who have attended school									
	Mean	13**	15	16	12***	7***	16	12	13
	Standard deviation	17	18	18	17	12	20	16	18
Years of school attendance for the woman with the greatest educational attainment in the household	Mean	0,6***	1,2	1,3	0,9**	0,6***	0,9*	0,4**	0,1
	Standard deviation	1,5	2,2	2,2	2,1	1,6	2,0	1,2	2,0

One-tailed test for the comparison of means with the mean of Sikasso, *p<0.05, **p<0.01, *** p<0.001
Source: EMEP 2001 (2001). Our calculations.

Poverty

Expenditures were particularly low in the Sikasso region in 2001 (Table 7). Expressed in real value, they amounted to 68,424 CFA Francs per person for the year. In constant Francs deflated according to prices, the differences between regions remain mostly unchanged: Gao is the region with the lowest expenditure, and Sikasso the second-lowest.

Table 7. Household expenditures: an indicator of poverty.

Administrative regions		Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
Total expenditures (current KFcfa /year/person)	mean	92***	83***	68	101***	75**	113**	61	87
	Standard deviation	67	69	38	51	38	62	26	59
Total expenditures (constant KFcfa with Bamako as reference /year/person)	mean	120***	98	93	139***	113***	141***	80*	114
	Standard deviation	88	81	52	70	57	78	34	75

One-tailed test for the comparison of means with the mean of Sikasso, *p<0.05, **p<0.01, *** p<0.001
Source: EMEP 2001 (2001). Our calculations.

These results are confirmed by other authors, and the incidence of poverty as measured per capita was always highest in the Sikasso region (with one exception), whatever the method used for the estimation and whatever the year considered (2001, 2006 and 2010) (Figure 4). In Sikasso, depending on the method of calculation and the year, the number of people living below the poverty threshold varied between 52% and 84% of the population, whereas at the national level this rate ranged between 44% and 56%.

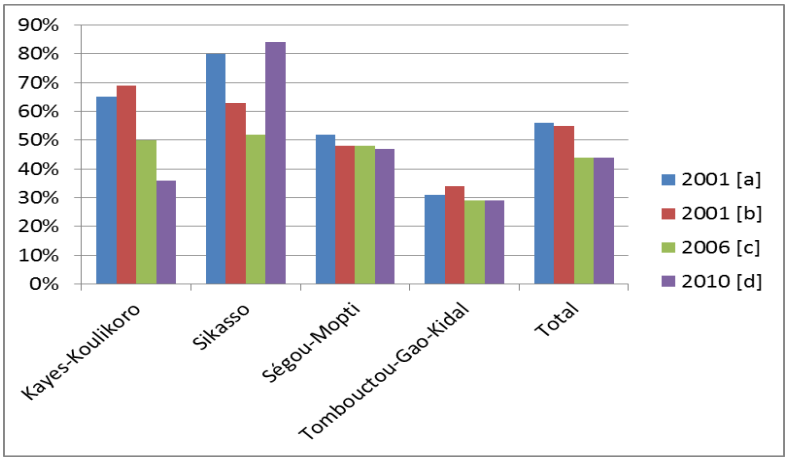

Figure 4. Incidence (in %) of poverty (as measured by expenditures).
Sources: a, b and c: Mesplé-Somps *et al.* (2008) from different sources and using different methods of calculation; d : IMF, 2011.

The physical capital of households is among the highest of the country, both in access to farmland (the surface area cultivated per person is among the greatest) and in farming equipment (Table 8). We had initially thought that the number of heads of livestock was high, but data from the agricultural census (Table 8) show that the farming households of the region own less animals on average than most farms elsewhere. In the Sikasso region, farming households have more draught bovines than elsewhere (data not presented) but fewer of other types of animal. The marked presence of draught animals, the farming equipment, and the long hours devoted to farm work together explain the larger tracts of land cultivated and the high productivity of the region.

Table 8. Number of animals on farms (mean number per person).

Administrative regions	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Kidal	Bamako	Total
Farm equipment index (1) (mean and *standard deviation*)	0.6*** *0.5*	0.7*** *0.5*	0.9 *0.8*	0.7*** *0.6*	0.6*** *0.5*	0.1*** *0.6*	0.1*** *0.6*	0	0	0.7*** *0.6*
Surface area cultivated (ha/person)	0.21	0.39	0.50	0.58	0.42	0.12	0.13	0.43	0.06	0.37
Cattle (number/person)	0.6	0.6	0.7	0.6	1.2	0.9	1.1	0.3	0.2	0.8
Sheep (number/person)	0.7	0.4	0.4	0.5	0.8	1.2	2.8	5.4	0.2	0.8
Goats (number/person)	0.5	0.5	0.4	0.6	1.0	1.7	3.0	5.6	0.1	0.9

The EMEP data concern rural households, and the RGA data households with farming activities.
Weighted sums with respective coefficients of 4, 3, 2 and 1 for a tractor, a petrol water pump, a petrol tiller and an animal-drawn plough.
Sources: (1) EMEP 2001 and RGA 2004 (CPS/DNA/MINAGRI, 2008 p. 25 and pp. 61-64). Our calculations.

The data extracted from the poverty surveys as well as the livestock data thus show that the inhabitants of the Sikasso region, in particular in rural communities, are comparatively poorer than inhabitants of the other regions – even though the farms tend to be better equipped than elsewhere and the mean acreage of cultivated land greater. These results confirm the persistence of the 'poverty despite high agricultural productivity' paradox.

The social capital

On average, households gave away 0.02 ration per person and per day (approximately 7 rations per person and per year) to outside people and received half of that from other households. The standard deviations are very large and the analysis shows that the behaviour is not significantly different from other regions of Mali, except the northernmost regions (Tombouctou and Gao), where this practice of exchanging prepared dishes seems more widespread (Table 9).

Regarding the number of people invited to share meals, Sikasso and Koulikoro are the regions where this is least practised. Relationships between households, at least as expressed by this indicator, thus seem less manifest in Sikasso than elsewhere in the country.

Table 9. Indicators of social capital.

Administrative regions		Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
Mean number of rations given away per week	mean	0.02	0.02*	0.02	0.03	0.02	0.13***	0.08***	0.03
	Standard deviation	0.13	0.06	0.07	0.13	0.05	0.23	0.14	0.12
Mean number of rations received each week	mean	0.04	0.01	0.02	0.03	0.02	0.08***	0.09***	0.03
	Standard deviation	0.34	0.06	0.12	0.09	0.09	0.16	0.17	0.03
Number of people invited for a meal	mean	0.14***	0.11	0.09	0.19***	0.13**	0.31***	0.12*	0.03
	Standard deviation	0.27	0.24	0.14	0.42	0.28	0.48	0.17	0.03

The mean number of dishes given away and received are expressed in daily rations per person. One-tailed test for the comparison of means with the mean in Sikasso, *p<0.05, **p<0.01, *** p<0.001
Source: EMEP 2001 (2001). Our calculations.

Discussion

Since the data are pooled by large administrative regions, they are masking disparities in terms of cropping systems, feeding systems and resource distribution, and it is difficult to arrive at a simple and definitive conclusion regarding the causes of the malnutrition that affects individual people. The analysis of the data using the selected conceptual framework of Figure 1 makes it nonetheless possible to organise the data, extract from them some general synthetic characteristics, clarify previous studies on the subject and propose a few new hypotheses.

In the Sikasso region, the production of food crops is abundant (in particular cereals) and the relative wealth of households is greater on average in farmland and farming equipment, as well as in human capital since their members have a higher educational level. Moreover, the region is better equipped in healthcare infrastructures, safe water supply and roads (data not presented here) than the other regions of Mali. However, the mean expenditure of households is lower than elsewhere and the incidence of poverty measured on the basis of expenditures is particularly high. This could be related to the fact that the method used for the survey specifies neither the amounts spent on durable goods, nor exceptional expenses. In addition, the "cultural habit of hoarding", as suggested by IMF (2011), may be particularly marked. It is possible that incomes are greater than elsewhere and at the same time expenditures lower, with more being set aside, but we lack information on this point. If such is the case, then the paradox could be reformulated: households are not particularly poor but prefer to save, invest in capital goods or durable goods (such as a house), or spend on one-off expenditures (such as for social or school needs) rather than spend the money on everyday needs such as food and clothes. These hypotheses could be in line with the findings of Banerjee & Duflo (2007), who explained that food is not always the priority of households, including when very poor and suffering from undernutrition.

Another aspect is that the diet is very monotonous, and this could potentially explain the growth retardation of children. A relationship can often be drawn between the dietary diversity score and the nutritional status of children (Arimond & Ruel, 2004).

Even if the farms are more productive than those in other regions due to more favourable climatic conditions and to a greater penetration of farming equipment, the benefit of this production for children's nutrition is limited because the income generated by the sale of crop surpluses, cotton and other cash crops is captured by the household heads (Tefft *et al.*, 2000, 2003) and is little used to cover everyday needs and food expenditures in particular.

In the Sikasso region, a greater proportion of adults - both women and men – is active, in particular in the farming sector, than in other regions of Mali. This would be a potential cause for a lack of time available for childcare, and a possible explanation for the high prevalence of stunted growth among children. It would fit in with the observations of Parent *et al.* (2002) in particular, in the irrigated areas of Burkina Faso, where the children of women engaged in horticulture or working longer hours tended to more often display nutritional problems. This hypothesis would be worth researching in greater depth and detail. As shown by Ukwuani & Suchindran (2003), for example, who analysed the results of the 1990 national Nigerian demographic and health survey, female labour has a different impact, depending on whether the women earn cash or not, on whether they take their children with them or not, and on the age of the children.

These fairly negative results concerning the linkage between agricultural production and nutrition may disappoint those who have striven for the agricultural development of the Sikasso region, but it must be underlined that the links between nutrition and the increase in agricultural production are extremely complex and not immediate. Recently, Masset *et al.* (2012) listed hundreds of interventions carried out in agriculture with the explicit objective to improve nutrition. Results are poor: very few interventions have had a direct and measurable impact on nutrition. Scientific studies empirically based on the relationship between the nature and volume of the production on the one hand, and, on the other hand, effects on the health and nutrition of farming households, are few and far between. The analysis of data from the 1980s in Rwanda by Muller (2009) is one of these, showing the effect of different crops on the nutrition and health of farmers. In 2011, IFPRI organised a conference on the relationships between agriculture and health (Fan & Pandya-Lorch, 2012). Building on a range of illustrations from all over the world, most contributions called for the design of agricultural policies geared to improve health in developing countries and insisted on the current knowledge gaps in both concepts and practical examples, with these being too rare and too scattered to allow conclusions to be drawn that would be both operational and broadly applicable.

Conclusion

This study illustrates the need to look beyond the common beliefs about the relationship between agriculture and food security. Higher farm production in itself is not sufficient to ensure the food security of children in rural households. In the case we are dealing with here, we showed that infrastructures in general and health facilities in particular are of a higher standard in the Sikasso region than in other regions; sickness rate is lower. The immediate causes of the highest child stunting rate of the country are related to an inadequate diet and probably also to a lack of care. The diet is less varied and often lower in energy. Given that the farming systems are more diverse than in most other regions of Mali, we are unable to say whether this monotonous diet is due to dietary habits more focused on cereals than in other regions, to the decisions of household heads who prefer spending on other things than food, investing and/or saving, or to a lack of means and rights for parents of young children in large, complex households. Moreover, working hours in the fields are particularly long in this region and the limited time available for childcare is certainly an additional cause for the poor nutritional performances observed. Our contribution also highlights the lack of statistics concerning agricultural productions other than cereals and the lack of detailed and reliable statistics concerning people's diets. It thus calls for more refined methods for collecting data on malnutrition, food intake and poverty. Although the surveys used here yielded much information, which tend to be underused, the absence of certain key elements regarding within-household distribution of income, expenditures and consumption as well as the labour of parents prevents us from reaching a more detailed explanation for the paradox observed.

Acknowledgments

We are deeply grateful to Jean-François Belières (CIRAD) for forwarding to us his documentation and agricultural data for Mali, Michelle Holdsworth, Yves Martin-Prével and Marie-Claude Dop (all from IRD) for their help concerning dietary aspects, and Francis Delpeuch (IRD) for suggesting to us the possible involvement of female labour in the paradox. The two reviewers engaged by the journal were also

extremely helpful as their careful proof-reading of our manuscript pinpointed to us different aspects that needed clarification.

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Cite this article as: Dury S, Bocoum I, 2012. Le « paradoxe » de Sikasso (Mali) : pourquoi « produire plus » ne suffit-il pas pour bien nourrir les enfants des familles d'agriculteurs ? [The Sikasso paradox: why does higher production fail to feed farmers' children?] Cah Agric 21(5) : 324-36. Doi: 10.1684/agr.2012.0584