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Review of Agri-Food Value Chain Interventions Aimed at Enhancing Consumption of Nutritious Food by the Poor: India

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About LANSAs

Leveraging Agriculture for Nutrition in South Asia (LANSA) is an international research partnership. LANSAs is finding out how agriculture and agri-food systems can be better designed to advance nutrition. LANSAs is focused on policies, interventions and strategies that can improve the nutritional status of women and children in South Asia. LANSAs is funded by UK Aid from the UK Government. The views expressed do not necessarily reflect the UK Government's official policies. For more information see www.lansasouthasia.org

I Introduction

Efforts to give a pro-nutrition focus to agriculture to address the problem of undernutrition in developing countries have predominantly focused on boosting production and/or consumption of nutritious foods by farm households. While this is clearly appropriate in countries where a large proportion of the poor have agriculture as their main source of livelihood, as in South Asia, it is increasingly recognised that a majority of the poor derive some or all of their food through markets (Henson et al. 2013). These might include individuals in producer households that are not self-sufficient in food for some or all of the year, rural non-farm and landless households and urban households. This requires that attention is given to the functioning of the agri-food value chains through which food is produced, processed, stored and distributed, and how this can be improved. In particular, when the task at hand is to improve the nutrition status of poor and vulnerable sections of the population, consumption of nutritious food and diets by them becomes the focus of attention.

A strand of work under the Leveraging Agriculture for Nutrition in South Asia (LANSA) research programme consortium addresses the question: What public and private actions are needed to strengthen the impacts of agri-food value chains on nutrition in the region?

Specifically, it examines the effectiveness of interventions along agri-food value chains aimed at enhancing the availability, affordability, acceptability and consumption of nutritious foods by the poor on a sustained basis, with particular focus on infants and women of child-bearing age. This is attempted by examining existing agri-food value chain-based strategies in Bangladesh, India and Pakistan, in order to draw lessons that inform policy. The ultimate aim is to identify the most effective strategies for ensuring that nutritious foods get to the poor households and are eaten by them.

The starting point has been a review of existing value chain-based interventions in India, Pakistan and Bangladesh that focus on enhancing the availability, affordability, acceptability and/or sustained consumption of nutritious foods in households beyond the farm gate. The review classifies interventions into three categories: 1) interventions focused on foods that are naturally nutrient-dense (e.g. drumstick, millets and animal-based foods), and whether or not they have an explicit focus on nutrition; 2) interventions focused on enhancing the nutritional value of foods, including staples and prepared foods whether directed at particular nutritional uses (e.g. weaning foods) or for consumption by the general population (e.g. fortified flour); and 3) food distribution programmes that incorporate foods in either of the preceding categories.

This report is on the India country review of agri-food value chains. The review does not aim to be comprehensive in that it does not represent a complete inventory of value chain-based interventions with nutrition focus or potential to impact on nutrition status. The purpose in compiling the review has been to identify a representative cross-section of interventions post farm gate, across the three categories mentioned above. The attempt is to capture the main approaches and/or focal foods, and

highlight instances of innovation, in the process filling an evidence gap on pro-nutrition agri-food value chains. Feedback on the review, especially where there are notable omissions, is welcomed.

2 Local Context

India was ranked 55th among 76 countries in 2014 on the Global Hunger Index. Undernutrition is a pervasive problem in the country. The National Family Health Survey round of 2013-14 (NFHS-4)¹ shows a drop in prevalence of child undernutrition in India compared to that of 2005-06 (NFHS-3). The levels however continue to be high, with 40 per cent stunting among children under-five in many states. Besides high levels of stunting, wasting and underweight, hidden hunger or micronutrient deficiency manifested in high levels of anaemia and vitamin A deficiency is an issue (Government of India 2006).

High rates of undernutrition are prevalent despite a period of modest growth of the Indian economy. The country also houses the largest population of poor in the world (Cruz et al. 2015). A large proportion of the country's population is rural and dependent on agriculture. Agriculture and allied activities account for about 14 per cent of the Gross Domestic Product (GDP) and more than 50 per cent of the population is engaged in agriculture. India has over the years moved from being a country with food shortage to a state of food self-sufficiency, thanks to the Green Revolution. The Bengal Famine in 1943 had seen thousands die of hunger and starvation. The Green Revolution in the late 1960s, steered by a synergy of technology and public policy, enabled the country transform itself from a 'ship-to-mouth' existence to a level of food self-sufficiency. Poverty and undernutrition, however, continue to be persistent problems (Government of India 1993, 2013b). The heavy dependence on agriculture as a source of (direct or indirect) employment for a large proportion of the population calls for examining the scope of leveraging agri-food value chains to improve nutritional outcomes.

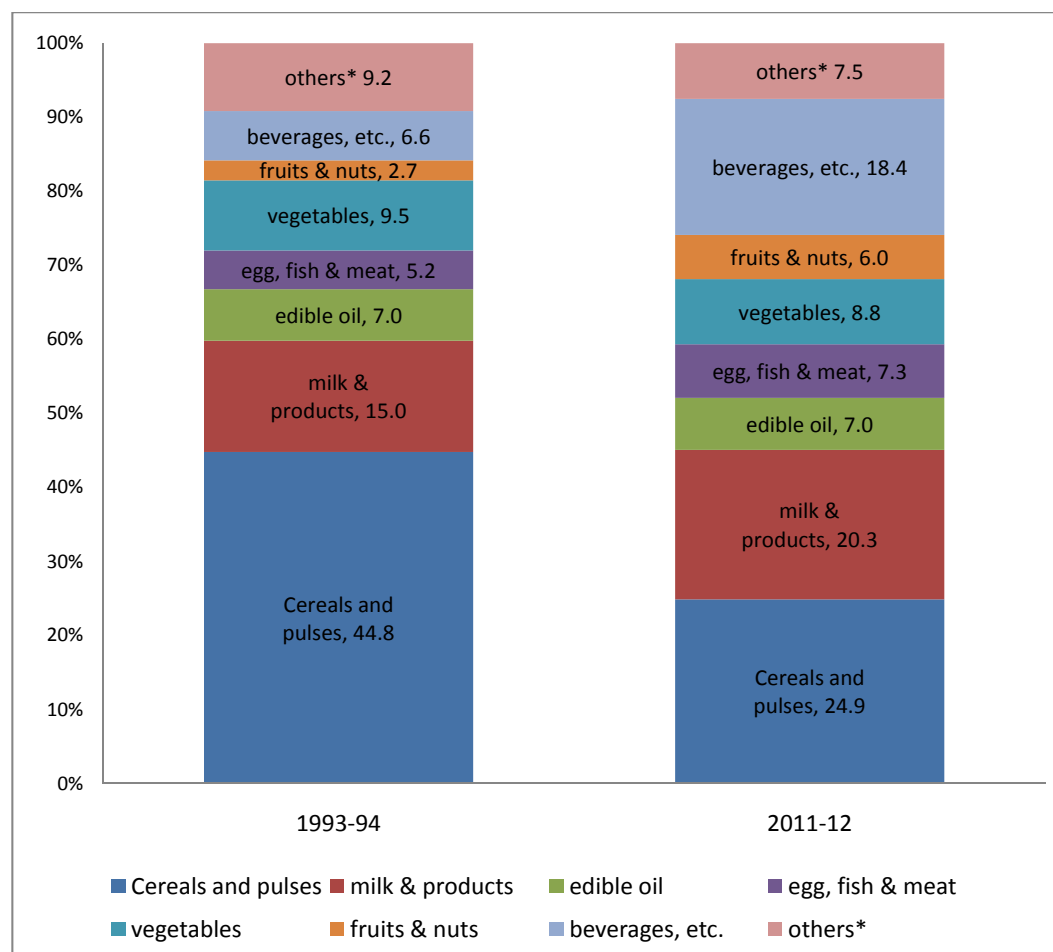
However, a rural household dependent primarily on agriculture, whether subsistence and/or commercial, does not produce the variety and quantity required to address its own demands; various supply chains have to be accessed to fulfil these demands. Poverty and economic pressure often prompt distress sale of entire produce by a producer household. They then access the market for their consumption needs. Lack of necessary infrastructure for storage and processing also precludes a poor household from retaining the consumable produce or getting higher value for it.

Over the years, there has also been diversification of the food consumption basket as revealed by National Sample Survey data. This is especially pronounced following the period of economic reforms in the 1990s. Overall economic growth, as well as growth in per capita income, is reflected in increased demand for protein-rich foods like milk and milk products, eggs, fish and meat vis-a-vis cereals. **Figure 1** shows the fall in the share of cereals and pulses and increase in that of milk and milk products, as also beverages, in the consumption basket between 1993-94 and 2011-12. Different supply chains have always existed; but the change in food consumption pattern coupled with increasing food demand and opening up of the economy following economic reform has expanded the market. This brings greater focus beyond the farm gate on market-based value chains

¹ http://rchiips.org/nfhs/factsheet_NFHS-4.shtml

for fulfilling the household’s consumption needs. However, many of these chains are not equipped to address nutritional deficiencies due to lack of awareness and availability at affordable price (Banerjee and Duflo 2011).

Figure 1 Changing food consumption expenditure patterns in India



*other include sugar, salt and spices

Source: NSS Report No. 555, Level and Pattern of Consumer Expenditure (2011-12)

The aspects of availability, access, affordability and sustained consumption become all the more important in determining the ability of economically poor and malnourished households to benefit from pro-nutrition agri-food value chains (Henson and Humphrey 2015). In developing countries, state-supported targeted value chains or food distribution under social protection programmes become important in this context (Ruel M.T et. al. 2013). Besides commercial value chains, there are different government food distribution supply chains operating in India as targeted social protection measures to address the food and nutrition insecurity of deprived and vulnerable sections of society. The Public Distribution System (PDS) in operation across the country makes cereals (rice and wheat) accessible at affordable price. Some states have also included pulses. Besides the PDS, programmes like Mid-Day Meal Scheme (MDMS) and Supplementary Nutrition Programme under the Integrated Child Development Services (ICDS) focus on nutritionally vulnerable sections of the population, i.e., children, adolescent girls and pregnant and lactating women.

Given the dimension of the problem of poverty and undernutrition in India, nutrition focus in both commercial and government-led food distribution value chains are important for impact at scale. It is equally important to recognise the producer side of the supply chain in terms of its sustainability, cost and risk aspects (Henson and Humphrey 2015). The questions we seek to answer in this review are: how can agri-food supply chains play a role, and/or what is required to enable them to play a role, in improving nutritional intake and thereby nutritional outcomes of poor undernourished populations. The methodology followed was a desk review to identify, shortlist and examine such initiatives from the perspectives of their reach and impact on nutritional outcomes of the poor or potential for the same.

3 Review Methodology

The review started by systematically listing all interventions that indicated intention or had clear strategies or objectives for pro-nutrition agri-food value chains. It excluded literature and interventions on irrigation and watershed development, land reforms and agriculture, farm financing and risk mitigation as well as extension systems. Careful scrutiny of the literature revealed relatively few interventions with nutrition focus beyond the farm gate. However, a significant number of interventions were identified with potential to have nutritional impact even if this was not an explicit objective; such types of interventions have been included.

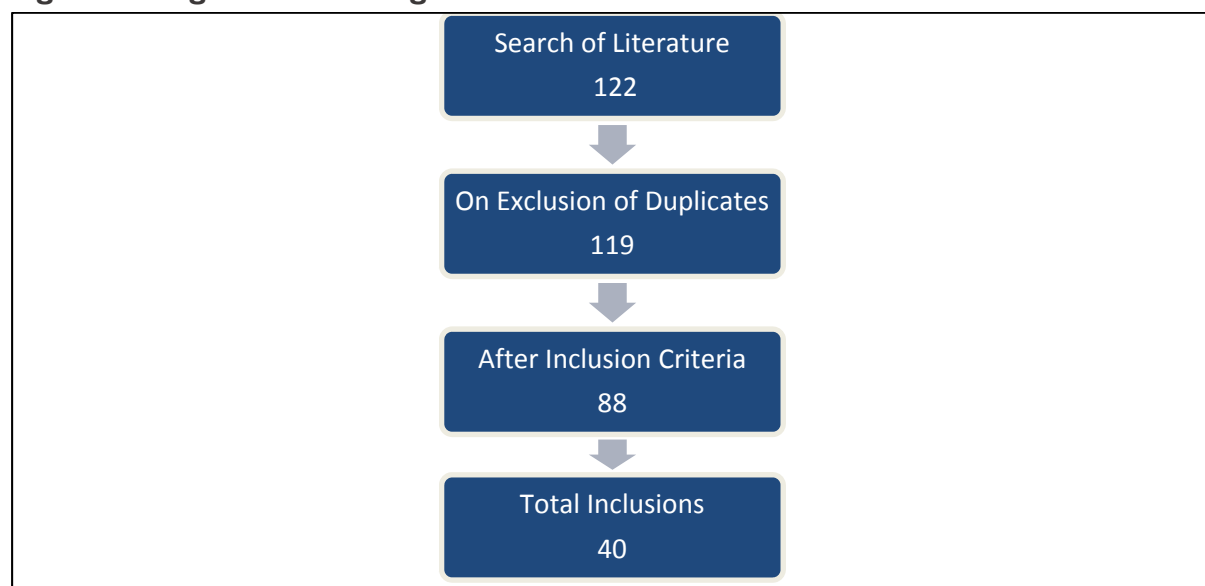
The review involved searching for interventions from the public domain (published), from print media and the internet. Keywords such as: 'food', 'nutrition', value chains' and 'India' were used in a targeted internet search covering institutions and organisations involved in the food and nutrition intervention space. **Table I** lists the keywords used in the search for identifying relevant interventions. Discussions were also held with experts in the domain to ascertain the relevance of including some of the interventions listed in the review exercise.

The cases for review were then selected using three inclusion criteria, following Henson and Humphrey (2015). This is depicted in **Figure 2**. First, the intervention can increase the consumption of nutrient-dense food beyond the farm gate. Second, the intervention uses value chains involving the private, public and/or not-for-profit sectors to reach the target population. Third, the intervention is beyond the experimental phase. With regard to the last, a few exceptions have been made and interventions that have shown evidence to impact on nutrition status in trials and thereby demonstrated potential, but are yet to go into commercialisation, have been included. This is primarily in the case of biofortified crops, a fast-growing area with great potential.

Table I Details of keywords

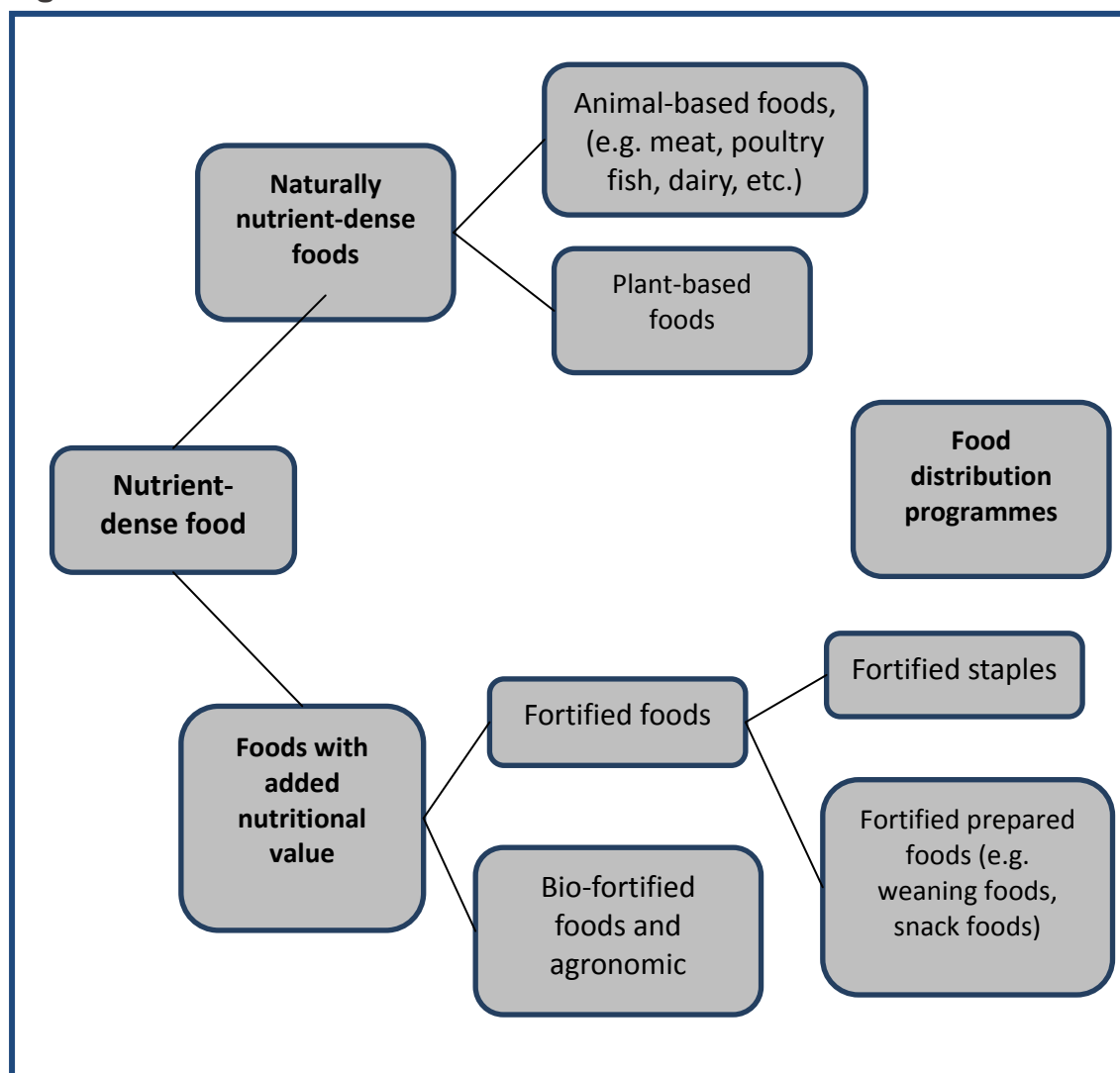
Primary	Secondary							
Biofortification	Products							
Dairy	Development							
Food	Companies	Government programmes	Nutrient-dense	Post farm gate	Processed	School feeding	Staples	Weaning
Fortified	Biscuits	Milk	Oil	Products				
Horticulture	Interventions							
Nutrition	Women/Children	Child						
Poultry	Chicken	Farming						
Value Chain	Agri-food	Poultry	Interventions	Meat	Vegetables			

Figure 2 Stages of screening the literature



The selected interventions were classified into three categories: naturally nutrient-dense, foods of increased nutritional value and food distribution. This categorisation and the inter-linkages are depicted in **Figure 3**.

Figure 3 Classification of value chain-based interventions



These three categories are key ways to enhance nutritional intake. Naturally nutrient-dense food includes foodstuff like vegetables, pulses, flesh foods and dairy products. The second category, ‘food of increased nutritional value’, covers interventions that enhance nutritional intake by improving access to fortified foods. In the context of reaching the poor, fortification initiatives have greater importance because naturally nutrient-dense foods (e.g., flesh foods) are often unaffordable and hence missing from diets of poor populations. The third category, ‘food distribution programmes’, cross cuts the other two categories and is very important in the context of developing countries (Henson and Humphrey 2015). These distribution schemes cater to large sections of the poor at the household and individual levels.

4 What Types of Interventions are Seen and Where are They Focused?

The review found a large number of interventions concentrated in the naturally nutrient-dense category in comparison to the other two, viz., foods of increased nutritional value and food distribution. **Table 2** shows the distribution of the interventions identified between the three categories.

Table 2 Distribution of preliminary pool of agri-food value chain interventions

Category	Percentage of the total
Naturally nutrient-dense food	50
Foods of increased nutritional value	27.5
Food Distribution	22.5

It is to be noted that these categories are not mutually exclusive, given that the category of food distribution cross-cuts the other two, as already stated; for instance, a naturally nutrient-dense food like milk or a food of increased nutritional value may be channelised through the food distribution chain. Discretion was applied to categorise interventions of this type, for the purpose of the review. **Table 3** gives the break-up of the 40 shortlisted interventions under the three categories.

Table 3 Identified agri-food value chain interventions

Nutrient-Dense Agri-food Value Chain Interventions		
Naturally Nutrient-Dense Foods	Foods of Increased Nutritional Value	Food Distribution
<ul style="list-style-type: none"> • 6 Dairy • 1 Poultry • 2 Fish & Duck • 6 Cereals, Millets & Pulses • 5 Fruits & Vegetables 	<ul style="list-style-type: none"> • 8 Fortified Foods <ul style="list-style-type: none"> ○ 4 Cereals ○ 1 Milk ○ 2 Beverages ○ 1 Meat & Fish • 3 Biofortified 	<ul style="list-style-type: none"> • 9 Mid-Day Meal/Community Nutrition/Distribution Programmes

Of the total interventions identified, 20 relate to naturally nutrient-rich foods, 11 to foods of increased nutritional value through fortification and 9 to food distribution through public distribution programmes like PDS, MDMS and ICDS. The summary description of the 40 interventions examined in this review is given in the Annexure to this report.

A pro-poor nutrition focus in agri-food value chains is a new idea (Hawkes, C. and Ruel, M.T., 2011). Several value chains deal with nutritious foods, but these are usually targeted toward high-end consumers. As stated earlier, value chain interventions that do not focus explicitly on enhancing nutrient intake of the poor were also taken into consideration if they exhibited potential to do so.

For instance, interventions focusing on income enhancement of smallholders were considered if they had potential to increase the consumption of nutritious food. Likewise, efforts for better productivity or storage of nutritious crops were also reviewed as this has implications for improved accessibility of nutritious food.

There are a range of actors involved in the interventions reviewed. While government agencies are involved in most of the food distribution-related value chains, private players often have a role in the government-led food distribution schemes. Initiatives directed by private players are mostly concentrated on market integration of smallholders (like contract farming, storage facilities, etc.) But there are also initiatives by private players that have targeted focus on specific consumer groups, like in the case of high iron-fortified Tiger brand biscuits of Britannia Industries Ltd (BIL). Many interventions focus on improvement of the livelihood of primary producers; a few have production and consumption of nutri-dense food as one of the objectives. An example is the intervention led by the M. S. Swaminathan Research Foundation (MSSRF) to increase the production and yield of millets, reduce the drudgery of women farmers in processing of millets and establish supply chains with a 4C approach encompassing cultivation-conservation-consumption-commerce (Bala Ravi et al. 2010). Millet is a nutrient-dense food and the supply chain has potential to reach the poor beyond the farm gate. These interventions are discussed further in the subsequent sections.

4.1 Naturally Nutrient-Dense Foods

In general, interventions related to naturally nutrient-dense foods are found to be limited within the farm gate (eg Rajasekaran, B. 2001; Vijayaraghavan, K., et. al. 1997). Interventions related to increase in productivity (e.g., of cereals and millets), duckery and poultry, as also dairy farming, however, improve the availability of nutritious food to a larger population; often the productivity increase translates into development of local supply chains.

There are a number of dairy interventions primarily focusing on the sustainable livelihood of smallholder farmers. Amul — the dairy cooperative of smallholder farmers that spearheaded the milk revolution in India — markets milk and milk products like butter and cheese in affordable packs, making the naturally nutrient-dense commodity, milk, accessible to poor households. With the formation of dairy cooperatives, there is increased access to larger markets; these forms of organisation also enhance the productivity of the dairy industry and income of smallholder farmers. Another intervention led by the private sector, the milk district initiative of Nestle, improved the productivity and income of small producers, in the process increasing their purchasing power to afford nutrient-dense foods. There is evidence in many cases of increase in milk consumption by small producer households, e.g. the Mulkanoor Dairy Cooperative which recorded indication of increased availability and consumption in the area of production.² Interventions like *Saanjhapan* (Create Shared Value) prioritise the aspects of hygiene and quality of milk, bringing into focus the dimensions of food safety and quality in addressing undernutrition (FICCI 2010a).

² <http://livelihoods-gender.ilri.org/2013/10/11/impacts-of-value-chain-development-on-smallholder-women-dairy-farmers/>

Indian farmers suffer huge losses due to dearth of adequate storage and processing facilities. These losses are also a deterrent for increasing the supply of naturally nutrient-dense food like pulses, fruits and vegetables. Some initiatives focus on addressing this aspect. Sohan Lal Commodity Management, working in Maharashtra, Rajasthan, Madhya Pradesh and Delhi, has substantially reduced the losses of chickpea on account of lack of storage with efficient storage facilities. A similar intervention led by Adani Fresh in Himachal Pradesh for fruits (apples) focused on quality storage, thereby reducing the post-harvest loss to farmers (FICCI 2010b). Large-scale innovations for reduction of post-harvest losses of nutrient-dense foods can help improve the income security of farmers and also address the problem of nutritional insecurity. *Samridhi* (meaning prosperity) is an initiative in Patna where street vendors are equipped with low-cost cooling carts; this helps increase the shelf-life of the fruits and vegetables. The farmers and vendors are also linked in direct contact to shorten the value chain for better and stable prices (Anjaly and Bhamoriya 2011). These kinds of innovative interventions, besides reducing food waste and ensuring hygiene, can have implications for the urban poor to access nutrient-dense food at affordable cost. Reliance, under its 'Reliance Fresh' initiative, makes vegetables and fruits procured directly from farmers available to consumers. There are several other similar initiatives by private players and cooperatives like Safal.

Similar to the initiative on millets by MSSRF cited earlier, there are efforts by different NGOs (e.g., WASSAN, Deccan Development Society, Timbaktu Collective) and development and research organisations like the University of Agricultural Sciences (UAS), Dharwad and the Indian Institute of Millets Research, to increase the consumption of millets. In some cases, private sector partnerships facilitate better market outreach. Sorghum and pearl millet provide a natural low-cost solution to combating deficiency of certain micronutrients. Enhancing production of millets, integrating farmers to an extent and working along the value chain through better processing technologies has shown potential for nutritional impact (Mal B. et al. 2010). MSSRF, in collaboration with the UAS, Dharwad and Bioversity International, has facilitated such interventions in southern and northern Karnataka. Deccan Development Society (DDS) has supported the setting up of an alternative public distribution system in Andhra Pradesh, linking local production of millets to local food security (DDS 2004). These initiatives have increased yield and thereby also increased the income of the farm households.

Overall, foodstuffs that are naturally nutrient-dense are by themselves important for addressing the issue of malnutrition; innovations and policy measures are needed in the value chain to improve their availability and intake by poor households and the women and children in these households in particular. In the case of NGO-led interventions, like that by MSSRF and DDS, women's groups are key actors in the value chain; it is expected that their capacity strengthening and increased nutrition awareness will lead to better intake and improved nutritional outcomes. In general, it is important for different actors like the private sector, development agencies and the government sector to improve productivity, affordability and accessibility to poor households, in order to reach the target group within these households.

4.2 Foods of Added Nutritional Value

Foods can be made more nutritionally rich through fortification interventions along the value chain. This may be pre-farm gate through biofortification of crop varieties at the breeding stage (e.g. iron-fortified pearl millet, zinc-fortified rice) or post-farm gate by adding micronutrients and minerals to foods (e.g., iron-fortified flour, vitamin A-fortified edible oil). Both the approaches, food fortification and biofortification, are initiatives aimed at enhancing the supply of nutrient-dense food through interventions along the value chain. Most of the biofortification interventions are government or international donor initiatives (e.g., HarvestPlus³ programme of the CGIAR) aimed at increasing the sustainability of nutrition focus in agriculture value chains and forging collaborations between the donors, governments and the private sector to reach malnourished populations. Trials on impact of intake of bio-fortified crops on nutritional status have shown positive results (Gunaratna et al. 2010; Finkelstein et al. 2015). Though bio-fortified rice, wheat and millets are yet to be introduced on scale, the pro-nutrition potential of these agri-food supply chains is to be noted.

Given the early phase of the biofortification route, food fortification is the most popular extant channel in operation for enhancing the nutritional value of foods to address different nutritional deficiencies. The food processing/fortification interventions considered in this review are mainly those led by private sector food players and international donor agencies. Milk Bikis, another product of BIL was re-launched in 2006 as a product fortified with calcium, iron, iodine and four “smart nutrients” — vitamins B₁, B₆, B₁₂ and D (Jarvis and Magarinos 2008). Sold with the message that four biscuits provided the equivalent energy of a glass of milk, it is popular across the country and available in petty shops in villages as well. A packet of 200g for Rs.10/- makes it very accessible and is consumed by both children and adults. Horlicks, a malted milk powder manufactured by Glaxo SmithKline Consumer Healthcare Ltd, another private player, has similar targeted products and is also steering a drive to address malnutrition.⁴ Amul is marketing a low-priced infant milk substitute, Amul Spray, fortified and sold in small packets, thus making it affordable to poor households.

Regulatory measures can go a long way in ensuring compliance with fortification, calling for action on the government front. A ready example, though not exactly within the purview of agri-foods, is the regulation to iodise all salt that enters the organised market in order to address iodine deficiency. Another example is the fortification of vanaspati or hydrogenated edible oil, which was made compulsory in India as early as 1953. Both public and private sector vanaspati manufacturers have to comply with the requirement. All vanaspati production from the organised manufacturing sector entering the market is therefore fortified. Interventions in the private sector are found to have helped in providing iron, zinc and vitamins through the fortification of food. Where women were involved in the processing work as a part of the fortification intervention, it could also be a route for reaching their households with the product. In the case of millets, there are studies that show improved supply of all the vital essential nutrients to the consumers through millet consumption (Verma et al. 2007).

³ www.harvestplus.org

⁴ <https://ahaarabhiyan.horlicks.in/>

There are several examples of targeted fortification initiatives led by the government with donor and NGO support. These represent a model of private-public partnership. **Box I** gives the highlights of a fortification initiative involving the government, the Food Fortification Initiative, an international partnership, and the local community. Capacity strengthening to ensure sustainability of such initiatives is a key aspect needing attention.

Box I: Village-level flour fortification in Madhya Pradesh

A village-level flour fortification project was undertaken in Madhya Pradesh (MP) through the Food Fortification Initiative (FFI) targeting the Sahariya tribal community, where 93 per cent of the children are undernourished and around 20 per cent are on the verge of death due to malnutrition. The fortification is being done by adding micronutrients in the wheat flour which is being supplied through the public distribution system. A situation analysis report by Public Health Foundation of India (PHFI) reported enthusiastic support for the initiative by the local government, community members and health workers.⁵ A report on the website of the Department of Food and Public Distribution, Government of India, mentions that the project was completed in September 2013. About 19591.6 mt of wheat flour were fortified through this project, utilising 29.4 mt of iron pre-blend, covering approximately 162,000 members of the Sahariya community in Guna, Shivpuri and Sheopur in MP through 540 millers. End-line evaluation results showed 4 per cent reduction in anaemia among the targeted tribal population from 91 per cent to 87 per cent, enhanced knowledge on causes, consequences and prevention of micronutrient malnutrition and anaemia, and a cost benefit ratio of 1:1.27 achieved. It is reported that the project is being sustained through self-help groups of local millers but the support of the Government of MP is limited.⁶

The pro-poor reach of fortification and biofortification programmes is a matter to be examined. Market-based distribution systems are not always effective in ensuring that fortified foods reach poor, undernourished populations who need it most. However, given the potential of a large rural market, several companies like Britannia Industries and Amul have developed good distribution and retail networks across the country and innovative strategies like small affordable packaging to reach out to rural areas and poor households. Britannia has also been using the advertisement medium to highlight the nutrition potential of their products and target its fortified biscuits at children.

4.3 Food Distribution

Food distribution programmes of the government come under the ambit of social protection measures and encompass or cross-cut the other two value chains, viz. naturally nutrient dense foods and foods of enhanced nutritional value. There are both state and central government schemes and these particularly target vulnerable sections of the population to address nutritional deficiencies. Value chains under food distribution programmes often involve different non-state

⁵ www.poshan.nic.in/jspui/bitstream/DL/635/2/Part-2.pdf

⁶ <http://dfpd.nic.in/?q=node/991>

actors/stakeholders who play an important role in the chain. The three major food distribution chains as mentioned earlier are: Mid Day Meal Scheme, Supplementary Nutrition Programme under ICDS and PDS. These are operational across all the states of India. We discuss here the interventions in these value chains as well as the importance of the food distribution value chains for enhancing the nutrient intake, in general, and by nutritionally vulnerable sections (children and girls/women) of the population, in particular.

The PDS is a food distribution network that provides subsidised foodgrains to economically deprived households. The primary commodities provided under PDS are rice, wheat and sugar; some states like Tamil Nadu and Chhattisgarh also supply pulses. The National Food Security Act, 2013 provided for the inclusion of millets in the PDS, following which the government of Karnataka announced the distribution of millets through the system. This source of supply can significantly help improve the consumption of millets by poor households.

The Supplementary Nutrition Programme (SNP) under ICDS provides nutrient-dense food to pre-school children aged below 6 years, adolescent girls, pregnant and nursing women. Special attention is given to undernourished children less than six years of age by giving additional dietary intake. The target population is provided with processed, ready-to-eat pre-mixes and hot cooked meals. The target population and food provisions vary across states. **Box 2** highlights the initiatives under the ICDS in some states.

The Mid Day Meal Scheme (MDMS) is targeted towards school-going children in government schools. Children attending school are provided with one full hot cooked meal. The state and central governments provide budgetary allocation for all the three food distribution supply chains.

The primary actors involved in the food distribution agri-food chain are state and central government agencies. Innovations in different states find international development agencies, NGOs, private players, self-help groups and co-operatives playing a role in the chain to enhance their effectiveness and impact. These innovations in food distribution value chains are efforts for improvement in efficiency, food safety and hygiene along the food distribution value chains.

Box 2: Bal Bhog in Gujarat, Ori-mix in Odisha and Pre-mix in Tamil Nadu, under ICDS

GAIN and the Gujarat government came together to develop the 'extruded fortified blend food' aptly called *Bal Bhog* (child's food), a pre-mix that is fortified with 11 essential micronutrients, fulfilling 50 per cent of the requirement of micro-nutrients and 33 per cent of the requirement of energy needs of children under the age of three years. This pre-mix is provided at the ICDS centres across Gujarat. The consumers are not charged for the products they receive from ICDS and the costs are borne by the government. The cost of product even after fortification is low, making it feasible for the government to sustain the initiative.

In a similar kind of initiative in the KBK (Kalahandi-Balangir-Koraput) region of Odisha, Ori-mix, a pre-mix is being provided to beneficiary households. Conventionally, at ICDS centres raw wheat, pulses and vegetable oils were provided to the beneficiary households; now Ori-mix or India-mix is replacing the customary 'take home ration'. The pre-mix is a more standardised product prepared hygienically and therefore better from the food safety point of view. A similar initiative is in operation in Tamil Nadu where a private agency and a women's cooperative are manufacturing the pre-mix that is distributed through ICDS centres.

Similar interventions in the SNP value chain are seen across different states in India

The Global Alliance for Improved Nutrition (GAIN) has launched an Integrated Food Fortification Programme with the Rajasthan government. Under this, more than 4,500 mt of wheat flour, 8,900 mt of oil and 41,000 mt of milk are being fortified every month and reaching about 15 million people.⁷ The focus of the initiative is to address micronutrient deficiency; the government food distribution system is the channel used to reach the target population.

The Mid Day Meal Scheme (MDMS) targeting school-going children is another innovative way to target undernourishment in young children and adolescents. Studies have shown that MDMS significantly improves school enrolment and nutritional outcome of children (Laxmaiah et al. 1999). A cost and benefit analysis of serving prepared food (i.e., 'on site' school feeding) highlights the significance of 'on site' over 'take home' of food distribution (Afridi 2010). It argues that a low cost of less than 5 cents (about Rs. 2) reduces the gap between RDA (Recommended Dietary Allowance) and the actual daily intake up to 30 per cent for calories, 10 per cent for iron intake, and almost 100 per cent for proteins. **Box 3** highlights key findings of some studies on the impact of MDMS on the nutrition status of schoolchildren.

In Andhra Pradesh, 61000 school children in Vishakapatnam were provided iron-fortified rice called Ultra Rice in MDMS in a pilot initiative to address iron deficiency. PATH and Naandi Foundation (both NGOs), GAIN and the government of Andhra Pradesh came together for this initiative. The

⁷ <http://www.gainhealth.org/knowledge-centre/project/india-integrated-food-fortification/>

fortified rice was blended with normal rice while cooking. The cost per child per day reportedly worked out to less than a quarter of a penny (Rs. 0.10). A study by the National Institute of Nutrition revealed reduction in morbidity in children who consumed Ultra Rice.⁸ A similar study in Madhya Pradesh suggests that MDMS is instrumental in reducing the gap between actual and recommended dietary intake of various food groups in children (Afridi 2010). NGOs, development agencies, self-help groups and cooperatives are instrumental for collaborating with the government in many of the innovative interventions under the MDMS supply chain.

Box.3: Dietary impact of Mid-day Meal Scheme in schools

A total of 2,694 children (MDMS: 1361; Non-MDMS: 1333) from 60 schools in Karnataka were covered in a study. Results of the study indicated better enrolment ($p < 0.05$) and attendance ($p < 0.001$), higher retention rate with reduced dropout rate ($p < 0.001$), a marginally higher scholastic performance and marginally higher growth performance of MDMS children. Thus, the MDMS is associated with better educational and nutritional status of schoolchildren in Karnataka. (Laxmaiah et al. 1999)

Another study utilising the data collected on the school meal programme examined the extent to which children benefit from the targeted public transfer. Relying upon built-in randomness in whether a child's 24-hour food consumption recall was for a school or non-school day, the study found that the daily nutrient intake of programme participants increased substantially by 49 per cent to 100 per cent of the transfers. The results are robust to the potential endogeneity of programme placement and individual participation. The findings suggest that for as low a cost as 3 cents (Rs. 1.35) per child per school day the scheme reduced the daily protein deficiency of a primary school student by 100 per cent, the calorie deficiency by almost 30 per cent and the daily iron deficiency by nearly 10 per cent. At least in the short run, therefore, the programme had a substantial effect on reducing hunger at school as well as protein-energy malnutrition (Afridi 2010).

In Rajasthan and Madhya Pradesh, high iron-fortified biscuits were introduced in MDMS to combat iron deficiency in children. Naandi Foundation, GAIN and Britannia Nutrition Foundation were the key non-state actors in this intervention. Britannia developed a variant of its Tiger biscuits that was included in MDMS. Efficacy trials suggest that intake of high iron-fortified Tiger biscuits in required quantities can reduce the prevalence of anaemia in school-going children (Bal et al. 2010). Food distribution schemes like MDMS provide an opportunity to target the deficiency through supervised consumption.

The Public Distribution System (PDS) in India is another important distribution chain. By providing cereals at subsidised price to targeted households, PDS aims to ensure availability and access at affordable price and thereby ensure household food security. While most states have a targeted PDS, Tamil Nadu has a universal PDS. The commodities supplied under PDS also differ from one

⁸ http://www.path.org/publications/files/MCHN_u_r_case_study_ap.pdf

state to another; Himachal Pradesh, Andhra Pradesh, Chhatisgarh and Tamil Nadu provide pulses in addition to rice and wheat (Khera 2011). Given the large-scale reach of PDS, a pro-nutrition focus in the PDS supply chain has high impact potential. As mentioned earlier, Karnataka is moving in the direction to include millets in the PDS. **Box 4** highlights two pilot initiatives of introducing millets in the PDS and ICDS.

Box 4: Millets in the food distribution supply chain

The Andhra Pradesh Drought Adaptive Initiatives project introduced an alternative public distribution system in Andhra Pradesh to link local production of millets with the local food and nutritional security. A pilot study in Anantapur district of Andhra Pradesh was done with 2000 households by the NGO, Watershed Support Services and Activities Network (WASSAN) with support from the district administration in 2009.⁹ The pilot programme was designed to study the improvement in off-take of locally produced millets (*ragi*) if provided at subsidised price (50 per cent of the market price) through the Fair Price Shop (PDS outlets). The study showed increase in off-take by labour households. The production of *ragi* increased three times in the pilot villages due to assured procurement.¹⁰

A similar pilot study with the Integrated Child Development Services (ICDS) scheme in Srikakulam district of Andhra Pradesh in 2013 focused on integrating millets into the SNP.¹¹ This initiative provided millets-based hot cooked meals to 320 children in the 3-6 year age group at 17 ICDS centres.¹²

With the enactment of the National Food Security Act India in 2013, there is now greater opportunity for local procurement of foodgrains and inclusion of millets in PDS. Millets are better suited crops for vast semi-arid and rain-fed farming areas of India; they are also more nutritious than the rice and wheat provided currently through PDS. Including millets in food distribution chains like PDS and ICDS, besides increasing the nutrient intake of poor households, will also provide an incentive to production through increased demand for such 'climate smart' crops.

Interventions through the food distribution supply chain are vital for reaching poor households in developing countries at scale. Adequate attention to issues of food safety and hygiene along the chain are important aspects. But overall, the food distribution agri-food chain provides an opportunity for addressing the widespread problem of undernutrition with focus on vulnerable segments like women and children, through nutrition sensitisation and effective targeting.

⁹ Introducing millets into Public Distribution System (PDS): A Pilot project by WASSAN in Andhra Pradesh http://www.dhan.org/smallmillets/docs/report/Introducing_millets_into_Public_Distribution_System.pdf

¹⁰ http://www.wassan.org/apdai/apdai_2.htm, accessed 27 March 2015

¹¹ http://www.wassan.org/resource_material/ICDS/documents/Brochure_ICDS_Srikakulam.pdf. Accessed 28 March 2015

¹² <http://www.thehindu.com/todays-paper/tp-national/tp-andhrapradesh/millets-nutritional-scheme-for-tribal-children-in-srikakulam-dt/article4363976.ece>. accessed 30 March 2015

5 Targeting and Measurement of Nutrition

The 40 interventions considered in this review either have potential for impact on nutrition status or were targeted for nutrition impact. The different strategies/pathways necessitate use of different indicators. Although the final nutrition outcome is expressed by a healthy body, most of the interventions focus on increased intake of nutrient-dense food or food of enhanced nutritional value as the way to improve nutritional outcome. In the case of naturally nutrient-dense foods, the interventions largely aim to improve livelihoods of farmers by improving production, but this has implications for: i) improving incomes and purchasing power to access nutritious food and ii) enhancing availability of nutrient-dense food like milk and millets, which in all likelihood would also be consumed by the producers as well.

Some interventions in the category of foods of enhanced nutritional value use biofortification as the strategy to improve nutritional intake. There are indications that biofortification interventions can significantly enhance the micronutrient intake and improve nutrition outcomes in women and children (Gunaratnaa et al. 2010; Kodkany et al. 2013; Finkelstein et al. 2015). **Box 5** highlights results of a study on consumption of bio-fortified millet by children in Karnataka.

Box 5: Bio-fortified pearl millet in Karnataka

Millet is unusually drought resistant and consequently there is a progressive increase in the use of these grains as a human food staple, especially in large areas of India. A study to determine the absorption of iron and zinc from pearl millet biofortified with 2 micronutrients that are typically deficient in non-fortified, plant-based diets was undertaken in 40 children aged 2 years in Karnataka, India (n = 21 test/19 controls). Three test meals providing $\sim 84 \pm 17$ g dry pearl millet flour were fed on a single day for zinc and 2 days for iron between 0900 and 1600 hours. The quantities of zinc and iron absorbed were measured with established stable isotope extrinsic labelling techniques and analyses of duplicate diets. The mean (6 SD) quantities of iron absorbed from test and control groups were 0.676, 0.48 and 0.236, 0.15 mg/d, respectively ($P < 0.001$). The quantities of zinc absorbed were 0.95 60.47 and 0.67 60.24 mg/d, respectively ($P = 0.03$). These data did not include absorption of the modest quantities of iron and zinc contained in snacks eaten before and after the 3 test meals. The study found that quantities of both iron and zinc absorbed when iron and zinc biofortified pearl millet is fed to children aged 2 years as the major food staple is more than adequate to meet the physiological requirements for these micronutrients.

(Kodkany et al. 2013)

Interventions in this category that enhance nutrition by physical fortification of micronutrients have assessed the impact and found improvement in nutritional outcomes. For instance, in the case of

iron fortification of Tiger biscuits, as mentioned earlier, studies have established reduction in prevalence of anaemia (Bal et al. 2010). Radhika et al. (2013) estimated the nutritional outcome of fortified red palm oil in pregnant women and their infants and established its effectiveness in delivering the desired nutrition inputs to the target segments. The highlights of this study are given in **Box 6**. The intervention is an example of effectively addressing the vulnerable or fragile segment of the population for improving nutrition status.

Box 6: Red palm oil supplementation in Andhra Pradesh

A total of 170 women were recruited at 16 to 24 weeks of gestation and randomly assigned to an experimental group that received red palm oil to supply approximately one recommended dietary amount (RDA) (2,400 micrograms) of beta-carotene or to a control group that received an equivalent volume of groundnut oil. The women received the oils for a period of 8 weeks, starting at 26 to 28 weeks of gestation and extending to 34 to 36 weeks of gestation. The mean post-intervention (34 to 36 weeks) levels of serum retinol were 1.20 +/- 0.22 (SD) mumol/L (95% CI, 1.15-1.25) in women receiving red palm oil and 0.73 +/- 0.15 mumol/L (95% CI, 0.69-0.77) in their infants; these levels were significantly higher than those in women receiving groundnut oil (1.07 +/- 0.26 mumol/L; 95% CI, 1.01-1.13; $p < .01$) and their infants (0.62 +/- 0.17 mumol/L; 95% CI, 0.57-0.67; $p < .001$). A significantly lower proportion of women in the red palm oil group than in the control group had vitamin A deficiency (serum retinol levels < 0.7 mumol/L) after intervention (1.5% vs. 9.7%). The proportion of women having anaemia was significantly lower ($p < .01$) in the red palm oil-supplemented group (80.6%) than in the control group (96.7%). The mean birth weight and gestational age of the infants did not differ significantly between the two groups. An increased risk of low birth weight ($p = .003$) and pre-term delivery ($p = .000$) was observed with decreasing serum retinol levels in the third trimester of pregnancy. These results show that red palm oil supplementation significantly improved maternal and neonatal vitamin A status and reduced the prevalence of maternal anaemia. Maternal vitamin A status in the later part of pregnancy is significantly associated with foetal growth and maturation. Hence red palm oil, a rich source of bio-available vitamin A, could be used as a diet-based approach for improving vitamin A status in pregnancy. (Radhika et al. 2013)

However, it should be noted that the study is an efficacy trial, which establishes that, once consumed, the product has positive effects on nutritional status. From the perspective of market-based interventions, there is a further challenge, which is to establish whether or not in the market environment the target populations will actually purchase and consume the foods in the right frequency and amounts. Several of the studies included in this review have assessed the impact on

nutrition status of the target population through scientific research methods, e.g., Laxmaiah et al. 1999; Tarozzi 2002; Afridi 2010; Muehlhoff et al. 2011; Muthayya et al. 2012.

Interventions through the food distribution chain generally do not evaluate the impact on nutritional outcomes, unless a private or donor agency is involved in piloting an innovation. But the focus of these supply chains is on targeting and making nutritious food available to the lowest economic segments and vulnerable sections of the population. As part of their regular mandate, ICDS centres have to monitor the nutrition status of children. There are indications that the introduction of Bal Bhog in ICDS centres in Gujarat has led to reduction in prevalence of undernourishment in children.

There are studies that have statistically assessed the impact of the school Meal Day Meal Scheme. As highlighted in Box 3, a cost and benefit analysis of serving prepared food (i.e., 'on site' school feeding programmes) proves the significance of 'on site' over 'take home' of food distribution (Afridi 2010).

Nutritional outcomes are associated with several factors other than just intake of nutritious foods — factors like caring practices, health, sanitation, and empowerment of women, as highlighted in Henson and Humphrey (2015); hence the impact of agri-food value chains often gets limited to ensuring availability and affordability of nutrient-dense food. There are issues of hygiene and food safety that will also determine impact on nutrition outcomes. Some of the studies reviewed, especially under the category of nutrient-dense foods, are not explicitly targeted at addressing undernutrition but have the potential to do so. The marketing channels are operated mainly by private sector players. The main focus of these interventions is to improve the availability of nutrition-rich food products to the consumers and establish supply chains to improve the sustainability of the market interventions in the value chains (FICCI 2010b; Hegde and Madhuri 2013). The impacts of such interventions on nutrition have however not been studied.

6 Cross-Cutting Themes

6.1. Gender

There remain questions of interventions along the agri-food value chain cutting across gender and reaching nutritionally vulnerable sections like women, girls and children in general. Food distribution programmes targeting children and women directly address gender in the post-farm gate agri-nutrition value chains. The involvement of women in community-based food fortification also impacts the gender component in the nutrition chain. Kilaru et al. (2005) assessed the scope of improved gender participation in nutrition value chains through community-based nutrition education programmes. ICDS is targeted to reduce nutrition deficiencies among adolescent girls, pregnant women and children. These interventions are designed to address the gender balance by focusing on the nutrition status of more vulnerable sections like women and children.

Largely, the agriculture innovations in biofortification as shown by trials and food fortification promoted by governments to mitigate vital micronutrient deficiencies among children and vulnerable segments as well as distribution of nutritious food among children in schools and at ICDS centres and other noon meal beneficiaries were found to be successful means of addressing micronutrient malnutrition in the integrated value chain. The review found 10 specific interventions (within the group) which targeted the iron, vitamin A and zinc intake among women and children. These interventions were made in different regions (locations) and at varying time points. At a

disaggregate level, these interventions were found effective in mitigating undernutrition among women, children and other vulnerable sections.

Two interventions were targeted at effectively reducing the anaemia levels among pregnant and non-pregnant women.

The gendered impacts along the value chain of initiatives aimed at increasing the production, processing and consumption of nutrient-rich foods are much less clear. Studies have shown that farm-level initiatives aimed at increasing the production of nutrient-rich foods while having positive outcomes, may in some circumstances unduly impact on women's workloads, either through production, or because of changes required in the processing and preparation of food. Similar effect might be expected in initiatives focused beyond the farm gate.

6.2 Fragility

The fragility crosscut examines the state's willingness and capacity to provide an environment that enables various value chains to work towards catering nutrient-dense food to targeted sections of society (DFID 2005). The existence of distribution systems for decades like PDS, school feeding programmes like MDMS, weaning food initiatives at ICDS centres and the recent enactment of the Food Security Act establish the fact that the Indian State has capacity and willingness to enable and support initiatives that are meant to reach the poor for their nutritional security.

However, a critical examination often reveals issues of leakages in these structures. Also, demeaning the importance of diversity in food by major food programmes running in India is another policy challenge yet to be addressed on the ground. There have been various pilot initiatives in different geographical locations, for e.g., fortification of flour (Public Health Foundation of India 2010), introduction of pulses in PDS and many other initiatives by ICDS (GoI 2013b); but there has been no thrust on replication and scaling up of successful initiatives of this nature.

The huge market penetration of Britannia's fortified Tiger biscuits, Milk Bikis or Amul's low priced Amulspray and other products highlights the possibility and potential of market strategies of business enterprises to impact on improvement in nutritional status of the poor. Initiatives where self-help groups of women have been integrated for supply of nutritious food to school feeding programmes are examples for integrating livelihood and nutrition issues. These instances show that government institutions are able to create environments for commercial value chains that can improve the access to nutritious food by the poor.

Although the country is food secure in terms of foodgrain production, the fact remains that India accounts for about one-third of the hungry in the world. This clearly points to the urgent need to address the delivery system and improve the functioning of existing agri-food supply chains.

6.3 Innovation

In a populous country like India with large inequalities in income and wealth, establishing food and nutrition security has to be an intelligent combination of strategic interventions and innovative operations in delivery. The integrated three-pronged strategy of increasing the availability of

naturally nutrition-dense foods through promotion of crop and livestock segments, enhancing the nutrient content in food through biofortification and food fortification, and creating distribution and marketing channels targeting different consumption segments for improvement in nutrition status is a potentially innovative intervention in the agri-food value chains. The reviews included here in the three vital segments are illustrative of the strategic linkages in the value chains for impact on the ground. Interventions in naturally nutrient-dense foods enable enhanced consumption as well as income on the one hand, and establish newer supply chains for improved nutrition delivery. The fortification value chains improve the availability of higher nutrition to consumers and the enhanced income generated out of the first may enable better access to such high nutrition food sources.

The dairy and livestock interventions are highly relevant in terms of increasing both production and market outreach for these nutrient-dense foods. The food fortification intervention and its distribution channels are innovative in the sense that it establishes unique supply chains. The school meal scheme caters to the nutrition deficiency of school-going children and also educates them on facts about nutrition. The GAIN-WFP partnership with the government of Gujarat to provide micronutrient-enriched food to children through the ICDS delivery channel based on the level of malnutrition highlighted in **Box 7** is a supply chain that could be considered for replication.

Institutional innovation is observable in the food fortification sector. Britannia, Naandi Foundation and GAIN demonstrated a private public partnership (PPP) model for delivering nutrition through food fortification (Jarvis and Magarinos 2008). Britannia has a number of fortified biscuits and has partnered with Naandi Foundation to introduce iron-rich biscuits in the diets of children twice a week through MDMS. The project implements a two-pronged approach: first, supplementation of the rice-based meals in Naandi Foundation's centralised kitchen for the mid-day meal programme in Andhra Pradesh with Britannia's iron-fortified Tiger biscuits twice a week; and second, wheat-based meals in Madhya Pradesh and Rajasthan supplemented with iron fortified biscuits.

Box 7: Improving supplementary nutrition under ICDS: An innovative approach in Gujarat

The focus of the intervention was to analyse feasibility of providing extruded fortified blended food (EFBF) to children aged below 6 years covered by the ICDS. The EFBF developed by GAIN and WFP, also known as *Bal Bhog*¹³, has 11 essential micronutrients and is rationed according to the severity of the malnutrition (underweight) of children. Private manufacturers selected through an e-tendering process produced, packaged and transported the food to the delivery point – the ICDS centre. The monthly progress report by the Department of Women and Child Development, Government of Gujarat (DWCD) reflected a declining trend in severe malnourished children over a period of 7 to 8 months. During the initial study period (2007-08) about one million children were covered. The programme has been taken over by the state government and as per more recent reports, more than 3 million children are beneficiaries.¹⁴ The cost of production for *Bal Bhog* was found to be Rs. 2 per child per day. Since the initiative uses a well-spread institutional set-up — the anganwadi (ICDS centre) — it is easier to keep records of the health of the children and ensure consumption of the EFBF. Given the acceptance of *Bal Bhog* as tasty and easy to prepare food by households, the intervention has been sustained for more than 6 years and has become a part of the government initiative to address malnutrition.

Markets are proactive in the food and nutrition value chain of India because of the high volumes and the potential it offers to the food processing industry. The interventions reviewed on the market front are innovative in the sense that the private market players have established their cost advantage in production by linking the back-end production networks, creating logistics and supply chain networks. This has enabled poor consumers to access food items that they were not able to earlier. Further, by packaging and pricing to suit different segments, they are able to reach different consumer segments. The introduction of smaller size packs by the health food segments (e.g., Horlicks, Aahar, Boost, Bournvita) and expansion of coverage in rural areas and smaller towns have been quite innovative as marketing strategies in the food value chain. The back-end market interventions by Adani Agrifresh, Reliance and Bharti Enterprises are innovative in establishing sustainable supply sources to retain the markets. Another enhancement in the value chain has been the creation of awareness and knowledge among people about the various sources of nutritious food.

¹³ 'child food' in Hindi

¹⁴ <http://www.wcd.gujarat.gov.in> accessed 19 July 2014

7 Conclusions

This review examined 40 agri-food value chain interventions under three categories: naturally nutrient-dense food, foods of increased nutritional value and food distribution. All these interventions aimed to, or have potential to, increase the consumption of nutrient-dense foods or increase their supply to post-farm gate poor populations in general and specifically to women and children. This review has provided a descriptive overview of the actors and activities involved in these interventions. It makes an evaluation of the extent to which such interventions address nutrition issues in a value chain mode.

An overview of these interventions has shown that few are focused directly on post-farm gate consumption by poor population groups. But a point to keep in mind is that the Indian population is largely rural and dependent on agriculture. So a large section of the producers (e.g., of foodgrains, milk, meat) would also be primary consumers; at the same time, a substantial part of the consumption basket of many has to be sourced from different supply/distribution chains. The overall nutrition intake across targeted beneficiaries arising out of the interventions can be the best indicator for assessing the effectiveness of the value chains. Of the 40 interventions reviewed, the ones that measure the nutrition impact look at the gains in terms of the beneficiary status before and after the intervention. The main variables identified in studies for impact assessment through food fortification and biofortification have been through calculating the levels of iron and zinc deficiency, height and weight, level of anaemia, deficiency of vitamins A, C and E. Most of these studies have a baseline and end result assessment of the nutrition outcomes. However, interventions like dairy, poultry, fishery, nutrient-dense cereals like millets and sorghum, do not have the exact measure of gains in the above components, though the outcomes are very positive in terms of nutrition gains arising from diet composition as well as income and substitution effects. The outcome column in the Annexure highlights the cases where the agriculture interventions do help reduce undernutrition.

Malnutrition is a multidimensional problem that requires multi-sectoral interventions. Nutrition intervention programmes have been taken up and are being implemented by central and state governments and voluntary agencies with a view to ameliorating the nutritional status and health of vulnerable sections of the population. While the PDS, ICDS and MDMS are nationally-mandated programmes, some states have gone an extra mile in innovation and delivery. Given the pro-poor targeting, just effective delivery of these existing programmes/schemes itself can make a difference (Khera 2011). These examples have to be highlighted for other states to follow. Likewise, the sustainability of food distribution approaches piloted and effectively demonstrated with donor support depends on the state's willingness to continue the same.

An aspect that has not been critically examined in the review but will be addressed in the case studies that will be undertaken in the next phase of research is the institutional and organisational dimensions of the value chain. Besides the consumer perspective, these aspects will help us highlight the issue of inclusion of primary producers in the chain and how far they gain in terms of better nutrition and participation in the value chain; how issues of gender, fragility and innovation are addressed will also be clearer. For instance, in the dairy sector, there is Amul and other dairy

cooperatives with a membership-based approach, member-owned cooperatives like Mulkanoor Dairy Cooperative or state-mediated initiatives like Aavin in Tamil Nadu and private sector dairy companies too. Their priorities and focus will determine their operational thrust and consequent impact.

The following observations emerge from the interventions included in this review:

The value chain approach is largely being utilised as a tool to improve livelihoods with some examples of interventions connecting this approach to post-farm gate consumption.

Interventions involving sources of naturally nutrient-dense foods such as home gardens and livestock largely focus on the producer and only subsequently the post-farm gate consumer. Naturally nutrient-dense agri-value chains in this review include millets, dairy and other livestock interventions which involve a range of actors from donors, to the government, NGOs, research institutes and the private sector. While many are directed at improving the supply and quality of natural outputs, a few focus on processing and value addition along the value chain, as on millets (Bala Ravi et al. 2010). There is scope for interventions of this type to incorporate objectives around post-farm gate consumption by poor populations.

Fortified staples have a strong potential to address undernutrition among target populations, but require the right processes and policy in place.

Food fortification has a vital role in ensuring sustainable nutrition security. The food fortification initiatives/studies of wheat, milk, edible oils, millets, etc., included in the review specifically aim to improve the nutrition of women, children and girls. Such interventions require coordination, monitoring and a set of procedures to be followed at practically every step of the value chain, to be successful (Hotz, C. and McClafferty, B. 2007). The regulatory frame and delivery and monitoring systems have to be strengthened. Trials of biofortification of staples have shown potential for impact on nutrition, and interventions in biofortification can be enablers of affordability and quality; but these are yet to be taken up on a commercial scale for post-farm gate impact; necessary regulation, pricing and consumer acceptance are factors to be taken into consideration while moving forward in this direction.

Fortification also happens at various stages of the food-nutrition value chain. For example, the fortification of flour by companies marketing wheat flour is enabling nutrition enhancement at household levels. Similarly, food fortification of the ready-to-eat segments and the intermediate levels are also boosters of nutrition intake. However, there is very little literature on the impact of such interventions in terms of measurable outcomes.

The geographical dimension becomes an important aspect in the case of the crop/food being fortified. For instance, zinc-fortified rice will have demand only among a rice-eating population and not among a population whose staple cereal is wheat. Likewise, the potential for flour fortification to impact on nutrition outcomes depends on wheat flour being a major item of the diet.

While local value chains enable better market reach for farmers by bringing down inefficiencies of long value chains, the consumer end is often the urban location; but there are products that are marketed well to reach the poor in rural, semi-urban and urban spaces in different locations.

The interventions led by the private sector do not market their fortified products solely to consumers in lower income groups.

The private sector players target a range of segments of the population in marketing their interventions; they are affordable to lower income brackets only when they are packaged and sold at affordable prices. Companies like Britannia, Adani and Reliance have demonstrated effective targeting of low income segments in their marketing chains through appropriate pricing and packaging strategies. The rural market also represents a large untapped segment for the corporate sector and making inroads through different strategies is important from the long-term perspective.

From the point of view of interventions focusing on establishing availability, accessibility and quality of the nutrition sources in the value chain, it is observed that those under distribution supply chains enhance the affordability of micronutrients to the target population. Interventions in processing and marketing can ensure the availability and quality of the nutritious food items to the target consumers, but affordability remains a question unless they are sponsored and targeted at vulnerable groups.

Markets play a significant role in distribution and enabling access to nutrition by integrating the product customisation, packing and pricing mechanisms.

Markets perform a vital role in linking the poor to nutritious products through differentiated marketing strategies for reaching out to them. The entry of major food brands into the small towns and the availability of their products enhance their access to consumers. Technology-oriented production systems and the integrated value chain strategy in the sourcing of base food materials make it feasible for food producers to offer a competitive advantage in the markets and create opportunities to primary suppliers. The competitive markets (with no entry/ exit barriers) and the large consumer base make pricing more affordable to the poor to access nutrition-dense products from the marketplace. The awareness interventions, media and advertising and market signals enable the consumers not to be exploited by the markets.

Direct link between private sector players and producers for marketing of farm produce has a two-fold effect – that of removing intermediaries in the value chain and ensuring better income for the producers and also improving quality of the produce reaching the post-farm gate consumer.

Initiatives like Adani Fresh and Reliance Fresh have established direct linkages with farmers for sourcing produce and have well-established supply chains for market outreach. Amul is another example of providing greater access to small producers for perishable products. The value chain also highlights efficiency in reaching across distant regions/states of India to fulfil unmet demand for milk.

The interventions reviewed do not bring out a gendered understanding of roles of actors in the chain.

The value chain case studies planned in the next phase of research, besides examining the impact on women's workloads, will endeavour to examine issues such as who is responsible for making decisions about purchasing products (particularly with respect to fortified prepared foods) and which income streams within the household are devoted to this. Women's roles as agents of change will also have to be examined, i.e., the roles that women play in facilitating value chains for nutrition.

Donor-government-NGO and private sector partnerships have demonstrated evidence of the positive impact of food distribution initiatives on nutrition levels.

Initiatives like support for flour fortification by GAIN and WFP and tying up with state governments and local NGOs for outreach under the mid-day meal programme, and similarly the Naandi-Britannia-state government partnership have demonstrated positive impact on the nutrition of schoolchildren and tribal communities. The sustainability, replication and expansion of these programmes are dependent upon the availability of continued funding support or budgetary allocation. The takeover of the GAIN-WFP-supported Bal Bhog initiative by the government of Gujarat as a state initiative is a positive example in this direction. This also highlights the importance of different stakeholders: Governments, NGOs, private sector and donor agencies and the efficacy of partnership models.

The food distribution chain is important for reaching poor and vulnerable populations in a targeted manner.

Markets-led interventions will not have explicit targeting. This places the onus on the food distribution agri-food chain to improve the nutrition status of the poor and vulnerable sections of the population. Governments in developing countries have a definite role to play in this direction.

The review examined different kinds of agri-food value chains that have potential to reach poor populations in India. These value chains will have greater roles to play in future with increase in national income levels and higher penetration in untapped locations. Given the changing economic scenario, it is important for decision makers of food policy to ensure that these value chains provide safe, nutritious affordable products for all sections of the population.

It is hoped that this desk review and analysis will serve as a guide to an understanding of the agri-food value chain landscape in India. Drawing from the review, three agri-food value chains are being taken up for detailed case study to examine their potential to deliver nutrient-dense foods to low income populations. These are:

1. Amulspray as an example of a business driven agri-food value chain of a fortified naturally nutrient-dense food targeted at infants
2. Iron-fortified Tiger brand biscuits of Britannia Industries Limited as an example of a food of enhanced nutrient value reaching low-income households

3. The Supplementary Nutrition Programme under the Integrated Child Development Scheme as an example of an agri-food based food distribution value chain targeted at women and children.

The case studies will follow the framework of Henson and Humphrey (2015), and aim to examine their effectiveness, the challenges, and areas of policy support needed for delivering results.

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Annexure
Summary of the review of agri-food chain interventions

Intervention	Aim	Primary Beneficiaries	Description / Key Activities	Expected Outcome	
Naturally Nutrient-Dense Foods					
1.	Sorghum- and Pearl Millet- based Nutrition in India	To understand dietary contribution to nutrition intake in major sorghum and pearl millet production regions to quantify micronutrient deficiencies	Consumers farmers, traders, wholesalers, retailers		Increased nutrient intake
2	Promoting Nutritious Millets for Enhancing Income and Improved Nutrition: A Case Study from Tamil Nadu and Odisha	To support the contributions of three nutritious millets, namely, finger millet, little millet and Italian or foxtail millet, to strengthen food security and to enhance the income generation of the rural poor	Farmers and consumers	<ol style="list-style-type: none"> 1. Enhancing the production and productivity through the use of better seeds and improved cultivation practices 2. Strengthening local capability for production and supply of quality seed at the community level 3. Introducing drudgery-free grain-processing technology to assist women towards promotion of consumption of these grains and enhancing income by building value chain 4. Creating awareness on the 	Increase in millet production and consumption

				importance of millets for food and nutritional security	
3	Enhancing Food Security and Income of the Rural Poor through Technological Support for Improved Cultivation of Finger Millet: A Case Study from Southern Karnataka	To increase production and consumption of millets	Farmers and consumers	Enhancing the productivity and production of finger millet; increasing the income of finger millet growing farmers, and creating awareness of the opportunities for enhanced and diversified use	Increased production and consumption
4	Enhancing Food Security and Income of the Rural Poor through Technological Support for Improved Cultivation of Finger Millet: A Case Study from Northern Karnataka	To improve local cultivation practices; to introduce value addition	Farmers and consumers	<ol style="list-style-type: none"> 1. Refining the cultivation technologies and disseminating these to the farmers 2. Developing value addition strategies (through processing, marketing, commercialisation) and promoting their sustainable utilisation 	Higher value addition to millets
5	Fisheries Sector Intervention for Livelihoods	To carry out livelihood development in fisheries sector	Fishermen and women	Promoting fisherfolk as co-producer partners with significant shares in residual claim and residual control in fishery organisations	Consumption of fish products

6	Milk District Model of Nestle for Improved Nutrition	A supply chain of milk procurement to improve profitability and well-being of small-scale producers	Small-scale milk producers	Linking cattle growers and milk cooperatives to Nestle for a continuous source of income	Maintenance of nutritional value of the products
7	Poultry Industry: Looking Beyond the Farm Gate	To promote small poultry units to increase supply and reduce prices of animal protein in rural areas	Households	Increasing productivity and farmer incomes; increasing availability of poultry products	Increased intake of poultry items, protein intake, dietary diversity
8	Duck-fish Production System for Nutrition Enhancement	To secure food and nutrition among labour households	Women farmers	Rearing ducks in the village fishing tank	Vitamins A and C, protein and calcium intake
9	Milk producers Cooperative: Karnataka Dairy Development Corporation	To assess the impact of milk producer cooperatives in terms of labour, income inequality and production as well as intake of milk/ milk products.	Village households	Increasing milk consumption	Dietary intake
10	Value-added Processing in Sorghum	To increase intake of sorghum	Farmers and Consumers	Educating about the nutritional content of sorghum; building entrepreneurial development through workshops; expanding value chain through post-harvest training; increasing awareness through mobile publicity vans and product promotions in malls	Increased consumption of sorghum; rise in income of cultivators by improving the value chain
11.	Creation of Storage Facilities for Agricultural Producers	To achieve better prices for farmers by introducing improved post-harvest	Farmers	Promoting scientific storage techniques	Reduction in storage losses

		management of agriculture produce			
12.	Adani Agri-Fresh Apple Value Chain	To create infrastructure for storage of apples and hence bring better prices for apple cultivators	Farmers and Consumers	Transferring post-harvest expertise, aiding price discovery, produce grading, and cold chain development	Increase in farmer procurement prices, reducing food spoilage and loss of nutrients
13.	Creation of Infrastructure for Fruits and Vegetables	To launch low-cost cold selling carts for supply of fresh fruits and vegetables, and thus to improve prices for vegetable cultivators	Farmers and Consumers	Transferring of post-harvest expertise, facilitating price discovery, packaging, branding, and promoting <i>Samriddhi</i> air-conditioned green carts	Consumer acceptance of <i>Samriddhi</i> cold cart marketing; promotion of cold storage facilities, setting up effective labelling and innovative price mechanisms
14.	Contract Farming of Field- fresh Foods: JV of Bharati Enterprises and Del Monte Pacific	To strengthen value chains by introduction of post-harvest/ storage infrastructure	Farmers and Consumers	Establishing public-private partnerships in research; promoting, agricultural extension	Quality control during all stages of production, provided a post-harvest facility which is equipped with temperature-controlled storage rooms, automated and conveyor driven material handling equipment, microbiological lab, is compliant with British Retail Consortium norms

15.	Amul: Low-priced Packaged Butter for the Poor Urban Population	To benefit consumers and producers of milk by increasing production and stabilising prices	Low-income urban consumers	Promoting Amul's several small quantity, affordable dairy products which can be purchased by low income groups, thereby improving dairy consumption	Increased consumption of dairy products
16.	Amul: A Model Co-Operative Dairy of Small- Scale Dairy Farmers	To assess Amul, the co-operative movement and to study the ways to uplift landless labourers	Poor rural dairy farmers	Assessing the extent to which cooperative dairying according to the Amul model developed by the Kaira District Co-operative Milk Producers' Union has been successful	Rural development
17.	Intervention to Improve Farm to Market Linkages in Dairy Farming	To assess costs and benefits in contract farming in milk value chains in western Rajasthan	Dairy farmers	Preserving the nutritional value of milk and value addition	Maintenance of nutritional value
18.	Retailing of Fresh Fruits and Vegetables through Chain Stores	To make fresh fruits and vegetables available and to lower prices by shortening supply chains and improving retail outlets	Producers and Consumers	Sourcing from the farmers and selling directly to consumers removing middlemen through the 'farm to fork theory', bringing fresh products like fruits and vegetables at a much lower price to households.	Shortened value chains
19.	Creating Shared Value in Dairy (<i>Saanjhapan</i>)	To promote hygienic practices and to retain quality of milk	Dairy farmers and milk consumers	Creating shared value with focus on rural development, nutrition and water	Good quality of milk, promotion of hygienic practices
20.	Primary Processing of Cashewnut by Farmers' Producer Cooperative	To add value to cashewnut by primary processing for cleaning, sorting and grading	Poor farmers	Linking poor and marginalised tribal farmer households cultivating cashew to the market	Better returns for the producers; increased consumption of cashew

	and Centralised Processing and Marketing	and centralised packing and labelling.			apple and cashewnut by the cultivator households
Foods of Increased Nutritional Value					
1	Improving the Crop Quality through Improved Content of Iron, Zinc	To provide additional gain of iron and zinc from morning breakfasts through fortified pearl millet	Smallholder farmers, consumers	Increasing micronutrient intake	Address malnutrition through biofortification
2	Enrichment of Fertilizers with Zinc	To improve nutrient content in crops	Farmers and consumers	Applying zinc fertilisers to provide a quick and effective approach to biofortification of cereal grains with zinc	Improvement in grain zinc concentration and grain yield
3	Quality Protein Maize (QPM)	To encourage consumption of QPM (quality protein maize) instead of conventional maize that will lead to a 12% (95% CI: 7–18%) increase in the rate of growth in weight and a 9% (95% CI: 6–15%) increase in the rate of growth in height in undernourished infants and young children	Smallholder farmers, consumers	Providing protein intake, iron intake	Consumption of QPM instead of the conventional low quality grain to better nutrition levels in natural millets and other grains and provide higher intake of iron, zinc and protein in the base food material, and thus improve the health and nutrition status of the people.
4.	Food Fortification Programme in Rajasthan	To introduce fortified food products in order to increase nutritional content of available food products	Micronutrient-deficient population in Rajasthan	Building the capacity within the state of Rajasthan to fortify staple foods like wheat flour, milk, oil and lentils; strengthening government quality control, monitoring and regulatory capacity to ensure safe and good quality fortified food commodities	Introduction of fortified wheat flour, oil and milk through commercial channels to reach the general population, and achieve 30% reduction in prevalence of anaemia and vitamin A deficiency in target

					populations; increase of fortified wheat flour, oil and milk from nil to 90% of the output of the organised sectors in the state by the end of project period; increase in regular consumption of fortified foods among target groups in urban populations of all socioeconomic groups from nil to 30%
5.	Enriching the Assamese <i>Thali</i> with Meat and Fish Pickle	To uplift women by encouraging production of the pickles and improving protein intake in daily diet	Women entrepreneurs making pickle and all consumers	Transferring technology from research university to Meghalee Food Products	Nutritious fish intake and higher protein consumption
6.	Low-cost Sachet of Horlicks with 12 Essential Vitamins and Minerals	To create awareness about malnutrition among children and introduce affordable sachets for the lower income class	Poor	Promoting awareness of malnutrition in mothers and households	Awaited
7.	Iron Fortification of Whole Wheat Flour	To introduce nutrition-dense wheat flour to combat iron deficiency (ID) in school-going children	Children 6-15 years	Setting up a clinical efficiency trial	Change in haemoglobin and Fe status, cognitive ability and prevalence of ID anaemia
8.	Vitingo: Low-cost Beverage Powder with Micronutrients	To create awareness about Iron deficiency and to promote beverages at affordable cost	Children	Launching of Vitingo, a low-priced powder drink, which contains iron, folic acid, vitamin A, vitamin C and zinc	Address nutritional iron anaemia
9.	WFP's Village-level Flour Fortification Programme	To analyse impact of fortification of wheat flour in tribal areas of Madhya	Sahariya Tribal Villages in Madhya Pradesh	Providing flour fortification facility in select <i>atta-chakkis</i> (wheat-grinding mills)	Lower prevalence of anaemia (intended) and reduction in undernutrition

		Pradesh			
10.	Nestle Fortified Spice Bouillon	To introduce affordable fortified mixed spices	Consumers	Distributing spice bouillon fortified by iron supplementation through Nestle's open innovation project	Fortification at secondary processing
11.	HarvestPlus bio-fortified Iron and Zinc Pearl Millet	To determine the absorption of Iron and zinc from pearl millet bio-fortified with micronutrients	Efficacy trial specifies 2-year-old children; HP estimates over 900,000 consumers	Providing bio fortified pearl millet seeds to farmers by HarvestPlus; commercialisation of iron-rich varieties	Determination of the absorption of iron and zinc from pearl millet bio-fortified with 2 micronutrients that are typically deficient
Food Distribution					
1.	Food Fortification for Children under ICDS Programme in Gujarat	To facilitate sustained use of fortified blended food to improve health status of children	Children aged 6-36 months	Manufacturing and distributing cheap and nutritious complementary foods for infants aged 6-36 months	Availability of cheap (Rs 2) complementary food packets for children between 6-36 months
2.	Supplementation of Wheat-based Meals in Madhya Pradesh and Rajasthan by fortified biscuits	To introduce iron- fortified biscuits through MDMS	School-going children	Implementing MDMS for school students in Madhya Pradesh and Rajasthan through Naandi Foundation's outreach programme	Diet diversification
3.	Dabbawallahs in Mumbai: Uninterrupted Supply Chains	To supply nutritional food using the efficient supply chain of lunchboxes by dabbawallahs	Urban office-goers	Assuring efficient and timely delivery of lunchboxes to offices	Regular intake of freshly-cooked nutritious food
4.	Mid-day Meal Programme in Karnataka	To assess the effect of MDMS on enrolment, attendance and dropout rates of children. as well as analysing the nutritional impact	School-going children	Providing mid-day meals to schoolchildren	Assessment of nutritional status

6.	Fortified Rice in the MDMS	To improve nutritional intake of school-going children by fortifying rice with iron	School-going children	Providing Ultra Rice as part of the mid-day meal programmes	Increase of serum ferritin levels
7.	Mid-day Meal Programme in Madhya Pradesh	To assess cost and benefit of MDMS in improving micronutrient in-take in school-going children	School-going children	Providing protein-rich meals for school students at lunchtime	Enhanced protein intake
8.	Introduction of Vegetables in the School Mid-day Meal Programmes	To improve food habits in children and increase their nutritional status	School-going children	Increasing consumption of micronutrient-rich fruits and vegetables	Nutritional awareness, dietary diversity
9.	Tiger Biscuits in MDMS	To introduce iron-fortified biscuits through MDMS	School-going children	Implementing MDMS for primary schoolchildren enrolled in government schools in Andhra Pradesh through Naandi Foundation's outreach programme	Diet fortification