XIth TAAS Foundation Day Lecture

Can India Achieve SDG 2 – Eliminate Hunger and Malnutrition by 2030?

by

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24th January, 2019 at B.P. Pal Auditorium, New Delhi

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Progress Through Science

Trust for Advancement of Agricultural Sciences
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Trust for Advancement of Agricultural Sciences (TAAS)

GOAL

An accelerated movement for harnessing agricultural sciences for the welfare of people.

MISSION

To promote growth and advancement of agriculture through scientific interactions and partnerships.

OBJECTIVES

- To act as think tank on key policy issues relating to agricultural research for development (AR4D).
- Organizing seminars and special lectures on emerging issues and new developments in agriculture.
- To institute national awards for the outstanding contributions to Indian agriculture by the scientists of Indian and other origin abroad.
- Facilitating partnerships with non-resident agricultural scientists visiting India on short period.

Can India Achieve SDG 2 – Eliminate Hunger and Malnutrition by 2030?

Prabhu Pingali[1]

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In 2015, member states of the United Nations approved the 2030 Agenda for Sustainable Development that were to be achieved through 17 Sustainable Development Goals (SDGs). These goals aim "to build on the work of the Millennium Development Goals (MDGs) and complete what they did not achieve"[2]. The 17 goals of the SDG have 169 targets, which has been designed to take a holistic approach to address the social, economic and environmental aspects of sustainable development. Goal 2 of the SDGs aims to end hunger, end all forms of malnutrition, double agricultural productivity and incomes of small-scale farmers and ensure an environmentally sustainable food production system and main genetic diversity of seeds and cultivated plants. It is explicit in its aim of tackling malnutrition, which was absent in the framing of the MDGs. It also gives an added emphasis on sustainable food systems focusing on environmental issues and genetic diversity.

Although there have been great strides towards hunger reduction in the past 25 years due to production increases of the green revolution, malnutrition remains, micro nutrient deficiencies are stubbornly high and inter and intra-regional inequalities in reducing hunger and poverty persist. Therefore, the challenges in the way of achieving the SDGs remain high. What is acknowledged in the SDG approach is that promoting growth and development in the agricultural sector is

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[2]United Nations (2015) Transforming Our World: The 2030 *Agenda for Sustainable Development*. Resolution adopted by the General Assembly on 25 September 2015 (A/RES/70/1) (United Nations General Assembly, New York)

GOAL 2: ZERO HUNGER

End hunger, achieve food security and improve nutrition and promote sustainable agriculture

Targets

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

2.b Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

2.c Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility

Source: Sustainable Development Knowledge Platform
https://sustainabledevelopment.un.org/sdg2

crucial to improving food security and nutritional status in developing countries. Agricultural policy with a smallholder focus to promote agricultural growth becomes central to achieving the SDG hunger goals.

The SDG 2 also explicitly recognizes that addressing hunger and malnutrition require more than achieving calorie sufficiency and thereby places an emphasis not just on the quantity of food consumed but also its quality and diversity. Hence a food systems approach that promotes the supply and affordability of a nutritious diet is central to successfully meeting SDG 2. Also, important are the multi-sectoral factors that influence progress in achieving SDG 2, these are access to clean drinking water and sanitation, women's empowerment and behavior change and overall investments in public health.

Where does India stand with respect to hunger and malnutrition?

Despite significant economic growth, India has not made comparable progress on reducing hunger. By 2011, India had been

able to achieve the MDGs poverty reduction target, but it had fallen far short of the hunger reduction target (Fig. 1). While the prevalence of undernourishment has decreased nationally, it is still around 15 per cent, which is amongst the highest in the global south (FAO, IFAD, UNICEF, WFP, and WHO, 2018). Even more startling, the absolute number of people undernourished in India has remained almost the same between 1990 and 2015 (Fig. 1)[3]. The prevalence of undernourishment is measured as percentage of population that has access to sufficient amount of food, measured in calories per capita, per day (ibid). By definition, this measure of hunger gives a high weight to calorie dense food, such as staple grains. In order to meet the SDG target 2.1 by 2030, India would need to reduce the number of hungry people by at least 200 million.

Beyond access to sufficient food, SDG 2.1 specifically calls for access to nutritious food. Access to nutritious food – protein and micro-nutrient rich food has been lagging relative to calorie dense staples. While there are definite trends towards diet diversification, rising relative prices of non-staples limits the affordability of a nutritious diet, especially for the poor. Over the past fifty years, we have

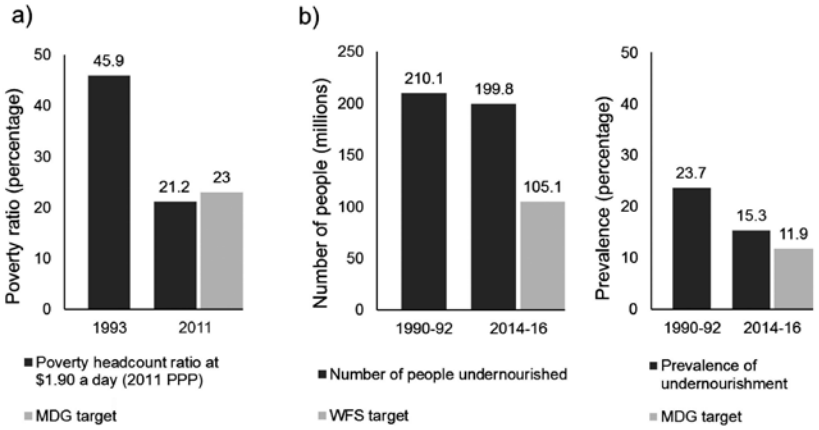

Figure 1. *Targets and achievements in alleviation of a) poverty (WDI, 2018) and b) undernourishment (SOFI 2015; FAOSTAT, 2018).*

[3]For more about the problem with measuring undernutrition as a percentage rather than a number, see "The hunger metrics mirage" (Pingali, 2016).

seen a steady decline in the real price of staple grains, but a sharp increase, and high volatility, in the prices of fruits and vegetables, pulses, livestock products. Rising relative prices of non-staples and hence poor affordability of more nutritious food has resulted in high incidence of micro-nutrient deficiencies in the diets of the poor, so-called hidden hunger. Hidden hunger is manifested in poor nutrition outcomes such as child stunting and wasting and high levels of anemia for women. The high relative price of protein and micro-nutrient rich food also leads to consumers substituting processed food, which is often cheaper, for fresh food thus leading to the emerging problem of overweight and obesity in the country. We are thus facing the emerging challenge of overnutrition even as we struggle to tackle the undernutrition problem.

SDG target 2.2 calls for an end to child stunting and wasting by 2025 and an end to all forms of malnutrition by 2030. Eliminating child malnutrition within the above time frame would be particularly challenging for India. The latest NFHS estimates show that around 30 per cent of all children under five were too thin for their age and gender (underweight)[4] and 38 per cent were stunted in 2015, i.e., too short for their age and gender. While there has been progress relative to the previous NFHS rounds, it has been slow and with significant regional disparities. The prevalence of child malnutrition in India is higher as compared to all other developing regions, including sub-Saharan Africa (Fig 2). Within India, child stunting and underweight prevalence is higher in the lagging regions of central and eastern India, regions characterized by low agricultural productivity and high rural poverty levels (Fig 3).

Poor nutrition outcomes are known to lower cognitive skills, lower educational outcomes, lower productivity and lower wages in adults who were malnourished as children compared to adults who were not. In addition to greater mortality risks for children, studies have also shown that adults who were undernourished in childhood have greater incidence of non-communicable diseases than those who were properly fed (Chen and Zhou, 2007; Gørgens, 2002; Roseboom *et al.*, 2006).

[4]Most of the improvements came from moving people out of the severely malnourished cases into the moderately malnourished

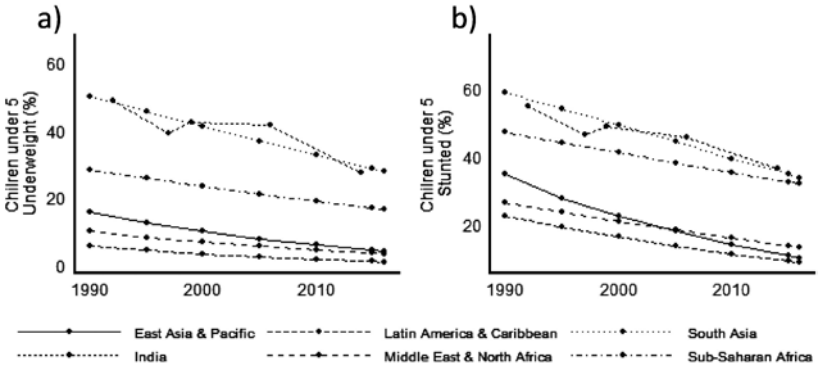

Figure 2. *Prevalence of a) underweight and b) stunted children by region, 1990 – 2016 (WDI, 2018).*

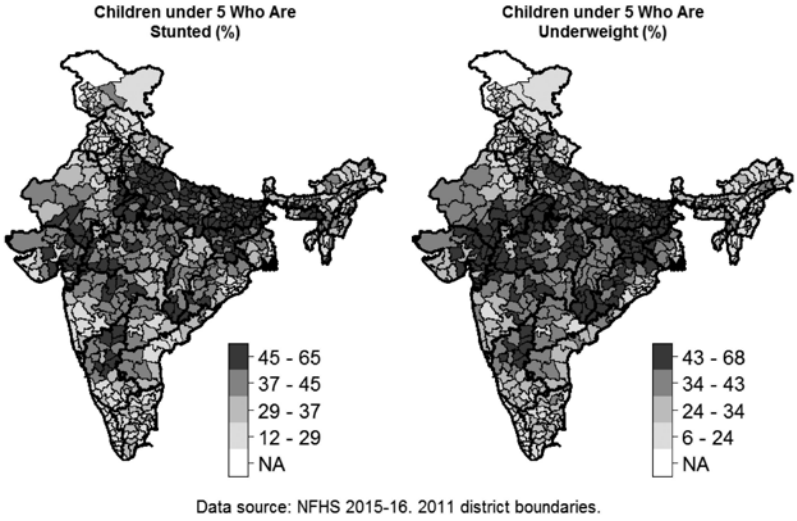

Figure 3. *Prevalence of underweight and stunted children (NFHS 2015-16; 2011 district boundaries).*

While the country continues to grapple with the problem of undernutrition, experts have called to attention, the unprecedented increase in obesity rates, both in rural and urban areas in the country (Popkin, 1997, 1999). Traditionally, obesity has been associated with countries with higher per capita incomes and a greater level of structural transformation (Popkin, 1997, 1999). However, obesity rates have increased at an alarming rate in India, in the last ten years they have

doubled for men and increased by 62 per cent for women (Figure 4). The spatial distribution of adult obesity incidence is a mirror image of the child stunting map, the richer regions have higher levels relative to the poorer regions. Obesity is a known risk factor for non-communicable diseases (NCDs) such as diabetes, heart disease, cancer and other chronic diseases.

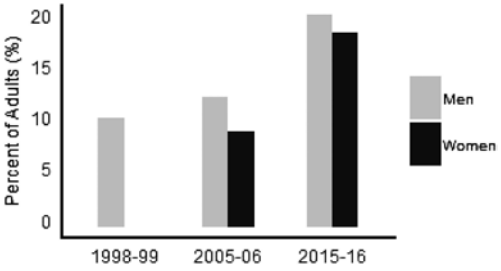

Figure 4. *Share of men and women who are overweight and obese (NFHS 2015-16).*

Given the close relationship between dietary diversity of households and nutrition outcomes, ensuring that households can access diverse foods requires interventions at two levels. First, is to ensure that there is greater availability of food diversity within the local system. The second set of interventions would need to improve the affordability of these diets. Effective food policy, hence, becomes tantamount to a nutrition sensitive food system which enables transition towards a healthier diet. Policy debates around food security in India have mainly focused upon ensuring adequate access to calories through a continued focus on staple grain production. However, trends around dietary changes and nutrition transition provide a compelling case for questioning the existing paradigm and open up conversations around access to a good quality, and balanced diet. Focus on staples has affected incentives to develop markets for non-staples thus affecting their supply and increasing price uncertainty. Creating new opportunities for the food system diversification, to cater to changing consumer demand should thus become a focus for policy makers.

Doubling agricultural productivity and incomes of small scale producers?

SDG target 2.3 calls for doubling productivity and income of small-scale producers by 2030. In the case of crop agriculture, productivity growth could come from increasing yields, intensification of cultivation – growing two or three crops per year on the same piece of land,

or increasing the efficiency of input use, thereby raising total factor productivity. Presumably all of the above strategies would lead to commiserate increase in farm incomes. In addition, explicitly income growth-oriented strategies would include the promotion of production system diversification, for crops and livestock, and enhancing rural non-farm employment opportunities.

Why the focus on smallholders?

A majority of the world's agricultural production takes place on small and marginal farms and presently, there are over 500 million small farms (less than 2 hectares in size) cultivated by two billion of the world's poor (Hazell *et al.*, 2010). In India, 85 per cent of all farm holdings are under 2 hectares, according to the latest round of the latest agricultural census. Despite recurring predictions that small farms will soon disappear, they have persisted and in the case of India, have increased in number. Small farms face numerous challenges in production, especially in terms of access to essential factors of production such as credit, inputs (seeds, fertilizers, pesticides), information and production technologies in addition to poor access to output markets (Pingali, 2012; Poulton *et al.*, 2010). Addressing these challenges is crucial for agricultural development, and for successfully achieving SDG 2.

Smallholder agricultural production is closely linked with nutrition and food security in three ways. First, it improves household food security through own production, second, it reduces the real cost of food thereby enhancing supplies and making it more affordable and third, it improves incomes of farming households enabling them to access nutritious foods. Sufficient evidence exists to validate the relationship between agricultural growth and nutritional outcomes. Countries that proactively support agricultural growth policies witnessed lower incidence in child stunting compared to countries that did not (Webb and Block, 2012). Data from the latest round of National Family Health Survey (NFHS 2015-16) shows that regions that have historically had high agricultural productivity growth have had lower incidence of child stunting relative to regions that have historically lagged in terms of agricultural productivity (Pingali *et al.*, 2019).

What are the opportunities for doubling crop productivity?

The green revolution is a testimony of how a combination of high rate of investment in crop research, policy support, market development and infrastructure has led to extraordinary growth in food crop productivity. There has been an overall increase in yields for all major crops in India over the last half-century. However, the magnitude of these increases has varied by crop and region. Overall, cereals have experienced by far the most dramatic increase in yields (Figure 5). From 1950 to 2014, average yield of rice, wheat, and maize yields increased by 258, 315, and 381 per cent, respectively. Coarse cereals and pulses witnessed only a marginal improvement in yields during the same time period. So the gains have come for calorie dense staples relative to protein and micro-nutrient rich pulses and coarse grains.

The main reason for the discrepancy in yield increases between cereals and pulses is that the Green Revolution focused on improving wheat and rice production through the introduction of high-yielding varieties, subsidies on power, fertilizer, and irrigation, and support prices (Bhalla and Singh, 2012). As a result, pulses were pushed onto marginal, rain-fed lands, and are now grown mostly with little or no modern yield-enhancing inputs (Roy *et al*., 2017). As we prepare to tackle the challenges in hunger and poverty through the SDG, there is a need to redress these challenges as well. Interventions at

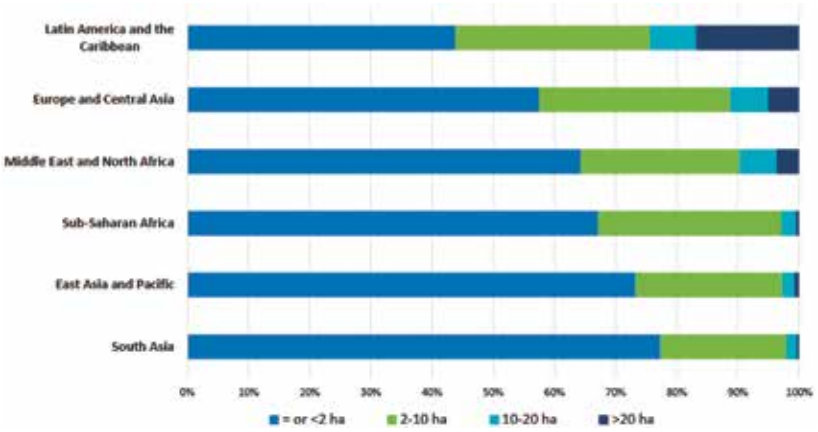

Figure 5. *Average share of agricultural holdings by land size and region (FAO).*

both the production side and the markets are crucial to bring about these changes.

Productivity gains in traditional staples such as millets, and nutrient-rich pulses and vegetables, that were not the focus of the green revolution now need to be focused on to improve diversity of diets and essential micro nutrient availability. Research into crop breeding and genetics, with a targeted focus on varieties, which will thrive within a specific agroclimatic zone, can substantially influence the productivity of a smallholder and maximize yields. Prospects for boosting productivity in the lagging regions of India would be higher if the focus is on promoting coarse cereals and pulses in these regions rather than on the big two staple grains – rice and wheat. We have seen successful productivity growth for the non-staple crops – cotton and oilseeds (soybeans) in the semi-arid zones of central India and hybrid maize for animal feed in Bihar and in Andhra Pradesh. Cotton yields went up over 4 times between 1950 and 2014, much of the increase can be attributed to the introduction of Bt cotton in 2002.

Looking beyond the lens of the main staples could provide new opportunities for small farm productivity and income growth in the lagging regions. The recent rise in pulse production is a case in point. Roy *et al.*, (2017) suggest that the increase in pulse production has resulted from the spread of new, short-duration pulse varieties and the significant increase in support prices for pulses. In addition, they suggest that in the lagging states that lack a "profitable star crop", pulses are replacing less productive crops. That's exactly what happened with cotton and oilseed production in Central India.

Prospects for intensification of production systems

Intensification of cropping system is another avenue for increasing crop productivity and incomes. The high productivity states such as Punjab, Haryana and the Southern Delta regions have witnessed high levels of intensification following the Green Revolution. These areas have had two or three crops per year on the same piece of land for decades. While much of Central and Eastern India is characterized by low intensity (one rainfed crop per year) production systems. Irrigation investments have been the primary driver of intensification

and the focus has been on promoting an additional crop of the primary staple, so we have seen the spread of rice-rice systems in the South and Rice-Wheat systems in the Indo-Gangetic plains. So what are the prospects for sustaining the current level of intensification in the high productive areas and increasing intensification in the lagging regions?

As mentioned above, cropping intensity is very closely linked to irrigation infrastructure. Although India has seen substantial growth in irrigation over the past 60 years, the growth has been uneven. In some areas, irrigation has developed so much that the main concern is now over-exploitation of water resources. In other areas, there is still great potential in development of irrigation. In fact, 55 per cent of the country is still unirrigated (Agricultural Census, 2010-2011). Much of the recent growth in irrigation has been from groundwater sources, which have surpassed surface water as the main source of irrigation. In 1966-68, canals irrigated 40 per cent of the total irrigated area, and wells irrigated 38 per cent (ICRISAT VDSA). By 2012-14, the percentage of land irrigated by canals had declined to 24 per cent, while the percentage irrigated by wells jumped to 66 per cent (DACNET). Tube wells have become the most common way to extract groundwater, irrigating 50 per cent of the total irrigated area in 2012-14 (up from 9 per cent in 1966-68).

Tube wells developed fastest in the Green Revolution states of Haryana, Punjab, and Uttar Pradesh, where high-yielding varieties of wheat and rice required more water, stimulating farmer investment in groundwater irrigation. However, the states that tapped their groundwater resources fastest are now running out of those resources – in much of Haryana, Punjab and western Uttar Pradesh, groundwater resources are classified as "over-exploited", meaning that annual withdrawals are exceeding annual recharge, and significant decline has been observed in ground water levels. Declining groundwater resources can have long-term negative effects on the productivity and sustainability of the rice-wheat systems in these areas. The prospects for sustaining high levels of crop intensification in the high productive regions is tied to substantially enhancing the efficiency of water use and diversifying into crops that are less water intensive relative to rice and wheat.

Ground water exploitation is also a problem in much of the semi-arid and arid zones of India in central and western India. Rainfed agriculture will continue to persist in these areas and the prospects for further intensification of crop production, especially focused on the major staples, is limited. Pulse production on residual moisture, or similar crops that are of lower water use intensity, may be the primary pathway towards further intensification and income growth in the regions.

The areas that could see further intensification are mainly in the Eastern part of the Indo-Gangetic plains - Eastern Uttar Pradesh, Northern Bihar, and parts of West Bengal, where the groundwater potential is high and parts of Odisha. Recent trends in hybrid maize production and pulse production indicate that crop intensification is rising in these areas. Sustainable intensification of cropping systems will not only require efficient water use but also smarter crop choices, a move towards those that are water saving.

Diversification of crop and livestock production systems

Population increase, rise in per capita incomes and urbanization are driving the rising demand for food products, especially for higher value products such as fruits and vegetables, dairy and meat and value added processed foods. Fig 6 provides data on the changing food consumption patterns in India over the past three decades. Meeting this rising demand is an enormous opportunity but also a challenge for smallholder agricultural systems in India.

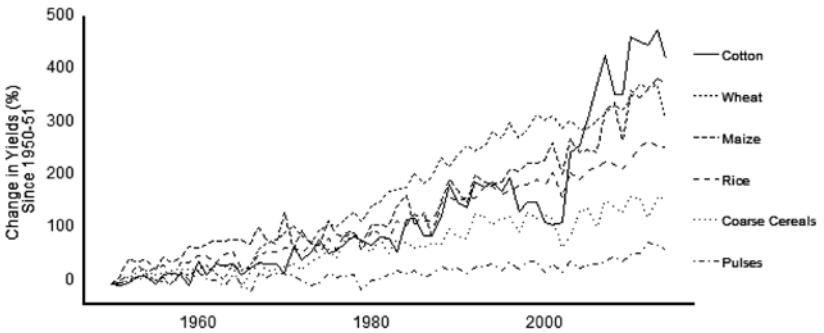

Figure 6. *Per cent change in yields since 1950-51 of major crops in India (EPWRF 2018).*

Commercialization of smallholders farms is an essential pathway to improved rural incomes and better access to diversified and nutritious food. The major challenges, however, are problems associated with the supply side conditions such as poor access to markets, credit, purchased inputs, technology and extension services that have hindered commercialization and made income opportunities inaccessible to many small farm producers. Rising rural wages due to growth in nonfarm employment opportunities add to the challenges of commercializing small farms.

The change in food systems have raised the costs of exchange for both staples and high value crops and these transactions costs are significant factors that inhibit small farmer entry into markets (Pingali *et al.*, 2005). Institutional arrangements to improve market access and reduce transactions costs are crucial to incentivize production and link small producers to the markets. Encouraging public-private partnership in cold chains, increased private sector participation in technology dissemination and extension services, quality control and promoting safety standards are crucial interventions to improve small farmer participation in the markets. Vertical coordination (VC) by

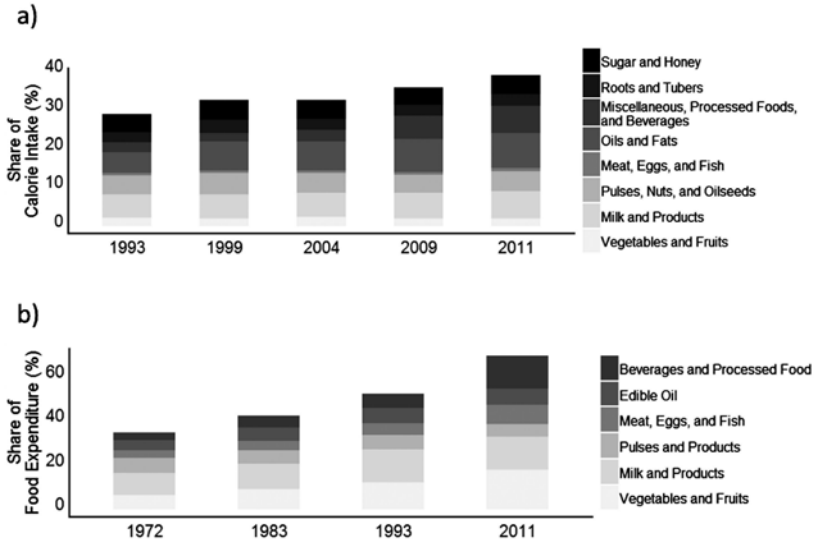

Figure 7. *Share of a) calorie intake and b) expenditure on non-cereals (NSSO 2014, rural numbers).*

which retailers form direct linkages with farms, bypassing traditional markets, has been growing in India's more progressive states.

Aggregation models such as producer organizations and cooperatives, where smallholders organize themselves in groups to jointly access resources and market their produce have shown to reduce transactions cost and benefit from the resulting economies of scale. The high productive states are natural candidates for transitioning to more diversified and commercialized production systems, however, the current policy environment that is staple grain centric provides limited incentives for farmers to make the transition. Lagging regions of Eastern and Northeastern India are a particular challenge regarding small farm commercialization. With investments in markets and agricultural infrastructure, such as irrigation, warehouses and cold storage facilities, and a supportive policy environment, such as promoting diversification and contract farming, it is possible for these regions to leap frog from the current subsistence systems to commercial operations that are focused on supplying urban demand for food diversity.

Increasing efficiency of input use and TFP

Increasing input use efficiency enhances agricultural productivity by increasing the ratio of the value of output to total value of inputs used and thereby enhancing profitability and incomes but also enhancing the sustainability of the production system. The pathways to increasing production efficiency can be through crop improvement, as well as, through improved crop and input management practices. Yield improvements coupled with the effective management of resources (nutrient, water, natural resources) is essential to improve efficiency and achieve sustainable intensification.

First and second generation GM technologies hold promise in improving returns to farming through reduced cost of production and increasing resilience and the nutritive value of crops. Crop improvement technologies are a priority for the more nutritious crops, especially coarse cereals, such as millets, and pulses. Unlike green revolution technologies which were public sector generated, technological innovations today are generated in the private sector and hence pose challenges of access for small farms. This is true for crop production

and post-harvest technologies. Institutional interventions that enable public sector access to private sector innovations and to adapt them to small farm conditions is crucial.

Priority areas for enhancing the efficiency of input use are in fertilizer, water and land management. More efficient and balanced fertilizer use has significant productivity benefits but it also has nutritional benefits. Areas with soil micro-nutrient deficiencies tend to also be the same areas with similar micro-nutrient deficiencies among the population. For example, where soils are deficient in zinc, and if this is not corrected, one could find the rural population in the area to be zinc deficient. The nutritional benefits of fertilizer use policy have been rarely examined but ought to be a major priority looking ahead. The environmental benefits of more efficient water use and conservation tillage technologies are well known. The problem with enhancing input use efficiency is not that the technologies and practices are not available, but that the incentive to adopt them is limited due to a policy environment that does not value investments in efficiency enhancement.

Enhancing rural non-farm employment

It is well known that a substantial and growing share of rural household income is coming from non-agricultural sources. Identifying ways of expanding rural non-farm employment opportunities contributes directly to SDG 2. As India grows through a rapid process of urbanization, provisioning the cities is the new growth opportunity for rural areas and could lead to accelerated rural transformation (Pingali *et al.*, 2019). Through an organized upstream and downstream network of activities in the emerging urban facing agribusiness value chains could absorb surplus agricultural labor and provide them with jobs, especially for the youth and women. Employment in logistics, like aggregation, storage, processing, etc. at the agribusiness upstream and food-related services such as restaurants at the bottom-stream could potentially be leveraged as the channel of employment generation.

Such inclusive transformation of rural spaces – by including those who are left out regarding access to nonfarm employment -- is essential to remove rural poverty. One of the channels for propelling stagnant

agricultural growth is to strengthen the rural-urban continuum which provides ample opportunities to the small farmers and other rural population with greater opportunities to share in the fruits of urban economic growth. Indian policies have not focused on the small towns and the middle spaces to create job opportunities. By recognizing these newer urban settlements and then providing them with urban amenities could be a springboard for non-farm diversification. The benefits of local economies can be realised through creating clusters of urban-rural spaces which feed the consumer services demand for agricultural households as well as the market for new inputs, technologies and information.

Climate change adaptation and mitigation

Impact of rising temperatures on the major staples, such as rice and wheat is well studied. Declining productivity of these crops can be expected with rising temperatures (Abraham and Pingali, 2019). However, less well understood is the impact of climate change on crops that are important to the poor, such as millets and sorghum (Sharma and Pingali, 2019). Also, less studied is the impacts of climate change on a more nutritious food system, such as its impacts on the productivity of fruit, vegetables, pulses and livestock products. Given the lack of technologies currently available to safeguard productivity and the lack of information about climate impacts on these foods, vulnerability of non-staple crop production becomes a major food security concern for the future. Safe guarding the production of these crops & livestock will be important to the goal of achieving nutrition security. Climate change can also have adverse impacts on production systems in the rainfed areas, particularly those in the semi-arid and the arid fringe areas. Higher temperatures could drive some of these areas out of crop and livestock production activities, especially where irrigation infrastructure is not well established.

Continuing down the current path of development without integrating adaptation and mitigation strategies will have serious negative repercussions on food security within the country. Side by side with adaptation strategies, integrating mitigation strategies that reduce overall carbon foot print will contribute to the global goals of GHG mitigation and help reduce global food systems risks. According to

emissions data from 2010 (the most recent data available), agriculture accounts for 22 per cent of emissions in India (FAO *et al.*, 2018). Within agriculture, enteric fermentation is the largest contributor, and has grown consistently over the last few decades (FAO 2018). Synthetic fertilizers are the second largest contributor, rising dramatically since the 1980s, and surpassing rice cultivation in recent years (ibid). Other contributors to emissions include burning crop residues and leaving manure on pasture. Major changes are necessary to reduce these emissions. One important change is to stop the excessive use of chemical fertilizer.

Policies to encourage investments in clean energy sources, climate-smart infrastructure, preservation and conservation of biodiversity and ground water management processes have been important steps taken in this direction by the government of India as well as individuals state governments. It is also important that these policies not only operate at the level of strategy, but that progress and goals can be measured and tracked. With the increasing frequency and intensity of climate shocks such as droughts, floods, and changing temperatures, there is an eminent need to adapt agricultural production so that it is more resilient to these shocks, such as drought or flood tolerant varieties.

As we look ahead, climate policies for the future should allow diversification of the food system in ways that enhance the environment while improving the nutrition content of foods produced and ensuring equity in access. In order to truly create a food system that ensures nutrition security of all individuals, climate change risks must not be understated and appropriate actions towards its mitigation need to be adopted.

Managing crop biodiversity

Agricultural intensification, and the adoption of modern varieties of the major staple crops led to the ubiquitous monoculture systems in the favorable production environments across the developing world. The lower productive rainfed environments, on the other hand, continue to maintain diversity of crops grown, such as traditional millets and root crops. These environments have also sustained the cultivation of landraces of rice, wheat and maize. Narrowing of

crop genetic diversity in the Green Revolution (GR) areas has been averted to some extent by the replacement of the first generation modern varieties with second and third generation varieties in more recent decades. The expansion in the numbers of varieties available through crop breeding programs has reduced the risk that intensive production systems would concentrate on a few dominant varieties. Modern plant breeding has also helped expand the genetic base of modern varieties by incorporating genes from landraces and wild relatives of staple grains into the breeding populations.

Pingali (2017) argues that areas that have been bypassed by the original GR are now witnessing intensification and agricultural productivity growth. This GR 2.0 is being observed in parts of sub-Saharan Africa as well as in the unfavorable environments of South Asia. Improved varieties of sorghum, millet, cassava and tropical maize, are being increasing adopted by African smallholders. In South Asia, rice varieties that are tolerant to drought, and to flooding, have made major inroads into the stress prone environments that were bypassed by the original GR.

While the food security benefits of the GR 2.0 are obvious, there are significant concerns about the consequences for crop biodiversity. The spread of improved varieties of the traditional African crops could lead to the encroachment of monoculture systems in areas where multi crop farming systems sustain diversity and landraces. In South Asia, the spread of a few "mega" varieties of rice that are stress tolerant could lead to the risk of genetic narrowing in rainfed environments where multiple landraces are cultivated today. As GR 2.0 proceeds it would be important to learn from original GR in terms of the appropriate mechanisms to balance food security and crop biodiversity concerns.

Conclusions – so what are the prospects for SDG 2?

The SDG commitments provide a great rallying opportunity for addressing the chronic developmental problems faced by India as it moves towards becoming an emerging economy. Eliminating chronic hunger and malnutrition is a particularly high priority given that the we have not seen significant progress in this area despite sustained economic growth and income improvement. SDG 2 also

brings smallholder productivity and income growth to the center of the strategy to eliminate hunger, thereby directly contributing to rural poverty reduction goals. Achieving progress on SDG 2 requires us to channel public, private and civil society resources and expertise. It also requires multi-sectoral coordination across the various ministries, such as: agriculture, food, women and child development, health, water and sanitation, rural development, etc. Achieving progress on SDG 2 would also require us to identify synergies and trade-offs across all other SDGs. To achieve geographical spread across the sub-continent, the commitment to the SDGs would need to be made at all levels, from the center and the states to the local panchayats. Finally, the political economy factors that have impeded progress in hunger and malnutrition in the past need to be identified and redressed. So, what are the prospects for achieving the various targets of SDG 2?

Ending hunger: It is certainly possible that India will be able to achieve the end of hunger as defined in terms of caloric adequacy. However, it is not at all certain that we will be able to make adequate progress on "hidden hunger" micro-nutrient deficiency. This is because we don't have systems in place yet to enhance supplies and to promote wide spread access and affordability to food diversity, especially for fresh fruits, vegetables and livestock products.

Ending all forms of malnutrition: We should expect to see significant reductions in child stunting and wasting given the current political commitment to addressing the problem, however, complete elimination will require significantly more inter-ministerial collaboration than there is today. At the same time the emerging problem of obesity is expected to rise towards 2030 since this problem has not yet been recognized at the political level as an important public health crisis that needs immediate attention.

Doubling small farm productivity and incomes: Low productivity agricultural regions, especially those in Eastern India will continue to lag in productivity and income terms unless concerted efforts are made to diversify their production systems and connect smallholders to urban food value chains. The more productive zones would also need to diversify away from their predominant focus on the primary staples – rice and wheat, and move towards greater levels

of commercialization. Enhancing input use efficiency in the high productive zones, especially for water, fertilizer and fuel, would also lead to significant income gains.

Adapting to climate change: The major staple crops will be able to adapt to climate change because of the research and varietal development that is currently underway to buffer these crops from the effects of rising temperatures and improve their resilience to unanticipated extreme weather events. The non-staples, especially pulses and coarse cereals have not had similar efforts and will not be able to adapt to climate change as effectively as the major staples. Also, agricultural production in the arid zones and the arid fringe areas in the semi-arid tropics may not be able to adapt to higher temperatures and we could see agriculture moving out of these areas.

Sustainable production systems: We have the technology and management practices that can substantially enhance the sustainability of the agricultural systems in India and improve resource use efficiency. However, the current policy environment does not provide the incentives for farmers to change their behaviors and practices in order to make their farming practices more sustainable. That's the political economy challenge that has been difficult to overcome in the past and the prospects are poor that it will change in the next decade.

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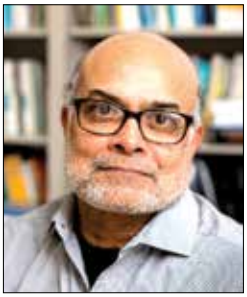

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