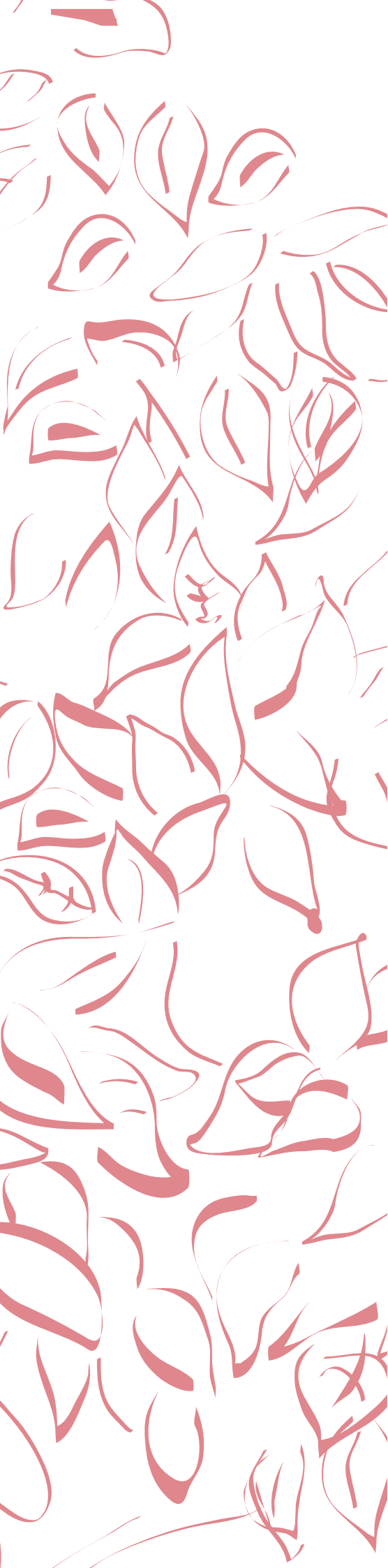


CIRAD's POSITION

Nutrition, a key aspect of food system sustainability



October 2026



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Nutrition, a key aspect of food system sustainability

Introduction

On a global scale, food systems produce low-cost calories, albeit without necessarily guaranteeing adequate nutrition. While certain population groups still face food insecurity and undernutrition, overweight and obesity are gaining pace worldwide and are linked to a rise in non-communicable diseases (NCDs).

Food systems (from agricultural production to processing and from distribution to consumption and nutrition), and the institutional context into which they fit, are also major culprits in terms of exceeding planetary boundaries. They are the main factor in biodiversity erosion, and their fossil fuel consumption makes them a significant source of greenhouse gas emissions, which exacerbate climate change. For several years, the international community has been calling for a transformation in food systems to address these issues. At the same time, it is promoting greater consideration of nutrition aspects (nutrition-sensitive food systems), to guarantee food and nutrition security for all. The nutrition aspect of food systems refers to the range of elements that foster the nutritional quality of diets, and physical and economic access to healthy food.

According to CIRAD, food systems cannot be made sustainable without addressing the nutrition aspect, whether the objectives be environmental, economic, socio-cultural or social justice-related. Its research is therefore aimed at supporting food system transformation to make them levers for public health, capable of supplying quality food while staying within the planet's boundaries. CIRAD is committed to tackling the many challenges linked to malnutrition, by considering the nutrition dimension of food systems and promoting interactions between their sustainability and the One Health approach, in line with the EAT-Lancet Commission's recommendations¹.

With its partners in the global North and South, CIRAD conducts interdisciplinary and contextualised research to combat malnutrition and improve the nutritional quality of foodstuffs and diets. To this end, it calls upon on a broad range of agricultural products (local agro-biodiversity) and foods, and seeks to foster fairer access to a healthy diet. CIRAD recognises the diversity of food systems, of the challenges linked to malnutrition and of the pathways for transforming those systems, depending on context. It targets those population groups that are most vulnerable from a nutritional and socioeconomic point of view: smallholder farmers in tropical and Mediterranean countries, rural households, women and children, low-income urban populations, etc.

What nutritional challenges are we talking about?

Every country is affected to some degree by malnutrition, which takes several forms: undernutrition (which notably results in stunting in children under five), micronutrient deficiencies (primarily iron, zinc, vitamin A, folic acid and iodine), and overweight or obesity, the latter of which causes non-communicable diseases such as type 2 diabetes or cardiovascular disease². These forms may co-exist, particularly in Africa³, constituting what is known as a "triple burden". On a global scale, almost three billion people do not have access to a healthy diet, in other words to a wide, sufficient, balanced range of foods that satisfy their nutritional requirements and do not include too many foods that may be harmful to health (more plant-based foods, fewer ultra-processed products). Worldwide, more than one in five children suffer from stunting and a third of women are anaemic. At the same time, the global rate of obesity among adults is running at 16%⁴. In industrialised countries, malnutrition due to excess calorie consumption and micronutrient deficiencies is fostering NCDs, which have become a major public health issue. In tropical and Mediterranean countries, while undernutrition and micronutrient deficiencies persist, overweight and obesity are progressing with urbanisation, changing lifestyles and increasing availability of ultra-processed foods that are nutritionally poor, often imported, and cheap. This has triggered a rise in NCDs that is burdening already fragile health systems. According to the World Bank (2025), if no action is taken, the global cost of malnutrition over the next decade is estimated at 41 000 billion dollars. For those countries most affected by malnutrition, that means a 3 to 11% loss in annual GDP, while every dollar invested in nutrition generates 23 dollars of economic benefits on average⁵. Food is the first lever to trigger for good human health.



1. Rockström *et al.*, 2025

2. <https://www.who.int/fr/news-room/fact-sheets/detail/malnutrition>

3. Development Initiatives, 2018

4. Development Initiatives, 2018, p.122

5. World Bank, 2025

Addressing nutrition challenges worldwide means transforming food systems to ensure their long-term resilience and supply safe and nutritious foods, while promoting healthy and diversified diets that help prevent NCDs. In Africa in particular, there are still opportunities to change the industrial path taken by food systems, which weakens microbiomes and creates obesogenic food environments. Addressing the need for a healthy diet means rethinking the entire food system to include the nutrition aspect.

The WHO and many countries have made detailed dietary recommendations, based on nutrition situations and according to food availability and dietary habits, to ensure a healthy, nutritious diet. The EAT-Lancet Commission recently proposed the concept of a “planetary health diet”, which also allows for environmental aspects.

The planetary health diet, a mainly plant-based model

Today, in every country worldwide, **diets are lacking in fruit, vegetables, nuts, pulses and whole grains**, while many include too much meat, dairy, sugar, animal fat and ultra-processed foods. The 2025 EAT-Lancet Commission suggested the concept of a “planetary health diet”⁶. This is a food model rich in plant-based foods and low in animal products, added sugar, saturated fat and salt. It fosters human health and reduces environmental impact. It is based on higher dietary diversity, favouring locally available plant-based foods suited to the cultural habits and environmental constraints of each country. In tropical and Mediterranean countries, for instance, the foods concerned may be those that are traditionally part of the diet, such as millet, sorghum, cassava, beans, lentils or peas.

CIRAD is committed to combating malnutrition

- Interdisciplinary expertise. The international scientific community working on nutrition has been calling for years for nutrition to be an interdisciplinary research topic. While CIRAD is not called to have a large number of in-house nutrition specialists (notably for clinical trials), it includes such expertise in its joint research units and takes care to use it to supplement its intrinsic skillset. CIRAD has the capacity to cover the full range of food system issues, particularly those associated with their sustainability and with nutrition security. Its multidisciplinary expertise (biophysical, technical, human and social sciences) allows it to articulate nutrition issues with agricultural and environmental aspects, while encompassing socioeconomic, cultural and political factors.
- An international commitment. CIRAD's commitment to the nutrition aspect of food systems notably takes the form of strong calls for action at international events relating to the topic. For instance, in 2025: Nutrition for Growth (N4G), International Congress of Nutrition (ICN), UN Food System Summit+4 Stocktake (UNFSS+4). This mobilisation has resulted in major strategic contributions, notably several position papers and policy briefs⁷ with IRD, INRAE and Institut Agro.

Combining nutrition aspects and food system sustainability

The work CIRAD and its partners are doing on the nutrition aspect of food systems currently covers several topics, as shown by an analysis of 335 publications between 2016 and 2023 explicitly

linked to the subject. Those publications can be classed under four main headings relating to different scales (see figure 1, page 5):

- (1) From farm to fork
- (2) From the composition of foodstuffs to their physiological impact
- (3) From supply characteristics to individual choices
- (4) From local and national public policy to international policy.

Nutrition, from farm to fork

For CIRAD, it is vital to include rural and urban consumer nutrition issues when designing agricultural production systems, to ensure that those systems promote public health rather than merely being productive in terms of the number of calories and amount of protein. Contextualised research is under way in tropical and Mediterranean countries, as are global foresight exercises (such as Agrimonde Terra⁸), to consider the carbon footprint of different diets containing more or less meat.

Agroecology, agro-biodiversity and the nutrition aspect

Production systems are being studied by means of sustainable agriculture models (agroecology, organic farming, agroforestry, more diverse cropping systems), which include specific farming practices (cereal-legume combinations, intercropping, service plants, integrated crop-livestock systems). The emphasis is on exploiting the available agro-biodiversity on different scales (plot, farm, region). In Africa and the French overseas regions, the MARIGO⁹ project is working to reduce pesticide use by introducing agroecological practices based on crop diversification, which benefit the environment and health. The nutrition aspect is primarily viewed in the light of its direct link with dietary diversity, notably through fruit and vegetable consumption.



Cookery workshop in Laos, simple recipes for young children using easily available, accessible products © Alissia Lourme Ruiz, CIRAD

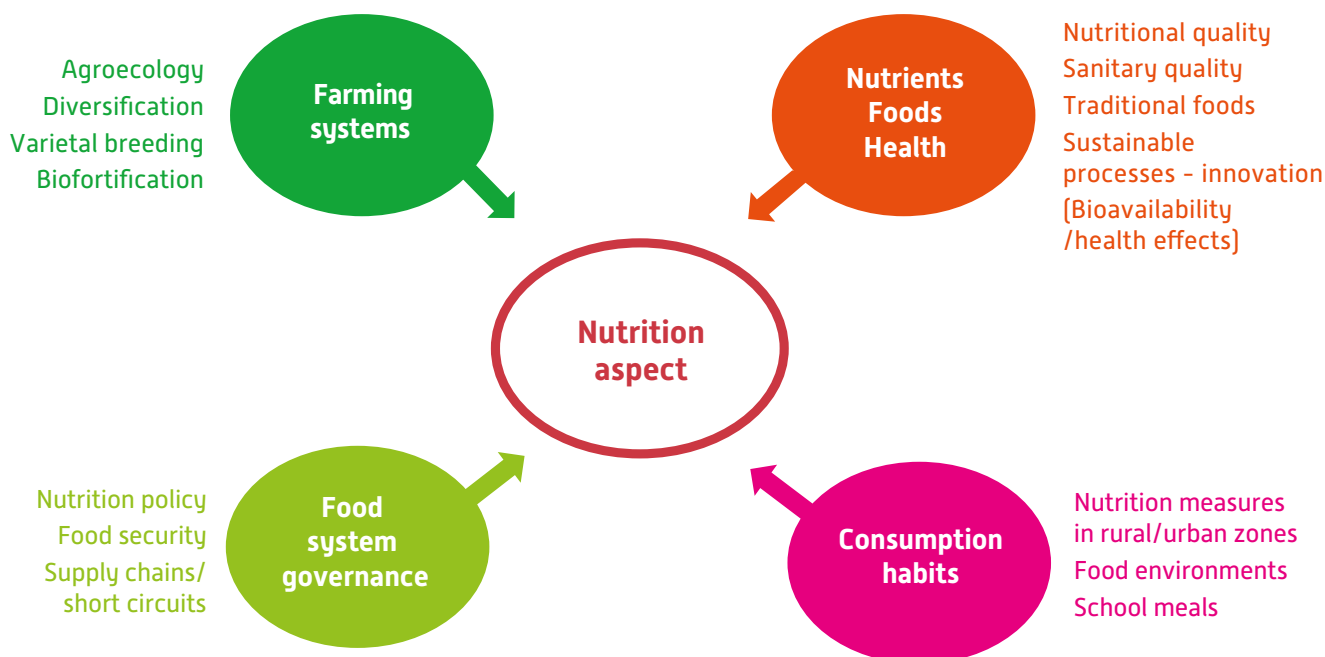
6. <https://eatforum.org/eat-lancet/the-planetary-health-diet/>

7. Alpha *et al.*, AFD-CIRAD position paper, 2025

8. Mora *et al.*, 2020

9. <https://www.cirad.fr/en/worldwide/cirad-worldwide/projects/marigo-project>

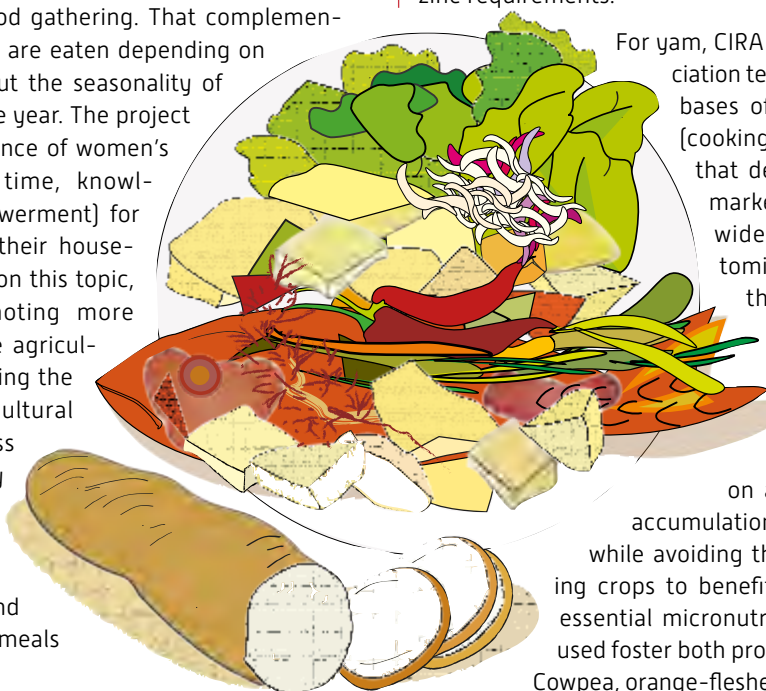
Figure 1. The nutrition aspect in sustainable food systems: the four thematic pillars



The pivotal role of women

CIRAD pays particular attention to the role of women in improving household dietary diversity, in line with the potential of production systems centring on agricultural diversification. In Burkina Faso, in a context of poor dietary diversity and micronutrient deficiencies among women, the RELAX¹⁰ project has shown that diets depend on three complementary sources: agricultural production, food purchases and wild food gathering. That complementarity means different foods are eaten depending on the season, and smooths out the seasonality of food consumption across the year. The project has highlighted the importance of women's resources (income, land, time, knowledge, autonomy and empowerment) for improving nutrition within their household. Based on its research on this topic, CIRAD recommends promoting more subsistence and sustainable agriculture, by decompartmentalising the nutrition aspect and agricultural production, raising awareness of the importance of dietary diversity, and encouraging production of a wide range of foods, agroforestry, frugal food storage techniques, and the development of school meals programmes.

criteria and resilient to climate change, including rice varieties. Research by the CIRAD-CIAT¹¹ programme in Colombia has characterised the genetic material available, certified two zinc-fortified rice varieties, zinc being an essential nutrient for the first 1000 days of life, and added nutritional quality to the list of traits for varietal breeding operations in Colombia and Bolivia. Those improved varieties cover more than 50% of children's average zinc requirements.



For yam, CIRAD has used genome-wide association techniques to pinpoint the genetic bases of the main cooking characters (cooking time, dry matter content, etc) that determine the acceptability and market value of varieties. Genome-wide association and transcriptomics are also serving to identify the genetic factors that determine grain quality and protein digestibility for sorghum and groundnut. Lastly, CIRAD is testing agronomic biofortification, based on agroecology, to boost nutrient accumulation in the edible parts of plants while avoiding that of anti-nutrients. By allowing crops to benefit from an environment rich in essential micronutrients, the agronomic practices used foster both productivity and nutritional quality. Cowpea, orange-fleshed sweet potato or teff¹³ varieties suited to their growing zones have been enriched with iron, zinc and vitamin A, by combining organic fertilisation with active soil microorganisms in Senegal and Ethiopia¹⁴.

The plant biofortification strategy

In contexts where people suffer from micronutrient deficiencies and do not have access to diversified food products, CIRAD is working to improve production systems using biofortification, by means of different approaches aimed at boosting plant micronutrient contents (minerals or vitamins). It is breeding varieties in Latin America and Madagascar that are tailored to nutrition

10. <https://www.cirad.fr/en/worldwide/cirad-worldwide/projects/relax-project>
 11. CIAT is now the Alliance of Bioversity International and CIAT under the aegis of CGIAR.
 12. Taleon *et al.*, 2020
 13. An ancient cereal primarily grown in Ethiopia
 14. <https://or4food.cirad.fr/en/projet>



Rice biofortification in Colombia © Cécile Grenier, CIRAD

From food composition to physiological impact

Improving food nutritional quality is one of CIRAD's longstanding commitments. This involves physico-chemical, microbiological and sensorial analyses, and monitoring changes in food nutritional quality during processing and storage. From experience, CIRAD now considers that it is vital to go beyond merely characterising

foodstuffs and to consolidate and step up its current research into their functional properties, micronutrient assimilation by organisms (bioavailability), and physiological effects. That research is based on in vitro assimilation models, supplemented by in vivo studies in animals.

Traditional foods: nutritional quality that could be used more effectively

Traditional foods are local food products that are part of local culture and are produced by means of ancestral farming and culinary practices. They are likely to contribute to dietary diversity and micronutrient supplies. Several studies have suggested that traditional African diets, which are based on a range of local grains, legumes, leafy vegetables, fruits and fermented products, can help to improve the nutritional quality of diets, by providing micronutrients, fibre and a range of microorganisms (in the case of fermented foods). It is not "tradition" as such that guarantees nutritional quality, but dietary diversity, nutritional density and the culinary practices associated with some dishes. In tropical and Mediterranean countries, CIRAD is working to improve the nutritional quality of traditional foods by investigating the impact of processing operations on food composition and promoting a diversified diet of micronutrient-rich local food. In particular, the AFTER (African Food Tradition Revisited by Research¹⁵) and FAMA (Food And Microbiota in Africa) projects are working to promote traditional African foods and fit them into inclusive, innovative and sustainable food systems. Traditional African foods are the fruit of sustainable secular practices that suit the climate conditions and local people's nutrition requirements. The AFTER project, funded by the European Union and being rolled out in seven African and four European countries, has made it possible to modernise certain processing operations while respecting the authenticity of the products concerned. The FAMA project¹⁶, in South Africa and Senegal, aims to help alleviate the triple burden

15. <https://www.after-fp7.eu/>

16. <https://tinyurl.com/538cwbj>



Market gardening, Senegal © Raphaël Belmin, CIRAD

of malnutrition in those countries by looking into alternative food systems based on traditional African foods. It is studying the role of traditional foods in improving the gut microbiota and promoting their production using agroecological practices, along with their processing and consumption.

Development of functional foods

In addition to their basic role in nutrition, functional foods are foods that have one or more proven health benefits and help to reduce the risks of certain diseases. In response to the escalation in diet-related chronic diseases, CIRAD is developing functional foods enriched with bioactive compounds, to prevent overweight and obesity, and assessing their effects on health. For instance, the PROMET (Probiotic-Metabolic) exploratory project, coordinated by CIRAD, has developed an innovative, sustainable plant-based probiotic functional food (inspired by akpan, a traditional African fermented food improved by the AFTER project). As a vegan alternative to dairy products, this product could help combat metabolic syndrome¹⁷ in both the global North and South. Its potential has been tested in vivo in animals. The synergic effects of bioactive compounds (carotenoids, flavonoids, pectin) and of probiotics tend to reduce metabolic syndrome, and also to recreate a balanced gut microbiota¹⁸.

CIRAD is also assessing the health effects of eating bioactive-enriched foods, particularly in Latin America and the Caribbean, where the co-existence of nutritional deficiencies and a high prevalence of overweight and obesity is a major public health issue. In vitro biological models (physiology of digestion) and in vivo studies in animals serve to understand how bioactive compounds work and are absorbed. Such models study the lipid and vitamin A metabolisms, insulin resistance, inflammation and

oxidative stress. In Costa Rica, CIRAD has developed fruit-based snacks as an alternative to ultra-processed equivalents. Studies in rats have shown that vacuum-fried papaya chips are a source of bioavailable provitamin A and do not adversely affect lipid or glycemic profiles¹⁹. In Brazil, in regions affected by vitamin A deficiencies, work on orange-fleshed sweet potato has shown that the right formulation and heat treatment strongly increase beta-carotene bioaccessibility, making it possible to cover up to 85% of daily vitamin A requirements²⁰.

In a context of acute malnutrition, several studies, notably in collaboration with IRD, are looking into foods developed to treat malnutrition, whether infant flour (adding fat, vitamin A and iron to RUTFs/RUSFs²¹) or flours and porridges for the wider population [eg biscuits fortified with safou²²].

Processing local foods of nutritional interest

To promote agro-biodiversity, CIRAD is working to improve processing of local foods with high nutritional value. For instance, it is looking at the nutritional quality of leafy vegetables in Madagascar or jicaro seeds in central America²³. As part of the LEGAE²⁴ and ICOWPEA²⁵ projects, CIRAD is identifying and exploiting opportunities for developing legumes in Africa, from production to consumption. The impact of processing on nutritional quality is under particular scrutiny. In Benin, for instance, innovative micronutrient-rich cowpea-based products have been developed to satisfy urban demand.

In South Cameroon, red palm oil has also been studied particularly closely by the Qualipalm project²⁶, which is analysing the links between nutritional quality and artisanal oil production conditions, along with consumer preferences for specific culinary uses.

A study for Brazil: sweet potato-based baby food

Mashed sweet potato:
% of recommended daily allowance (RDA) of vitamin A
for children aged under six

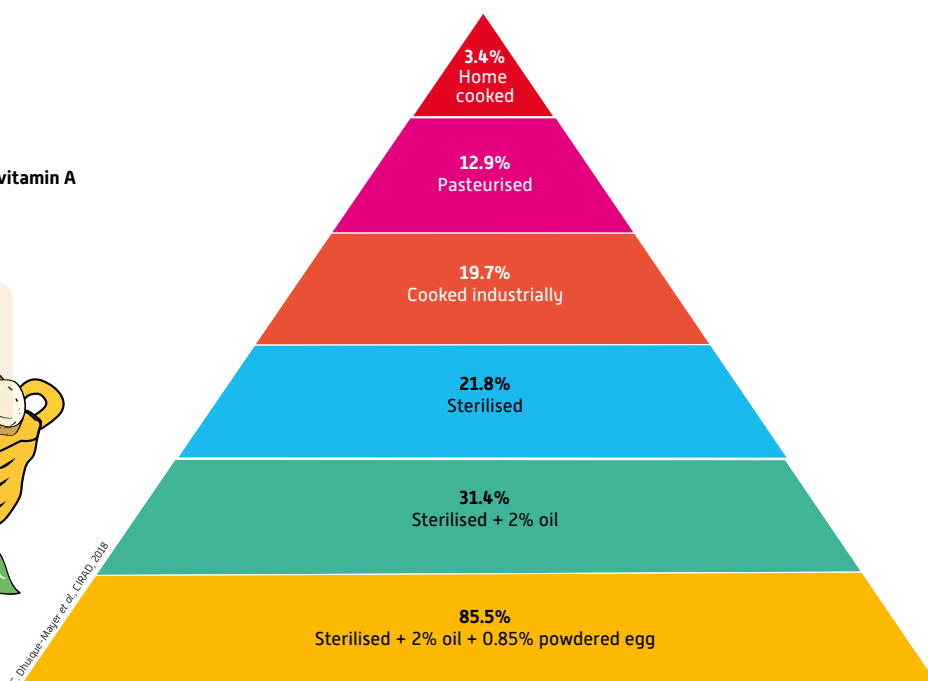
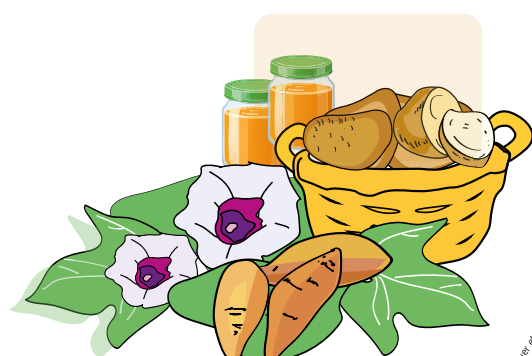


Figure 2. Positive impact of processing on pro-vitamin A bioaccessibility

17. Metabolic syndrome is not a disease as such, but a set of physio-pathological risk factors (abdominal obesity, high blood pressure, dyslipidaemia, hyperglycaemia) that raise the likelihood of developing type 2 diabetes or heart disease [Alberti *et al.*, 2009]

18. Dhuique-Mayer *et al.*, 2025

19. Soto *et al.*, 2021

20. Dhuique-Mayer *et al.*, 2018

21. RUTF: Ready-to-Use Therapeutic Foods; RUSF: Ready-to-Use Supplementary Foods

22. Fruit traditionally eaten in Cameroon

23. Corrales *et al.*, 2017

24. <https://ur-aida.cirad.fr/nos-recherches/projets-et-expertises/legae>

25. <https://niebe-icowpea.cirad.fr>

26. Rafflegeau *et al.*, 2024

Work is also under way to develop improved oil palm varieties with higher vitamin and lower saturated fatty acid contents, for better nutritional quality²⁷.

Lastly, CIRAD's work on animal products, particularly fish from Cambodian lakes or camel's milk in North Africa, is aimed at exploiting their nutritional qualities. For the latter, research is looking at production systems and supporting marketing operations, notably in the Mediterranean basin. The focus is on the nutritional quality (protein, fat) of camel's milk and its digestibility for lactose-intolerant people, in addition to other benefits (socioeconomic, environmental, cultural, etc) linked to its production within pastoral systems²⁸.

From supply characteristics to individual consumption choices

The nutrition status of individuals is strongly linked to their dietary habits. Understanding those habits, what determines them and how they change, in different contexts, has always been a major line of research for CIRAD. The organisation looks at the act of eating from a broad perspective, setting it into a range of social perceptions and relations rather than reducing it to the mere consumption of nutrients.

CIRAD is particularly interested in purchasing and consumption habits, focusing on certain ways consumers buy food and certain foods or specific population groups. Those food practices are also linked to household and individual nutrition status and to their food environment, in other words the set of conditions that influence consumption habits (distance from points of sale, types of points of sale, prices, possibilities for home preparation, etc). In tropical and Mediterranean countries, for instance, we are working in urban environments to study the effects of away-from-home consumption on people's nutrition status and health²⁹. In rural environments, as part of the SWM programme³⁰, we are looking at wildlife product consumption and how it fits in with biodiversity conservation

issues. Health questions (zoonoses), consumption of other animal products, and the production/buying/borrowing/giving strategies used by rural households are also under study. Research is ongoing into consumption in other contexts, particularly in France, such as the steady increase in food supplement consumption among the elderly or the changes in food buying habits during the Covid-19 crisis. Work is also under way on the question of how food is perceived (standards/values associated with certain foods, dishes or consumption practices), and of what value people place on nutrition and health through their diet. There is a particular focus on new urban consumption habits in tropical and Mediterranean countries, and on consumption as a militant act in countries in the global North.

CIRAD is studying animal product consumption (dairy and meat) in tropical and Mediterranean countries. Depending on context, that consumption may supply insufficient protein and calcium in relation to nutrition recommendations. If so, it is necessary to work with stakeholders in the countries concerned to find ways of sustainably increasing animal product consumption. CIRAD considers that it is vital to understand what place these products have in consumer diets, along with the factors that determine their consumption, and consumer perceptions, to determine what action is required. For instance, in urban parts of West Africa, which are major meat product consumption basins, surveys by the Animal Products in West Africa project³¹ have shown that consumers prefer "traditional" products, which they see as tasty, healthy and environment- and animal wellbeing-friendly, while keeping a close eye on industrial hygiene and meat processing and preparation practices.

From public policy to international regulations

For CIRAD, public debates and policy—notably nutrition policy—, which influence food system governance, are a real issue for research. The organisation is working on various scales: municipal,



Market in Thiès, Senegal © Raphaël Belmin, CIRAD

27. Morcillo *et al.*, 2021

28. Adary T., Corniaux C., 2023; Laameche *et al.*, 2023

29. Landais *et al.*, 2022

30. <https://www.fao.org/in-action/swm-programme>

31. Wane Abdrahmane and Serena Ferrari, 2024

territorial, national, regional, international. In particular, there is great debate regarding the agricultural models that should be promoted, the importance of public food stocks, and the concepts such as nutrition security or food and nutrition security on which governance is based. CIRAD contributes to forums and to international initiatives and bodies such as the High Level Panel of Experts on Food Security and Nutrition (HLPE-FSN) of the Committee on World Food Security (CFS), UNFSS+4, N4G, LEAP4FNSSA or the Long-term Europe-Africa Research and Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture (LEAP-Agri). It analyses national food security and nutrition policy in different contexts, for example in Latin America and Burkina Faso. Those analyses reveal the different ways in which the public authorities address hunger and malnutrition via agricultural, social and nutritional framing, depending on the context and point in time.

In urban zones, which are growing rapidly in tropical and Mediterranean countries, CIRAD is looking into how consumers' food environments are governed. A study of food habits and perceptions in cities in Africa, Latin America and Asia revealed the limitations of analyses consisting in observing consumption changes in terms of westernisation, standardisation, "transition" or convergence towards a common model. Surveys in urban areas have shown that consumption habits cannot be reduced to a pattern of standardisation; urban inhabitants also invent new types of consumption based on a multitude of local and/or external references³². Concrete action is also being tested as part of

the AfriFOODlinks project³³ involving actors from municipalities in five African cities [Cape Town [South Africa], Kisumu [Kenya], Mbale [Uganda], Ouagadougou [Burkina Faso] and Tunis [Tunisia]], with traders and schools, to transform the food environments in those cities. For instance, this means modernising markets or developing school meals and community gardens. A network on the transformation of food system governance in Africa is also being set up with more than 65 cities worldwide.



Conclusion and future research

Based on its knowledge and expertise, and thanks to its scientific and partnership position, CIRAD contributes to tackling the nutritional challenges surrounding food system transformation to ensure greater sustainability, inclusivity and resilience. To this end, it intends to continue and consolidate its research with its partners, along four complementary lines, while also moving into emerging fields:

- **Improving food nutritional, sanitary and functional quality and health effects.** Studies of the bioavailability of micronutrients from traditional processed foods will be supplemented with approaches encompassing the interactions between diet, microbiome and health. This as yet exploratory knowledge will be consolidated in the coming years. Food safety will be taken into account in these approaches, as biological and microbiological hazards such as mycotoxins or pathogenic bacteria [Salmonella, for instance] continue to exist in many parts of tropical and Mediterranean countries, compounded by the sharp increase in chemical hazards associated with industrial agrifood systems (pesticides, heavy metals, microplastics and drug residues).
- **Developing complementary food diversification, fortification and biofortification strategies—notably considering the effects of climate change on plant nutritional quality—, particularly in zones with severe micronutrient deficiencies.** The food diversification strategy will focus particularly on fish and animal product consumption, whose effects on health (and on the environment) differ depending on context (overweight or deficiencies), as well as the development of plant-based foods (eg legumes). The micronutrient bioavailability and health effects of these different strategies are due to be studied, while making use of agro-biodiversity and supporting various value chains to ensure a balanced food supply.



The "niébétruck", an innovation to benefit food security
© T. Teixeira Da Silva Siqueira, CIRAD

32. Soula *et al.*, 2020

33. <https://afrifoodlinks.org>

- **Documenting gender issues, particularly the role of women in production systems (notably horticultural systems), processing and distribution, food purchasing and preparation, and child-care.** The aim will be to ensure that transforming food systems for greater sustainability and better family nutrition really does improve their nutrition status and social and economic condition. More broadly, this work on gender will help to position the organisation as regards the increasingly significant question of equity and social justice within food systems.
- **Analysing and taking action on food system governance on different scales (territories, value chains, public policy, international forums).** The information and social aspects of urban food environments, which are increasingly obesogenic, will be targeted specifically (for example promoting positive habits, using social media, etc). This notably means studying power relations within value chains and practices among dominant agribusiness actors and agrifood firms. These actors' logics of interest have lock-in effects and significantly influence food consumption. The aim is also to work with the whole range of

stakeholders to co-design coherent public regulations, spanning different ministries and scales, that would encourage changes in practice among value chain actors and improve food environments. Alliances with local councils are vitally important for this. Institutional catering is one option that could be promoted to help build new social norms and eating habits and guarantee access to healthy products for all.

To all of these ends, CIRAD is committed to promoting the agroecology-food systems nexus, with a focus on nutrition security in both rural and urban environments, using participatory research approaches and rigorous impact assessment of the various interventions implemented. This will mean strengthening coordination and exchanges between the different scientific communities concerned. CIRAD intends to pursue this research agenda by maintaining its long-term collaboration with other French research organisations and with its partners in tropical and Mediterranean countries (academics, public authorities, professional organisations, NGOs, civil society and international organisations). ■



CIRAD is working to document the rôle played by women in nutrition, in this case in Laos © Caroline Dangleant, CIRAD

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