



Photo: Tegemeo farmer inspecting his millet. KIT

All in on millet?¹

Introduction – the re-emergence of millet

This article explores the re-emergence of millet in domestic value chains and its use by private actors with innovative business models – using fortification or biofortification – to highlight millet’s smart food properties. While millet has been in the shadow of rice and wheat production for decades, recently there has been renewed interest in millet to enhance food security and livelihoods for small farmers. According to the CGIAR, the development of new millet products ‘needs to make business sense for farmers, seed suppliers, food producers,

and consumers.’² While the food security and climate resilience aspects of millets have been the focus of programmes targeting the most vulnerable populations, this article explores the innovators behind changing the narrative around millets: from a ‘poor people’s food’, towards a smart food (Box 1).

Millets have long been a staple food in many regions of Africa and Asia, but their cultivation declined significantly as they came to be associated with poverty and other crops and foods were regarded as more desirable and better tasting. As part of growing efforts

Box 1 | Millet and smart foods

What are millets: Millets are gluten-free cereals of the Poaceae family, more commonly known as the grass family, that have been consumed by humans for about 7,000 years. Millets are mostly grown in the semiarid tropics of Africa and Asia due to their short growing season under dry, high-temperature conditions. There are several

types of millets, including pearl millet, finger millet, foxtail millet, proso millet, and kodo millet. While sorghum is also part of the Poaceae family, it refers to grains from the *Sorghum bicolor* plant, whereas millet refers to grains from the *Panicum miliaceum* plant. Among the millets, pearl millet is the most widely produced type for human consump-

tion, though all types are renowned for their regional adaptation, high nutritional value, and health benefits.

What are smart foods: highly nutritious crops, which target some of the largest micronutrient deficiencies and needs, especially of women and children (ICRISAT).

¹ The article has been prepared by the Royal Tropical Institute (KIT), Amsterdam. Authors: Bitzer, V., Petrutiu, S., Huet, E. and Diallo, M. (2023). <https://www.kit.nl/publications/working-paper-series>

² <https://www.harvestplus.org/home/catalyzing-markets/>

to revive global millet production and consumption, the United Nations and its Food and Agriculture Organization, on India's request, named 2023 as **the International Year of Millets** (IYM 2023). Two key properties of millets are repeatedly highlighted: first, their climate-smart properties, as millets can be cultivated in adverse and changing climatic conditions, with few inputs. These cereals can be a potential solution for many regions' self-sufficiency and reduction of reliance on imported cereal grains.³ Second, millets' health benefits as compared with other cereals: elevated levels of protein, fiber, key vitamins and minerals, including iron, zinc, and calcium.⁴ In addition to their nutritive value, millets are the main cereal for many cultural, ceremonial (funeral, wedding and baby showers) and religious (especially during the Muslim fasting month Ramadan) foods. Millets are gluten-free and have several potential health benefits relevant to cardiovascular diseases and diabetes, among others (Saleh et al., 2013).

The FAO's goal in 2023 is to increase awareness of millets' production potential and enable the adoption of necessary policies which can maximise its nutritional and health benefits. Such policies should enable the creation and scaling of new sustainable market opportunities for producers and consumers.⁵

The following sections explore production and consumption patterns developing in key millet-producing regions, using examples of national and international ongoing public and private efforts that are affecting these patterns. Development actors, including financiers, can get new insights into the hypothetical (and audacious) question 'should we go all in on millet?'. While the answer is likely 'no', the question is illustrative of the growing number of public nutrition campaigns, processors and brands which, in recent years, have started to aggressively promote millet's nutritional and health benefits. The article includes case studies enterprises (as well as a project) which exemplify the diverse opportunities of investing in processors and brands to achieve farm-level and consumer-level impact.

Global production and consumption patterns

Production of millets

World millet production is estimated at 30.6 million tons in 2022. While millets are grown in more than 93 countries worldwide, only a few countries have a sizable production. India alone is responsible for 39% of global production, followed by Niger (11%) and China (9%). As a region, West Africa is the largest producer (Table 1).

Table 1 | Top global millet grain producers

India	11.8
Niger	3.4
China	2.7
Nigeria	2.0
Mali	1.8
Sudan	1.5
Ethiopia	1.1
Burkina Faso	1.0
Senegal	1.0

Sources: USDA and Index Mundi⁶

In most millet producing Low- and Middle-Income Countries (LMICs), the crop's production has declined over the past decades due to shifts to other staples, changed food habits, and ensured returns from major commercial crops (Meena et al. 2021). Only few countries, including China, recorded increasing production levels. Recently, however, there are different efforts underway to put millet back in the global spotlight. In India, the government has promoted millet production for over a decade already, starting with rebranding millets as 'nutricereals' instead of calling them 'coarse grains'.⁷

Millets' characteristics as dryland cereals make them much more resilient crops than maize and other major cereals and offer good insurance against crop failure. Millets offer shorter maturity periods – around 60-90 days for some cultivars - and lower post-harvest losses than other staples (Kaminski & Christiaensen, 2017). These can be important advantages for small-scale farmers, who account for the large majority of worldwide millet production, particularly as millets can be grown on arid lands and nutrient-depleted soils with minimal inputs such as water or fertiliser (Hassan et al., 2021). Finally, unlike wheat, maize and rice, millets emit little or no greenhouse gases (Saxena et al., 2019).

There are still a number of major production constraints, including limited access to modern equipment and technologies, such as good quality seeds and improved varieties and incidences of diseases, pests and weed infestations. Additionally, traditional methods of post-harvest processing (dehulling) are labor-intensive and time-consuming, and modern processing facilities are limited (Meena et al., 2021). In Mali, for example, according to the Institute of Rural Economy, the main challenges in promoting millets include limited availability of millet grains as raw material to processors, unattractiveness of packaging

³ <https://www.fao.org/millets-2023/en>

⁴ <https://pressroom.icrisat.org/millets-the-nutritional-powerhouses-making-a-comeback-in-2023>

⁵ <https://www.icrisat.org/smartfood/>

⁶ <https://ipad.fas.usda.gov/cropexplorer/cropview/commodityView.aspx?cropid=0459100> and <https://www.indexmundi.com/agriculture/?commodity=millet&graph=production>

⁷ <https://www.bbc.com/travel/article/20230208-why-2023-is-the-year-of-millets>

of end products, difficulties in transportation and storage, lack of capital to invest in machinery, lack of available equipment leading to manual labor still widely spread which limits outputs, and a lack of millet-specific capacity building for processors.⁸ These challenges speak to the underinvestment in and underdevelopment of millet value chains in major production countries, which makes it difficult to scale up production and meet the growing demand for millet products.

Consumption of millets

The Sahel region of Africa dominates global consumption of millets, followed by India, as the largest single consumer of millets. Most millets are consumed where they are produced, but there is also growing trade and important importers include Indonesia, Germany, Iran, Belgium and South Korea, among others.

About 80% of the millets produced are used for human consumption, while the rest is used as animal fodder and for beer production (Vinoth & Ravindhran, 2017). Individual kernels are commonly ground to make flour, which is then made into a thin or thick consistency porridge in many African countries, while in other areas it is consumed as a flatbread (e.g., dosa in India) or baked into a fried cake (e.g., masa in Nigeria) (Hasan et al., 2021). The shelf life of millet flour is short due to the presence of polyunsaturated (healthy) oils but can be extended using heat treatments and/or antioxidants (such as vitamin E or rosemary extract).⁹

Millets fell out of favor in many countries and started being seen as an old-fashioned poverty crop. In Senegal, for instance, consumption fell from 78 kilograms per capita in 1990 to 49 kilograms per capita in 2009 (Resnick et al., 2020). In India, per capita consumption of millet fell from 32.9 kg to 4.2 kg between 1962 and 2010.¹⁰ British colonizers disregarded millets in favor of wheat and other crops but with the Green Revolution millets' downfall accelerated as the government pushed for hybrid, high-yield varieties of wheat and rice.¹¹ Crops that were once widely consumed became mere fodder crops. Millets gained a reputation as the food of rural and tribal communities and over time, they simply disappeared from households' menus.

Recently, millets' diverse health and environmental benefits are beginning to be appreciated once more. In the example of India, this is partly due to the country facing the triple burden of hunger, malnutrition and over-nutrition, whilst environmental resources are being depleted. The Indian government made significant investments in promoting millets' many qualities to

urban and rural consumers. Demand for millets is increasing and the crop is finding its way back into Indian diets.

At a global level millet is making an impressive comeback, with the global market being estimated at \$9 billion in 2018. This is expected to grow to more than \$12 billion in 2025.¹² Drivers for the anticipated growth are millets' production advantages over rice and wheat, in particular in a dry climate, and the cereals' multiple health benefits, including calcium, iron, fibers, vitamins, phosphorus, magnesium and manganese. Rising awareness towards healthy diets is expected to drive growth, especially among the rising urban population in Asia. As millets are also gluten-free, they offer opportunities to produce gluten-free products.

In sub-Saharan Africa, and especially in West Africa, many processors are promoting millet consumption by proposing new types of ready-to-cook or ready-to-eat millet foods (as opposed to selling millet products which require overnight processing (i.e., soaking) at home). For example, in Mali, a variety of new millet products are available in most small food stores, supermarkets and outdoor markets, such as couscous, granules of porridge and cream (Degue), millet flour, Larau (a mix of millet, groundnut and spices), millet biscuits, breads, pane cake, Takoula (bread made on vapor), infant foods, etc. In urban areas of Mali millet is considered a cereal for rich people, as higher prices of new millet products make these unaffordable to low-income consumers. Millet is used in many breakfast foods (porridge, fried cake, pane cake), often sold by women in small stands in urban areas.

Today the growing demand in West African countries leads to one of millet processors' main challenges: the low supply of raw material, i.e., millet grains. Although the effort will take long, Indian urban consumers are being educated in the tastes and benefits of new millet products, and here too, demand is on the rise. It remains to be seen if international (Western) markets will catch up.

Millets as a superfood

The United Nations estimate that almost 3.1 billion people could not be able to afford a healthy diet in 2020, an increase of 112 million more people than in 2019 due to rising food costs. Particularly in Africa, a healthy diet is out of reach for 80% of the population, followed by Asia with 44% (FAO et al., 2022). While this may not lead to obvious hunger effects, it can cause different forms of malnutrition, including undernutrition,

⁸ Interview with representative of the Institute of Rural Economy (16 May 2023).

⁹ <https://www.harvestplus.org/wp-content/uploads/2023/02/Iron-Pearl-Millet.pdf>

¹⁰ World Food Program and Odisha Millet Mission 2022. Increasing the consumption of millets: need of the hour. https://docs.wfp.org/api/documents/WFP-0000144439/download/?_ga=2.50371434.299532067.1684301226-1701232443.1681377916

¹¹ <https://www.bbc.com/travel/article/20230208-why-2023-is-the-year-of-millets>

¹² Oswal, S. (2023). The importance of Millets in today's global scenario. The Times of India. <https://timesofindia.indiatimes.com/blogs/voices/the-importance-of-millets-in-todays-global-scenario/>



micronutrient deficiencies and overweight / obesity (FAO, et al., 2022). Micronutrient deficiencies are widespread, as people rely on staple foods, such as rice, which are low in micronutrients to meet their energy requirements (FAO et al., 2022). Hence, improving micronutrient availability in foods, especially iron (Fe) and zinc (Zn) is important to address underlying causes of malnutrition.

Different efforts to deliver nutrient-dense foods to poor populations can be distinguished: (1) food fortification and (2) biofortification. **Fortification** is the practice of deliberately increasing the content of one or more micronutrients (i.e., vitamins and minerals) in a food or condiment to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.¹³ The usage of millets in fortified products has already gained some traction in infant food and nutrition products. Many countries have laws or policies to promote the use of post-harvest, industrial fortification to add iron to flour and other foods, but they are rarely enforced.¹⁴ In addition, while fortification is a cost-effective strategy, it remains difficult to ensure the availability of these fortified foods to people living in remote areas (Gangashetty et al., 2021).

Biofortification, on the other hand, refers to adding micronutrients through techniques of crop crossbreeding with varieties of higher concentration of desired micronutrient(s) such as minerals and vitamins. The advantage here is the potential to supply essential micronutrients to large segments of the population

without requiring radical changes in food consumption patterns nor individual decision for compliance (FAO et al., 2022).

The HarvestPlus programme of CGIAR is leading a global effort to breed and disseminate micronutrient-rich crop varieties, including pearl millet, through partnerships in developing countries. In India, a high-iron (Fe) and zinc (Zn) open-pollinated variety (OPV) of pearl millet, called Dhanashakti, was developed and released in 2014, followed by a hybrid pearl millet variety with similar iron and zinc levels. In West Africa, OPVs with higher Fe/Zn levels were tested in different countries (Niger, Nigeria, Mali, Burkina Faso, Senegal and Ghana). To date, two OPVs and nine hybrids of pearl millet have been released in India (since 2014), Niger (2018) and Nigeria (2023). Annex 1 gives a full overview of these new varieties.

Public programmes enabling a re-emergence of millets

Various public and public-private programmes have been initiated in recent years, to promote millets' production and consumption. A few examples from West Africa are given below, as well as a description of India's efforts, a country which has invested heavily in millets over the past decade.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Mali, is co-lead of the five-year project Enhancing Crop Productivity and Climate Resilience for Food and Nutrition Security (EU-APSAN). This is part of ICRISAT's focused efforts on increasing the popularity of smart foods, starting with millet and sorghum. The institute is training women associations and individual processors on improved new technologies of processing millet. It developed the scientific Smart Foods concept, marketing strategies and messaging, and worked on the classification and accreditation of smart foods.¹⁵ The approach of ICRISAT also aims to create consumer demand through viral campaigns, to facilitate processing of modern convenience products with Smart Foods, and to engage with the health, food service and media industries. ICRISAT is filling knowledge gaps, identifying and addressing scientific research needs on how smart foods affect consumers (nutrition and health), the planet, the farmer and the whole value chain (cooking, processing, marketing).

The EU-APSAN project goals formed the main themes in a recent conference on 'Smart Foods' in which millet's potential for climate mitigation and health were highlighted. Many attendees aimed to learn about the development of millet value chains and how to enable more efficient and profitable millet processing as a Smart Food, attractive to both rural

¹³ https://www.who.int/health-topics/food-fortification#tab=tab_1

¹⁴ HarvestPlus (2023). Iron Pearl Millet. Improving food and the food system with a naturally nutritious harvest. <https://www.harvestplus.org/crop/iron-pearl-millet/>

¹⁵ <https://www.icrisat.org/smartfood/>

and urban consumers.¹⁶ The EU-APSAN-Mali project is undertaking market demand studies for different improved, hybrid millet varieties, and is planning various interventions to increase this demand.¹⁷

ICRISAT is providing an agribusiness incubator service and an Innovation Platform which brings together public-private partners, providing training, mentoring, access to finance and research and technology (e.g., on improved millet varieties). In India, 74 women farmers were trained by ICRISAT as nutrition entrepreneurs, to produce ready-to-cook and ready-to-eat millet and legume products that are supplied to childcare centres.¹⁸

Another example of a project which uses millet as a main 'quality, fortified, manufactured food product to prevent malnutrition' is MERIEM (French for: Mobilizing Sahelian Businesses for Innovative, Large-scale Responses to Fight Malnutrition), active in Mali, Burkina Faso and Niger (Monroy-Gomez et al., 2022).¹⁹ This project is funded by the French Development Agency and the Bill and Melinda Gates Foundation and brings together NGOs and academia to test innovative commercial solutions with Sahelian private sector partners in response to malnutrition and related health issues in Sub-Saharan Africa. The actors aim to tackle anaemia ('45% of women in the target countries'), and malnourishment ('up to 19% in peri-urban areas'). MERIEM addresses availability and affordability of millet products, to address the problems identified in cities such as Ouagadougou where only 14% of outlets offer locally produced fortified foods for young children.

In Senegal, an international consortium (Food Processing and PostHarvest Handling Innovation Lab) aims to alleviate micronutrient deficiencies, reduce post-harvest losses, link farmers to markets, increase marketing opportunities, and increase and diversify food-processing markets for cereal and legume products (De Groote et al., 2021). The project introduced a market-driven model for nutritionally enhanced foods, produced using novel technologies, and promoted consumers' acceptance of four new pearl millet products, each with different traits: instant products, whole meal products, products fortified with commercial premix, and products with food-to-food fortification. Part of the project was an experimental study with 296 consumers from Dakar, which evaluated sensory characteristics as well as willingness to pay (WTP). Some fortified products' sensory attributes were appreciated by consumers, who showed a willingness to pay premiums between 9 and 30 percent if offered nutritional information on the packaging, with

the highest premium paid for whole grain instant millet fortified with premix (De Groote et al., 2021).

India and the IYM 2023

Millet diets in India phased out one to two generations ago, but there has recently been a surge in the government's promotion of millets. Hundreds of startups are raising consumers' awareness of the nutritional benefits of millets, and Indian urban consumers are slowly reintegrating millets into their diets (Dayakar and Tonapi, 2021). Realising the potential of millets for food and nutrition security, the Indian government has already taken several steps since 2012 to promote production and consumption, including celebrating the national year of millets in 2018. Now India is seeking to be at the forefront in celebrating IYM 2023, with public support by India's Prime Minister Narendra Modi. Speaking at the Global Millets Conference in March 2023, he called millets a solution for the problem of food and nutritional security faced by the world.

To mark the IYM 2023, India developed a multi-faceted action plan as a concerted effort involving Central Ministries, State Governments and Indian Embassies, but also societal stakeholders including farmers, start-ups, exporters, businesses, and hospitality organisations. The purpose is to position India as the 'Global Hub of Millets' and to enhance their production, processing, consumption, and exports. Activities are planned, aiming at various audiences. To promote millet production, incentives are provided to farmers under the National Food Security Mission, including farmer training, technology demonstrations and seed production programmes. There are also different incentive schemes to promote primary processing and production of millet-based foods, including for micro-entrepreneurs. Linked to this, the Indian Institute of Millets Research, recently upgraded as a Centre of Excellence, is undertaking various research projects related to shelf-life, food standards, value addition and product development. Finally, at consumption level, the government has rolled out several awareness-raising campaigns ranging from millet food festivals, releasing recipe books, including millet in school feeding programmes, and having airlines and railways serve millet dishes.

A recent study points out that millets in India²⁰ are in the 'boom' phase, and warns of a potential bust, comparing it with teff in Ethiopia and quinoa in the Andes (Andreotti et al., 2022). Risks include price escalations, the rapid increase in non-farming consumers coupled with slowly improving yields which can create a demand-supply gap, and the increase in exports by main producers which may negatively affect local markets.

¹⁶ <https://www.icrisat.org/eu-and-icrisat-in-mali/>

¹⁷ <https://ue-apsan-mali.com/en/home/>

¹⁸ <https://pressroom.icrisat.org/harvesting-hope-empowering-tribal-women-as-millet-entrepreneurs>

¹⁹ <http://www.meriem-nutrition.org/en/>

²⁰ Authors' note: and perhaps soon in other producing countries.

Empirical cases

The Common Fund for Commodities (CFC) has been committed to support the cultivation and development of sorghum and millet as food security and income-generating crops since 1994. Over the years, the CFC has committed over USD 8 million to initiatives focused on these vital crops. These cases below explore CFC's and other sorghum development projects, elucidating the strategies employed, funding challenges, and the consequential impact on communities that rely on sorghum and millet for food security and economic sustainability. CFC's continuing support extends beyond mere financial assistance, underpinning a broad spectrum of agricultural development with significant implications for poverty alleviation and socio-economic advancement.

Case 1: the valorisation of millet by ICRISAT and the Common Fund for Commodities²¹

Between 2005 and 2009, ICRISAT and the CFC have funded and implemented the project '*Enhanced utilisation of sorghum and pearl millet grains in poultry feed industry to improve livelihoods of small-scale farmers in Asia*'. Active in India, China and Thailand, the partners invested USD 2.1 million (including a USD 1.5 million grant from the CFC) in a range of interventions and technologies, targeting 7,500 small scale farmers organised in farmer organisations. Other targeted beneficiaries included business support service providers, off-takers, processors and local financiers.

A total of 15 partners were associated with the project in India, nine in China and five in Thailand. ICRISAT partnered with local universities and crop research institutes to identify suitable technologies which can increase production and to train farmers in adopting and using them. NGOs and farmers' federations organised farmers into nine associations, which cascaded training, organised demonstrations and marketed the grains. Other partners included improved-varieties seed and input suppliers, feed manufacturers and grain processors who also provided offtake, storage and transport services.

As a precursor to public-private initiatives promoting biofortified varieties for human consumption and nutrition objectives, this project from ICRISAT and the CFC introduced and distributed 35 improved varieties and hybrids of sorghum and pearl millet seeds.

Over 100 training sessions were organised for over 7,500 farmers (including 3,000 women) on improved technologies, new science tools in agriculture, soil testing, planting, intercropping, integrated crop, nutrient and pest management, harvesting, seed production, storage, marketing, organisational management

and finance. The project produced information materials in local languages and held over 175 field demonstrations on farmers' fields. Scientists visited farmers regularly to address any production challenges. Farmers were linked to seed and input suppliers and encouraged to make direct purchases. Eight village-level warehouses were built, and the farmer associates were trained in managing them, enabling the storage of produce and its sale at favourable times. Partners also organised the provision of low-interest loans, enabling farmers to buy inputs and to store grains until prices improved. Ultimately, the partners organised regular meetings between the farmers' associations and private-sector buyers, which led to strong partnerships and the sale of grains in bulk at price premiums.

Impact achieved by the project

The project reached 6,290 families in 71 Indian villages, and 506 families in seven villages in Thailand, and 631 families in nine Chinese villages. To improve production, the project distributed the seed of these improved varieties and hybrids for farmers to buy. It built village grain storage warehouses and facilitated low-interest loans and links with buyers. It helped the farmers organise themselves into farmers' associations, provided them with training and information materials. A contract farming model was popularised in China, with three buyers making purchasing arrangements with around 150 families. Among project beneficiaries in India, yields of pearl millet grain rose by an average of 32%, and fodder yields went up by 20%. Yields of sorghum increased by 19% to 73%. By buying in bulk, farmers were able to cut the cost of seed by 13–51%. Adoption rates of improved varieties and hybrids ranged from 3 to 88%.

The warehouses attracted several processors to buy grain, and convinced banks to provide short-term credit to the farmers to meet immediate cash needs using the stored grain as collateral. Market links were created between farmers' associations and various food, alcohol and poultry feed processors. In China, associations were engaged in contract farming with the alcohol industry, with three buyers buying sorghum at or above an agreed floor price. In Thailand, two years after the project ended, farmers were selling sorghum to the duck-feed industry and mushroom producers.

While the participation of women in Thailand and China was satisfactory from the start, in India, cultural reasons meant that initially only a few women farmers participated. The project partners promoted women's involvement (e.g., women's self-help groups were included in seed distribution) and women's leadership in trainings and in the management committees of farmers' associations.

²¹ All information based on 'From Sorghum to Shrimp' report by Royal Tropical Institute and Common Fund for Commodities (2011)



KEPHIS and TEGEMEO representatives inspecting a sorghum farm

Case 2: the valorisation of millet by Shalem, Kenya

Shalem Investment Ltd. (Shalem) is an innovative social for-profit business aggregating, transporting, and marketing grains, cereals and legumes for use by agri food processors (i.e. East African Breweries, Unga Ltd, and Bidco). In the last five to six years, Shalem transitioned from a grain aggregator to an added-value manufacturer and deepened its producer engagement. The company provides 46 full-time and 401 temporary jobs.

In 2017 Shalem obtained a loan co-financed by the Common Fund for Commodities (CFC), which was used to build a storage facility, to allow its supplying smallholder farmers to benefit from periods of high prices. Shalem's vision is exemplified in the recent food prices rise (e.g., maize prices in Kenya almost doubled in 2022). The company absorbed the added purchasing costs, aiming to offer affordable products to consumers with limited purchasing power.

The CEO of Shalem reports in 2023 that their use of millet is still limited, but that she recognises the growing interest in biofortified millets. The company so far uses pearl millet and finger millet for producing porridge flour.²² Shalem built a processing factory in 2019, in which they fortify foods (mainly sorghum) with minerals and vitamins. These value-added products account for 70% of its revenue, which Shalem obtains from its targeted low-income consumers (52,000 individual consumers in 2021).²³

Marketing activities of Shalem are centered around the promotion of quality milled products. These are ranging from maize flour to porridge, fortified with extra minerals and vitamins 'to provide health benefits that will extend your life and improve your life through what you eat.' The first nutritional products,

Asili Plus and Ugali porridge, were launched in 2018 in schools. As of 2020, these are available in over 50 retail locations.

Current and potential impact of Shalem's use of millet

In 2021 alone, Shalem supported more than 40,000 smallholder farmers (100% increase since 2017), of which 74% were women, boosting household incomes by an average of USD 240 per year. Technical assistance and trainings to 20,000 producers have led to average yields of 1,350 kilograms per hectare (kg/ha), up from a minimum of 650 kg/ha in 2020. For the coming five years, Shalem is in the process of expanding the topics of its agronomic training programmes, adding soil testing, linking farmers to certified seeds and other farm inputs, assisting them in adopting new technologies and providing access to microloans. These improvements are expected to further increase yields and volume sourced and to create an additional 17 full time jobs.

Besides the support and price stability for smallholder suppliers, Shalem aims to provide affordable nutritional food for the poorest people in the region. More than 50% of its sold products will be fortified with needed minerals and vitamins, although there are no targets yet for millet specific ingredients.

CFC support

CFC provided a loan to Shalem, to enable the company's investment in storage and processing facilities, for Shalem to access the Bottom-of-Pyramid (BoP) market with more innovative nutritious blended food.²⁴ Shalem aims to invest in a storage facility and in a value addition facility for maize cleaning and blending with sorghum, millet and beans for better nutrition bonding. These investments would reduce the financial risks that local farmers are facing due to volatile maize prices while addressing the need of their nutrition security.

²²<https://shaleminvest.co.ke/index.php/asili-plus/>

²³Information on the business case of millet products versus other products in the portfolio was not obtained.

²⁴<https://www.common-fund.org/reducing-vulnerability-price-volatility-kenya>



Products under the brand name Health Sutra, by Fountainhead Foods, India.

Case 3: the valorisation of millet by Fountainhead Foods, India – Health Sutra brand

Health Sutra is one of India's first brands that sources millets directly from farmers and processes them for creating innovative and convenient food formats. The founder of Fountainhead Foods Private Limited, with a background in engineering, switched careers as he realised the potential impacts of millets in his home country. The company was established in 2013, with the dual mission to solve farmers' challenges related to growing crops in dry areas, and to help modern urban individuals to eat healthier.

Under the brand name of Health Sutra, the company launched 25 products, in categories of flakes, biscuits, rawas, beverage mixes and diet namkeen. About 80% of sales come from products which are 100% millet. 20% of sales come from products which are 30-40% millet. These are currently sold in over 3,500 retail locations around the city of Hyderabad, with a geographic focus on Southern India.²⁵

In 2018, the Indian Chamber of Food and Agriculture selected Health Sutra as one of the 20 best agri-startups.²⁶ In the last five years the company experienced significant growth and as of

2023 it is processing 30 MT per month. Health Sutra currently employs 25 full-time staff (15 female, 10 male), the majority in production and sales. It has a total annual turnover of USD 500,000. A new USD 6 million factory, partly financed by a local bank, opens in October 2023.

The first and largest over-arching challenge for Health Sutra (and for similar millet-focused companies) is that advanced processing technologies and techniques for millet are not yet available, compared with those used in maize-based breakfast cereals in Western supermarkets.²⁷ Secondly, the lack of awareness from consumers requires large investments in marketing and millet startups recognise that it is 'early times for the millet sector and there is a long way to go.'²⁸

To overcome these challenges, Health Sutra invested in a new factory, and experimented with various marketing and promotional messages (e.g., on packaging, website, through videos and social media). The company believes that millets will be back in mainstream diets, if customers feel that it is easy to use, cook and consume. Consumers should not be required to put in any additional efforts versus what they are already used to when consuming ready-to-eat products. This is why Health Sutra's founder

²⁵ <http://www.healthsutra.in/products.php>

²⁶ <https://www.icfa.org.in/assets/doc/reports/all-india-agri-startup-convention-2018.pdf>

²⁷ Interview with Health Sutra CEO.

²⁸ idem

focuses on the company's innovations in the processing of ingredients, for example by producing ragi from finger millet, which can be consumed simply as a breakfast cereal. The company pre-cooks and pre-soaks millet grains (time and effort-intensive activities which other bottom-of-the-pyramid consumers, for example in West African countries, commonly do themselves at home).

Current and potential impact of Fountainhead Food's use of millet

The creation of innovative millet products was enabled by the Indian Council for Agricultural Research, which provided Fountainhead Foods with technologies and recipes for producing instant millet mixes, jowar vermicelli (a gluten-free and protein rich millet), multigrain atta (a type of flour) and cookies. After working with the public institute on natural processing methods, Fountainhead Foods reintroduced traditional Indian millet grains in tasty formats 'suitable for modern lifestyles'.²⁹

The Health Sutra promotional messages currently centre almost entirely on millet's benefits for health-conscious consumers (rather than on socio-economic or environmental benefits for producers). Various myths around millet are broken down in videos on the company's YouTube channel and websites, recipes are promoted, and each product is presented with facts about its nutritional properties. For example, for the brand's foxtail millet products, the following benefits are described:

- Foxtail is packed with good quality fibre which improves digestion, manages obesity, regulates blood sugar levels and curbs the risk of high blood pressure and strokes. 100gm of Foxtail contains more than 8 grams of dietary fibre.
- One cup of Foxtail has 29 grams of Protein. Protein helps in building muscles, cell regeneration, and gives a feeling of satiety which further helps in weight reduction.
- Low glycaemic index, High-fibre and good Protein content of Jowar makes it an excellent diabetic option. Both fibre and protein in Jowar help slow down the release of sugars into the blood preventing sugar fluctuations thereby controlling Diabetes.
- Iron and copper are two important minerals found in Foxtail. Iron is crucial for development of red blood cells in the body, while copper helps enhance the absorption of iron in the body thus improving overall circulation of blood in the body

For Health Sutra's founder and CEO, the opportunities for creating a profitable business case for a millet-brand, coincide with the grain's impact potential opportunities. These can be grouped in three categories: nutritional (millets have a large number of unique selling points in this category, which helped in the growth of Health Sutra sales), climate resiliency (millets are the most climate resilient crop on the planet, although promoting this to consumers did not translate to sales), and traditional diet aspects (which when used in marketing activities also did not result into increase sales).³⁰ The Health Sutra founder compares millet with quinoa, a grain native to South America, which is exported and consumed around the world: 'Millets can stand on their own against any other super food. Foxtail millet for example has very good amount of protein, a macronutrient in high-demand'.³¹

The business case is positively affected by the brand's distribution and sales through physical retail locations. As the company's breakfast products are voluminous in nature, logistics costs for online sales and delivery would be too high. Such costs cannot be absorbed by an increase in prices. As Health Sutra's customers have many mainstream products (millet alternatives) available, consumer prices need to stay competitive. The company cannot ask for premiums above 20-30%, which it currently charges for the products' nutritional benefits.³²

The founder of Fountainhead Foods and his partners believe in the potential for an increase in local consumption but also in exports (exemplified by their recent investment in a new factory). India has many advantages in terms of affordable inputs and labor and food production and processing offer many opportunities. Compared with other producing countries, the operating environment is very stable (many producers were affected by the Russia-Ukraine war). According to the Health Sutra founder, large companies in India are also looking at adding millet to their products. Smaller and up-and-coming businesses such as Fountainhead Foods would benefit from an increase in the size of the millet market, with large players driving more consumer awareness and smaller players riding this wave.³³

Farm-level impact is primarily achieved through the climate-resilient properties of millet and through the increase in prices over the past years. For example, Health Sutra is purchasing pearl-millet at 50-60% higher prices than 7-8 years ago, and its founder recognises the various governmental policies which have contributed to these increases.³⁴

²⁹<http://www.healthsutra.in/our-story.php>

³⁰Personal communication with Health Sutra CEO.

³¹idem

³²idem

³³idem

³⁴idem



Products under the brand name Wacoul Services

Case 4: the valorization of millet by Wacoul Service, Mali³⁵

From aggregation to value-added processing of biofortified millet

Wacoul Service is a firm specialised in agro-processing in Mali. It was created in 2017 by Mrs. Raihatou Wague with the aim to promote the consumption of locally produced foods and the creation of jobs for women and youth.

Wacoul sources and processes a large number of agricultural products including: fonio, rice, sorghum, millet, groundnut, mangos, bissaps and gengember. Amongst the company's output products are: pre-cooked fonio, pre-cooked djouka, couscous of millet, millet flour, Tiagri, Segou Degue, brisure of maize, Monikourouni (porridge granules), instant drink of mangos, bissaps and gengember, biscuits of millet, Larau (mix of millet, groundnuts and spices), fried cake of millet and pane cake of millet.

Wacoul sources millet grains, paying in cash, and supports farmer groups from Baraweli in the Segou region. Building sourcing and trust relationships with farmers was difficult in the beginning, but at present a good collaboration is established. Aggregation and processing occur at the company's facilities in Bamako, with end products being sold at the same location or at local retailers (small shops and supermarkets). Small volumes are also exported to Gabon, Guinea, Senegal and France.

The company's processing capacity is 50 metric tons of millet per year. It has 14 employees among which four are permanent. It is managed by the owner, director of production and a director of marketing. Its close partners are the national Laboratory of Food Technology (LTA) of the National Institute of Agriculture Research (IER) of Mali and various NGOs.

Wacoul Service participates regularly to promotional fairs where it exhibits its products. The company's director travelled to India for an exposition where she was introduced to new millet prod-

ucts, which she is now aiming to produce in Mali. One of these will contain a fortified millet formula with iron, zinc and vitamins, targeted as a nutritional product for both infants and adults.

Main challenges faced by the company related to its access to raw material (millet grains), in enough quantity and of sufficient quality, the instability of market prices of end products, the lack of 'adapted' equipment to process big quantities, and the inappropriate packaging available on the market for storage over long periods, for transportation over long distances, and for appropriate consumer-friendly, attractive marketing.

The company highlights the opportunities arising from its use of millet compared to other crops, such as: the diversity of food types of millets, the use of millet in almost all cultural, ceremonial (funeral, weeding, baby showers, etc.) religious dishes, the gluten-free and easy to digest properties, the richness in micronutrients, the existence of local and international markets, the availability of biofortified new varieties, and the opportunities to generate new jobs for women and youth.

Current and potential impact of Wacoul Service's use of millet

As millet can be produced on low-fertility soils and tolerates high temperatures resulting from climate change in sub-Saharan Africa, the company considers the use of millet as urgent. It can reduce the productivity losses and it can contribute to fighting against food insecurity and extreme poverty in rural areas.

Wacoul's mission is to leverage the diversity of millet products and markets (domestic, regional and global), to enable job creation for women and youth in processing, distribution and sales. The promotion of processing opportunities for small-holder millet farmers offers a cash alternative and leads to a higher motivation for investing in production, using improved seed varieties and fertilisers to increase productivity.

As a third impact area, the company recognises millet's health benefits, due to its micronutrient rich properties.

³⁵ All information based on the interview with the company's director.

Conclusions – Do we go all-in?

From the increase in the number of public and private-public programmes promoting millets, and from various recent studies on the crop's climate-resiliency and nutritional properties, we conclude that millets form some of the most dynamic and fastest-growing value chains in LMIC. An increasing number of startups active in processing and branding millets as ready-to-eat or ready-to-cook products are benefiting from the growing interest in millet as well as fuelling this trend. India seems to be positioning itself as a global leader in moving the millet sector towards a modern, consumer-focused market. In West Africa, countries like Senegal and Mali are supporting the upscaling of a large share of micro-businesses into SME processors, brands and retailers, presenting unique opportunities for creating employment and wealth among youth and women entrepreneurs (Resnick et. al., 2020).

The renewed global interest in millets can be seen in conjunction with several global and regional developments, such as the reoccurring droughts (e.g., in Africa), the war forged by Russia in Ukraine which led to a spike in food prices and fertiliser prices across the world, and the increasing realisation of the contribution of wheat, rice and maize production to global warming. However, millet value chain actors are confronted with underinvestment, high marketing costs, unstructured markets and millet's old stigma as a poor person's food (Resnick et. al., 2020). If millet is to make a compelling comeback, innovative, multi-disciplinary partnerships, programmes and technologies must be employed, covering the largest possible spectrum of the crop's value chain, from field-level improvements, innovations in processing and branding and consumer acceptance of new products to the policies affecting the sector. Policies need to target the emerging millet processors to enable access to finance, services, knowledge and technology, to create competitive domestic, regional and global sectors, drive innovation and meet consumers' preferences and food standards.

International organisations are calling for increasing the production of millets, particularly due to their ability to grow in hot and drought-stricken regions. ICRISAT, for instance, estimates that millet production (pearl millet and sorghum) can be enhanced in Africa by at least 2-3 times in 2022/23, to solve food security threats, such as the anticipated wheat crisis. However, with the enthusiasm present in producing countries' markets and in international development discourse, the risk to repeat previous mistakes must be counterbalanced. Millet markets should not repeat the boom-and-bust cycle evidenced for example in the quinoa and teff sectors (Andreotti et al., 2022) (Box 2).

Depending on the audience, the answer to the question of 'going all-in on millet' will obviously vary, per interest, resources and region. Two of the enterprises interviewed for this article (Health Sutra and Wacoul), have certainly placed their bets on millet, and its environmental and climate benefits for producers, its potential for job creation (processing, marketing, sales) and income increase (for producers and successful processors and brands), and its nutritional benefits for a wide range of consumers. Other grain processors (Shalem) are more cautious but are also witnessing an increased interest in millet and are exploring opportunities to source and use more of this grain.

Analysing recent literature and taking a systemic view, it is likely that production and processing-related challenges of millet value chains, such as access to quality seeds and processing equipment, are not that much different from those of other staple crops. Yet the opportunities seem compelling, compared to other cereal crops. The growing public and private support of millet value chains – from production to consumption – is indicative of the vast potential of this crop in supporting farmers' livelihoods, improving nutrition levels of both poor and affluent consumers, and making an important contribution to climate change adaptation. Moreover, by harnessing the potential of millets, we can address the challenges of food and nutrition security, promote sustainable agriculture, support rural livelihoods, and contribute to a healthier and more resilient food system.

Box 2 | Risks for millet markets to enter a boom-and-bust cycle such as those in quinoa and teff

After 2013 was declared International Year of Quinoa, it gained reputation as a superfood. After being promoted globally, demand in Europe and North America quickly grew, international prices elevated, and quinoa markets boomed. As a result, in the Andean region, where quinoa had long been

just a locally consumed crop, saw a sudden transformation in its economic and social structures, and the soaring demand led farmers to ignore traditional farming practices, including fallow periods between harvests, and increasingly large-scale farming models were introduced. Soon output

was doubled. Meanwhile, production was promoted in several other countries and while quinoa consumption increased, production grew even more, resulting in oversupply and a decline in prices.

Andreotti et al., 2022

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Annex 1 – List of biofortified millet varieties released

Variety Name	Other Names	Country	Year Release	Micronutrient concentration (ppm)	Yield (t/ha)	Grain Size	Grain Color	Released for	Maturity	Crop Type
LCIC MV5	Chakti	Nigeria	2023	74,2	3,9	Large	Cream	Sahelian Agro-ecologies	Inter-mediate	OPV
LCIC MV6	ICMP 1970115	Nigeria	2023	51,7	3,8	Large	Yellow	Sudano Sahelian-ecologies	Inter-mediate	OPV
LCIC MV7	ICMP 187093	Nigeria	2023	52,7	3,4	Large	Cream	Sudano Sahelian-ecologies	Inter-mediate	OPV
Chakti	ICTP 8203	Niger	2018	65	1.2-1.5	Large/ Shape: bold	Deep grey	WCA : ECOWAS regions (Niger, Togo, Burkina Faso, Nigeria, Senegal)	Extra-Early	OPV
Dhanashakti	ICTP 8203 (Fe) 10-	India	2014	72	2,5	Large/ Shape: bold	Deep grey	All India/ recommended for Karnataka, Maharashtra, Telangana and Andhra Pradesh states	Extra-early	OPV
Shakti 1201 (Dhoni)	MH 2077, ICMH1201	India	2015	74	3,6	Large/ Shape: bold	Grey	A seed company marketing/ recommended for Haryana, Rajasthan, Gujrat states	Early	Single Cross Hybrid
HHB 299	MH 2076, ICMH 1203	India	2017	73	3,3	Large/ Shape: bold	Grey	Zones A and B (adapted to Rajasthan, Gujarat, Haryana, Punjab, Delhi, Maharashtra, Tamil Nadu)	Inter-mediate	Single Cross Hybrid
AHB 1200 Fe	MH 2072, ICMH 1202	India	2017	77	3,2	Large/ Shape: bold	Grey	Zones A and B (adapted to Rajasthan, Gujarat, Haryana, Punjab, Delhi, Maharashtra, Tamil Nadu)	Inter-mediate	Single Cross Hybrid
HHB 311	MH 2179, ICMH 1501	India	2018	62	3,2	Medium	Grey	Adapted to Zones A1, A & B (Rajasthan, Gujarat, Haryana, Punjab, Delhi, Maharashtra, Tamil Nadu)	Inter-mediate	Single Cross Hybrid
RHB 234	MH 2174, ICMH 1504	India	2018	62	3,2	Medium	Grey	Adapted to Zones A1, A & B (Rajasthan, Gujarat, Haryana, Punjab, Delhi, Maharashtra, Tamil Nadu)	Inter-mediate	Single Cross Hybrid
AHB 1269 Fe	MH 2185, ICMH 1502	India	2018	73	3,2	Large/ Shape: bold	Grey	Adapted to Zones A1, A & B (Rajasthan, Gujarat, Haryana, Punjab, Delhi, Maharashtra, Tamil Nadu)	Inter-mediate	Single Cross Hybrid
RHB 233	MH 2173, ICMH 1503	India	2018	64	3,2	Large/ Shape: bold	Grey	Adapted to Zones A1, A & B (Rajasthan, Gujarat, Haryana, Punjab, Delhi, Maharashtra, Tamil Nadu)	Inter-mediate	Single Cross Hybrid
Moti Shakti (GHB 1225)	ICMH 1505	India	2019	74	3,2	Medium	Deep grey	Gujarat state release	Inter-mediate	Single Cross Hybrid
Phule Mahashakti (DHBH 1211)	MH 2078, ICMH 1301	India	2018	78	3,5	Large/ Shape: bold	Grey	Maharashtra state release	Inter-mediate	Single Cross Hybrid