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Food Security in India: Accumulated Wisdom and the Path ahead

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Abstract

The current work attempts to organize a detailed and thematic survey of the key empirical works on the food security scenario of India. This review paper recognizes its collected literature as a sample based on which inferences about the larger population of actual analytical patterns on this issue are made. We concentrate our attention on the selected empirical works on this issue undertaken during the period 1991-92 till 2018-19. Our sample of evidence has been constructed by accounting for the facts such as the disaggregated nature of the evidences and the differences in quality of analysis across different sources, among others. We have stressed particularly on the issues, debates, controversies and proposed solutions that have characterized the efforts on the analysis of food insecurity threat in India. Preliminarily, we find that there is a strong disagreement among the analysts on matters such as the fundamental units of analysis; the appropriate economic and social frameworks needed to understand this issue; the policy matrix that can help tackle this challenge and the statistical and econometric strategies required for generating reliable as well as spatially and temporally consistent insights. The key insights of this paper include, among others, the importance of the macro-micro dimensions of the food insecurity challenge, the production-trade-productivity solutions on this issue, the quantity versus nutritional routes to attacking this challenge, the inherently multidisciplinary nature of food security analysis, the optimum institutional mechanisms for eliminating food insecurities and, the nexus between technology, productivity and distributional efficiencies in shifting India's foodgrains production frontier to higher policy-targeted levels, still remain areas that require much more intense and exhaustive academic and policy exercises.

Keywords: Agricultural Productivity, Economic Development, Food Grains Production Function, Food Security, Nutritional Security.

JEL Codes: Q10, Q16, Q18.

1. Growth, development and food security nexus in India

India's economic experiences have been characterized by several persistent contradictions. On the one hand it has been able to lift millions from the clutches of socio-economic deprivations

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since its independence with impressive and at times massive strides in the growth indicators; on the other hand a large proportion of its population still suffers from malnourishment and other health and developmental inefficiencies. While the economy has grown larger with time, distribution of the economic pie has shown a diverging trend from traditionally expected notions of equality, justice and fairness. Concentration of income and wealth, including that of productive cropland, in the hands of a limited proportion of population, has created a wedge between those who are in a position to leverage their large-scale resources in accessing, and at times manipulating, critical socio-economic resources and those who are marred by limited social, economic and political powers to change the unjust prevailing socio-economic outcomes. Food insecurity, in its various incarnations, is one such contradiction that Indian policy makers have been consistently attacking so as to bridge the gap between India's growth and development narratives.

The analytical preoccupation with food security in India has had a long genesis with the rampant and recurrent food crises till the Green Revolution era leading to increased attention on the need for food self-sufficiency. Once the technological shifts introduced via both the Green Revolution reforms and the later Structural Adjustment Programme (SAP) rippled their positive externalities across farms, villages, regions and the country, food crisis reincarnated itself into the nutritional crisis of today. A nation that had already achieved strong growth foundations found itself facing a new contradiction: an expanding Gross Domestic Product (GDP) and improving economic growth, but persistent malnourishment, "hidden hunger" (Soni & Singh 2018) and wide inequalities in developmental outcomes across states and regions. These observation resonate the echoes that "the problems of chronic hunger and malnutrition persist on a mass scale" (Swaminathan & Rengalakshmi 2016) even in the modern India. This gradual shift in the nature of food crisis from that of limited economic and physical access to food, to lack of absorption of nutrition and sub-optimal health outcomes also resulted in a shift in the perspectives and deliberations of the analysts and policy makers. The story of food security analysis in India is a rich process of issues, insights, debates, controversies and challenges that unfold a narrative which requires a systematic survey of the ideas and results inferred by various analysts so as to supply an organized structure to the vast web of interconnected and often contradictory findings and carve a road ahead for the dynamic changes and challenges that are urgently needed in the Indian policy matrix.

Accordingly, this survey of evidences and literature is organized as follows. The second section discusses the broad nature of the sample of studies that were chosen for undertaking a detailed review and which were utilized to derive various issues and insights on the present context. Next section elaborates upon the key and critical debates, issues and challenges faced by India today on the threat of food insecurity. Then, the further section discusses some qualifications and limitations of this study that need to be borne in mind while interpreting the findings contained herein. Finally, the last section reviews some of the most important policy proposals in the present context and thereafter concludes the study.

2. Nature of the literature: some sampling and related dimensions

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The period covered in this study ranges from 1991-92 to 2017-18. We have employed judgmental sampling to derive a sample of studies that correspond to our predefined criteria. These criteria included, among others, checking the quality of studies which were assessed by roughly employing the framework developed by Department of International Development (2014). Our methodology of collecting studies consisted of searching some well-known indexes such as the Scopus index, searching for studies from the official web sources of key Indian and international organizations such as the Ministry of Agriculture, Ministry of Rural Development (Government of India), Food and Agriculture Organization (FAO), International Food Policy Research Institute (IFPRI), World Bank, United Nations Development Programme (UNDP), using various search capabilities of Google Scholar and, locating high quality and empirically-rich studies from the reference list of other high quality studies. Finally, we gave special preference to well-known (roughly defined in terms of the intensity of articles written, their citations, review process, etc.) journals such as the Indian Journal of Agricultural Economics, Agricultural Economics Review, Economic and Political Weekly, etc. This gave us in total more than 120 studies (including reports and working papers), which were reviewed briefly so as to finalize 90 studies that met our *a priori* criteria. Accordingly, these 90 studies (including some that were theoretically well-structured but not pertaining to the Indian context) were then reviewed in detail and major patterns of thought, analysis and empirical regularities were located and are elaborated in further sections.

Because our attempt is to develop a narrative on the food security analysis in India, we have refrained from degenerating our work into a typical review paper and hence do not discuss much about what each study in our sample has done, but rather try to curate a larger theoretical and empirical picture of the kind of works done so far. Thus, due to our objective and space constraints, we have not cited all the collected studies in this paper and the full bibliographical list along with the key aspects of each study can be supplied by the authors on request.

3. Issues, debates and challenges in the Indian food security analyses

The review of theoretical and empirical evidences on various dynamics pertaining to food security in India has thrown open a set of inter-connected, temporally and spatially heterogeneous and non-linearly evolving set of issues, debates and challenges which are briefly elaborated below.

3.1 Measurement and methodological dimensions

The very fundamental unit of analysis remains an area of intense debate in the Indian context. While several studies have attempted to derive welfare implications for individuals, the unit of analysis has been the household. This underlying tension between deriving individual-based implications of food security policies while focusing on the household as the core focus unit has resulted in a constant need for more intense and "higher frequency sample surveys" (Headey & Ecker 2012) so as to extract individual-level data itself rather than relying on average estimates derived from household level information. Another issue that comes to the fore is the excessive reliance of various studies on response-based data, particularly on account of the National Sample Surveys - NSS (Saxena 2011). Most of the studies in the present context have depended on such information while overlooking the possibilities of natural experimental data, particularly in the post-structural reforms of the 1990s. Closely connected to these matters is the

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construction of appropriate Index numbers to capture the nutritional, physiological and other health aspects of food security. Literature has mainly employed simple index numbers such as the Body Mass Index (Swaminathan & Rengalakshmi 2016) or composite measures such as Global Hunger Index (Viczianzy & Plahe 2017), self-constructed Food Security Indexes (Kumar and Sharma 2013) or India State Hunger Index (Kattumuri 2011). Most of these indexes and measures have had competing proxy measures and the choice of the researchers on this account determined to a large extent, the results derived. The core sources of these measures in India have been the NSS household expenditure rounds and the National Family Health Surveys (NFHS).

It is probably not an exaggeration to propose that food security analysis demands a multidimensional framework at its core (Crush & Caesar 2017). In some cases, and more dominantly in the international scenario, the Food and Agriculture Organization (FAO) data, particularly its Food Balance Sheets (FBS), have been frequently utilized to derive spatially and temporally comparable international food security indicators. However, FAO data-based indicators suffer various limitations mainly due to the nature of national data sets used in constructing various estimates on hunger, malnourishment, etc. (Schmidhuber & Tubiello 2007). Even though studies have attempted to measure various dynamics of food security in India, there seems to be a lack of clarity on the conceptual and welfare interpretation of concepts such as malnourishment, undernourishment, hunger and starvation. The emergence of the "hidden hunger paradox" highlights such concerns (Soni & Singh 2018). In terms more exhaustive measures of food security in India, and even globally, literature has proposed measures based on "calorie-intake, monetary poverty, dietary diversification and subjective indicators" (Headey & Ecker 2012). Dietary diversification has especially received considerable interest internationally as a substitute to more costly calorie and subjective indicators (Hoddinott & Yohannes 2002). The underlying force governing these choices has been the need for relating individual-level implications with household-level information. Debate has also raged over the Macro versus Micro measures of Food Security in India (Suryanrayana 1997).

The Econometric foundations of Food Security measurement also deserve special attention. We found that barring a few studies such as Birthal et al. (2014); Debnath et al. (2017); the large corpus of our sample used descriptive methodologies to derive inferences on various dimensions of the nutritional and food insecurities in India. Among those that did employ econometric frameworks, use of Panel Regression frameworks was quite popular. The most fascinating econometric challenges lie in climate change and climate simulation modeling in India. Several studies such as Kang et al. (2009), Brown & Funk (2008**),** Schmidhuber & Tubiello (2007); among others locate important issues in climate modelling and these are equally applicable to the Indian context too. These include, among others, accounting for the non-linear association between climate change and crop productivity, deriving climate-sensitive estimates of crop-specific production and cost parameters and modelling key climatic changes, such as variations in Green House Gas (GHG) Emissions as external shocks within a structural framework. Incidentally, we could not locate any study that estimated food security indicators using more sophisticated, even non-linear aggregation based indexes.

3.2 Climate change dimensions

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In the extant global literature, climate has generally been defined as "the joint probability distribution describing the state of the atmosphere, oceans, and freshwater systems" (Hsiang & Kopp 2018). A logical corollary of this definition is the idea that climate change can be decomposed into secular and short-term variations in climate as defined above. Indian literature has broadly used this framework. Climate impact studies have generally hovered around the quantitative changes in food production, often undertaken at highly disaggregated levels, food consumption including calorie intake, nutritional outcomes and sustainability of current agricultural systems- due to temperature, rainfall, humidity and related variations. It seems that India faces a rainfall-temperature-yield nexus today (Birthal et al. 2014). Furthermore, the most pressing challenge has been to locate General Equilibrium estimates while being constrained with partial equilibrium information. An important recent work in this context that focuses on India is Pal et al. (2018); who find a stark contradiction, namely that of less food availability in times of record high food production and they very rightly argue that "in the rural areas, the fine edge between survival and destitution hinges on the advent of the monsoons", which is true even for the modern India.

An important dimension of climate impact studies in India has been the broad consensus that rainfall and temperature variations put a negative stress on the food security situation facing it., though the consensus is weaker on account of rainfall-yield nexus. Some studies such as the Birthal et al. (2014) find negative connections between rainfall and agricultural production, some others such as Tripathi & Mishra (2017) have found no significant impact, indeed the sensitivity of results being conditional upon the crop being studied, the climate under which the chosen crop is grown, etc.. Differences in measurements, data, etc. might explain these contradictions though more analysis is required to pinpoint the exact reasons for such mutually inconsistent findings. Another critical challenge has been the bias of climate impact simulation models towards food availability rather than the other three aspects of food security, namely access, utilization and stability (Birthal et al. 2014). Closely related to these issues is the heterogeneity in the regional and social distribution of the food security impacts of climate change both internationally and in India (Gregory et al. 2005). A broad finding is that variations in latitude, longitude and elevation of agricultural lands, particularly croplands, result in the spatial differences in climate's impact on food production, consumption and nutritional outcomes (Mall et al. 2004).

3.3 Technological foundations

Irrigation (FAO 2015), Biotechnology (Gunatilake et al. 2013), Nanotechnology (Chellaram et al. 2014) and Sustainable farming and Sustainable intensification (Swaminathan 1991; Godfray & Garnett 2014) have been proposed as key technological developments that India has been utilizing for shifting and moving its food production frontier to a higher efficiency level. The pressures on India's inelastic agricultural landscape particularly its limited cropland has received intense attention off-lately. Studies have broadly found that it is the intensification route to nutritional improvements and higher food production which is the key to long-term food security, given the significant opportunity costs of extensification both in socio-economic and ecological efficiency terms. Intensification produces much more stress on already existing scarce natural and human resources, making technological innovations the most pressing need of the hour.

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While technology has been an issue of intense debates, particularly for the food production analysts, it has not been the only modelled way for achieving food security. Productivity movements must further be decomposed into technical change and efficiency improvements (Mechri et al. 2017) and the efficiency aspect has received a much larger analytical concern in India. Two kinds of efficiencies have received intense focus namely Irrigation and water-use efficiencies (FAO 2015; Carruthers et al. 1997) and Biofuel efficiency (Gunatilake et al. 2013**;** Brahmanada et al. 2013). Biofuel efficiency analysis pertaining to food security has been further sub-divided into first generation and second generation biofuel crop efficiencies (Ravindranath et al. 2011; Brahmananda et al. 2013); with studies finding that first generation biofuels dominate in terms of their agricultural applications in India. Biodiesel and Bioethanol have been found as critical competitors of traditional fossil-fuel based energy sources, with biodiesels showing a promising future as an ecologically more efficient alternative energy source.

While the nature of technology suitable for agricultural efficiency has been a key issue, equally important have been the major areas of their application with reference to achieving food security in India. Soil nutritional system (Srivastava et al. 2016), CO_2 emissions and water management dynamics have been the three most important areas requiring urgent technological innovations. Hyrbid applications have been debated that account for two or all three of the above areas where technical improvements can be usefully applied to enhance food production, availability and access. Soil Carbon Sequestration-SOC (Frank et. al 2017) has been one such promising technological avenue. Exploiting local farming knowledge (Vicziany & Plahe 2017), using decentralized mechanisms and solutions (Swaminathan & Rengalakshmi 2016), Organic farming (Srivastava et al. 2016) and Biodiesels (Gunatilake et al. 2013) have been located as the most realistic technological foundations for long-term nutrition and food security.

3.4 Nutritional dynamics

The Food Security discourse in India is characterized by raging debates on some of the most profound issues pertaining to a large set of socio-economic problems facing us as a nation today. The dynamics of nutrition - its production, access, physiological absorption and its nexus with poverty have been extremely important challenges in the Indian context. The foremost debate has been that of Food versus Nutrition and the ways in which these two different yet similar concepts can be harmonized into a single homogenous and economically consistent framework. While food security addresses the physical and economic aspects of food, nutrition has been understood as a set of outcomes which are not strictly constrained by food production and availability (Golait & Pradhan 2006). Deaton & Dreze (2008) throw illuminating light on the theoretical construction and factual representation of nutrition via multiple and often mutually interconnected and at times even inconsistent measures. The efforts in this direction have not yielded the desired results though. Not only is there a certain degree of contradiction and tension between food access and nutritional outcomes, but the very shifts in dietary structure of Indians, both at rural and urban fronts, such as from pulses to cereals, from cereals to animal products, from low-value to high-value calorie diets and, from calorie and proteins to fat (Meena et al. 2016) have resulted in mounting challenges for food security analysts in devising appropriate research and intervention strategies.

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Off-lately, the micronutrients versus macronutrients debate (Ritchie et al. 2018**;** Saxena 2011) has preoccupied the researchers in this arena. Macronutrients, particularly calorie and protein, have had a particularly strong historical genesis in India while the increasingly complex consumption baskets of individuals in modern India have ignited interest in the availability, access and utilization of micronutrients such as essential vitamins, amino acids, etc. Micronutrients analysis demands much more micro-level and disaggregated data on consumption patterns and generating such estimates has been a critical challenge for the existing developmental data generating agencies in India such as the National Sample Survey Office (NSSO). Furthermore, lack of solid causal linkages between economic growth and nutritional outcomes has added to the already existing problems for food security analysts, who now have to move beyond traditional calorie-intake-biased estimators to more sophisticated multi-dimensional food security indicators that account for both food and nutrition aspects of health and well-being. Moreover, NSS based data in India are now available in both per capita and per consumer unit terms (Meena et al. 2016) and this has opened up further avenues to understand the ways in which macro and micro economic dynamics affect individual level food security status.

While the above issues pertain mainly to consumption markets, factor market-related debates pertaining to the ways in which nutritional content of agricultural produce themselves can be further enhanced have also been an important concern. Within this theme, the stress on better utilization of plant nutrients via enhanced capabilities of plants to absorb and retain higher and more complex nutrients has been a fascinating analytical development (FAO 2006). Lastly, the studies have generally focused on the possibility that nutrition intake might not be the only decisive factor in determining nutritional outcomes (Schiff & Valdes 1990) with increasing attention being paid to private and public goods and services that are consumed both outside and inside the household, which in turn might act as substitutes or complimentary commodities depending on the underlying price, income and cross elasticities of various socio-economic groups.

3.5 Crop-specific frameworks of analysis

Consistent with traditional choice-theoretic microeconomic frameworks, food security in India has largely been theorized within the methodologically individualistic framework and debates on the reliability and efficacy of such individualistic theorization, as against socially enriched constructions, has received considerable attention. Patnaik (2005) is a particularly enlightening assessment on these lines who goes to the extent of accusing current academia of representing "hunger as voluntary choice" and questions the validity of mainstream official socioeconomic data such as that of poverty as "bogus". While such pessimism might be a hyperbole, the scope for shifting towards methodologically more holist measures on food and nutrition and their related indicators remains vast in India.

Spatially, food security analysis has ranged from individual districts to individual crops and from individual states to at times aggregate all-India level analyses. The dynamics of crop productivity and their inter-connections with the traditional pillars of food security (FAO 1983) have been an active area of debate among the analysts. Largely, the attention has been privileged upon crops such as wheat (Mottaleb et al. 2018) and rice (Debnath et al. 2017)**.** In particular, the

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nexus between climate change and crop yield has garnered considerable attention. Our broad finding suggests that the direction of impact of climate change strongly depends on the geographical location, temperature-sensitivity and some other ecological features of biology such as the extent of albedo (Aggarwal & Mall 2002)**.** Another important matter has been the strategies to reduce the concentration of nutritional supply of humans in few crops and induce a more balanced nutritional supply in diets of individuals (Pal et al. 2018). Lastly, the nature of food security challenges across regions with historically high crop productivity versus those with low crop productivity has been another noteworthy area of concern (Dhillon et al. 2010). A critical challenge here has been to estimate and quantify the heterogeneities among crop-specific production functions and their further variations across regions and time.

3.6 Food prices volatility and stability dimensions

Prices embody complex information which is derived from the underlying decentralized decision making processes undertaken by economic agents (Hayek 1945). This information content of prices is one of the most profound economic coordination technologies till date (Baria & Sharma 2018). Given the immense role that prices play in the efficient functioning of markets, their stability and smoothness has important implications on the observed economic and social outcomes. Volatility in agricultural prices is a source of violation of this coordination role of prices in an agriculture-sensitive economy like India. Unstable prices generate randomness that may, at times, overpower the systematic fluctuations due to underlying movements and shifts in demand and supply forces. Such non-systematic and at times even systematic but highly fluctuating variations in prices pose great challenges for farmers, particularly at "the bottom of the pyramid" (Prahalad 2004).

While the Targeted Public Distribution System (TPDS) in India and the subsequent changes in the Public Distribution System (PDS) allowed maintenance of large stocks of grains and other essential crops thereby enabling stabilization of prices, international oil and other energy price shocks, global agricultural price shocks and asset price shocks- particularly those emanating in the commodity futures markets, destabilized domestic food prices, especially at the retail level. Interestingly, recent evidences point out that the observed food price volatility in India is induced by "internal production shocks and not so much due to international price shocks" (Mittal et al. 2018). Volatility in food prices in India has been analyzed as an important source of food insecurity. This interconnection between volatility and food insecurity flows logically from the poverty-food security nexus in India. Volatile prices generate instability in the incomes of the poor and low-income populations (Naylor & Falcon 2010) and thus constrain their ability to make longer-term savings decisions and move out of the clutches of deprivation. In the present context, volatility has been conceptualized mainly in ex-ante and ex-post senses (Kalkuhl et al. 2016), their key difference lying in the fact that ex-ante measures of food price volatilities are based on conditional probability distributions and can account for more complex dynamic forces governing the behaviour of food price behaviour. Non-linearity in the causal links between food price and its determinants also poses another challenge for researchers in this arena. This has generally not been addressed intensively in the Indian context.

Stable prices have been preferred over volatile food prices particularly for promoting pro-smallholders agricultural growth (Sharma & Gulati 2012). It is well-known that the landholding

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distribution in India is highly unequal and a large corpus of farmers own marginal and small sizes of land. The erstwhile farm size-agricultural productivity debates can be traced back to this fact. Given such an unequal nature of agricultural resource distribution in India, volatility in food prices can introduce increased uncertainty, risk and irrationality in both agricultural factor and product markets. Further, volatility can induce unexpected changes in the behaviour of real food price, which globally has been broadly falling, and can even worsen the inter-sectoral and perhaps the international terms of trade. Food prices are also affected by the underlying input costs and prices. The recent Indian experience suggests that agricultural inputs have had "negative and inelastic demand" (Srivastava et al. 2017). Such findings point towards good amount of scope in utilizing input price behaviour to induce stable food prices.

4. Microeconomics of food security analysis

As stated earlier, food security analysis in India has been bent towards methodologically individualistic frameworks. It is thus important to understand the microeconomic dynamics of food security related issues and this section attempts to dwell into some of the basic matters on this theme. The dominance of partial equilibrium models in examining food security dynamics in India is an important outcome of the fundamentally disaggregated nature of the data that has been primarily utilized in food (and nutrition) security studies. Closely related to this idea is the difficulty in building General Equilibrium Models as the analyst must inevitably face the dreaded aggregation bias problem, though excessive reliance on partial equilibrium frameworks might result into "disaggregation bias" too (Shanmugan & Baria 2018).

The advent of Game theoretic modelling has revolutionized microeconomic theorizing, and food security analysis can be modelled on similar lines. While structural modelling has been mildly employed in India to construct food market functions such as Debnath et al. (2017) that develop a structural model for domestic rice market, its use for building large-scale macroeconomic models of aggregate crop and livestock with dynamic feedbacks among them remains a fascinating area for future research. Game theoretic modelling of food market behaviour might allow more realistic quantitative results and more reliable policy insights into the strategic tensions among producers, consumers and the Government. Another key theme in the present context is the interconnections between agricultural productivity and food security and it seems quite evident to us that unless and otherwise the productivities- both partial and total factor, of whole Indian agricultural sector are not pushed upwards, pockets of productivity growths across regions and crops will not be able to generate long term food security and well-being of Indian population.

Lastly, the dimension of food trade has thrown its own set of challenge to food policy makers and analysts. The nexus among food trade and domestic food prices (Patnaik 1996; Sharma & Gulati 2012) reveals that trade by itself has not been a threat to domestic food security, though it does leave considerable room open for transmission of international price and quantity shocks into domestic agricultural markets. Further, the key debate in this context has been upon the optimal route to food and nutrition efficiencies- whether integrate with the global agricultural supply system via trade or increase domestic productivity or both? These concerns continue to remain areas requiring intense empirical investigations so as to improve the toolkit of

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the Indian policy maker in her efforts to eradicate the problem of hunger, malnourishment and other socio-economic ills.

5. Key limitations

This study has not undertaken a detailed and micro-level analysis on the various issues touched upon. Moreover, given the judgmental nature of our sample of studies, it is not possible to derive very specific inferences from our findings. More detailed set of literature in a more heterogonous sample might provide much more intense insights into the dynamics of food security discussed here. Further, space constraints have forced us to only focus on the most critical and currently important sub-issues under each of the major theme elaborated above. However, our belief is that despite all the limitations of our humble attempt, it does provide some peek into the key underlying forces governing the food security dynamics of India and we believe that at the margin, more exhaustive surveys might not diverge much from our broad results.

6. The path ahead: some issues in optimal policy interventions and concluding remarks

While the theoretical, measurement, empirical and other underlying dimensions of food security analysis in India have been briefly unearthed in the preceding sections, this final section attempts to extract the most important, currently relevant and realistic policy interventions that India can utilize in its quest to a food and nutrition secured and healthy nation.

An important dilemma facing India is whether to increase food production, which is a necessary condition for nutrition security, or whether to reduce population pressure itself which is actually one of the fundamental sources of these problems (Ehrlich et al. 1993). The policy suggestions in extant literature are highly controversial and contradictory on this account. The middle-way, namely that of attacking the food insecurity issue from both the demand and supply angles, has been the popularly proposed long-term strategy in the present context. The demand-siders argue for price stability, agricultural income expansion, increasing literacy, empowering women, inducing changes in the composition of the typical food basket of people, among others, so as to control and stabilize the demand and hence pressures on the food sector in feeding the ever expanding and increasingly economically better-off populations. However, the supply-siders reject such notions and instead stress upon the need for overhauling the supply structure of India's food sectors. Supply side proposals dominate the Indian scenario on this issue. The stress on technology as a source for continuously inducing efficiency expansion in the underlying production functions of crops and livestock has been an especially important addition in the policy matrix available with India on this account.

Increased public investments in agricultural technologies and, Research and Development have been found as inducing positive changes in food and nutrition capabilities of India (Aggarwal 2008**;** Rosegrant & Cline 2003). Biotechnological innovations such as Genetically Modified (GM) crops and their active inclusion in the mainstream farming systems have been found as a useful coping mechanism against food pressures (Godfray and Garnett 2014). Others have vehemently opposed such proposals and have instead favoured more sustainable and structural reforms. Sustainable intensification (Swaminathan 1991**,** Godfray et al. 2010**,** Godfray & Garnett 2014) land reforms (Gahukar 2011); precautionary preparations against extreme climate events such as floods and droughts (Devereux 2006) so as to mitigate shocks to food

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production functions, exploiting food access as a means for poverty reduction (Devreux 2006); overhauling the existing PDS system (Kattumuri 2011; Masiero 2015**;** Swaminathan & Rengalakshmi 2016) including technological innovations such as increased use of Information and Communication Technology (ICT) and E-Governance in food distribution networks (Masiero 2015), promoting organic farming (Chandrasekhar 2009; Gahukar 2011); enhancing cropping intensity and agricultural labour productivity among others **(**Kumar & Sharma 2013); adopting local community and stakeholder driven solutions that account for local-specificity of food security challenge (Jha 2002); improving the data infrastructure on food security measurements by combining individual consumption data with household level information so as to derive consistent and efficient hunger, nutrition and access related estimates (Golait & Pradhan 2006), investigating the gender dynamics of and information asymmetries in the existing PDS and other government food security programmes, and bridging any gaps that might exist in this context (Ray 2007); addressing the increasing shift towards fats rather than calories and proteins (Kumar 2017**;** Meena et al. 2016); combating food price volatility and finally, finding water-intensive and water-saving irrigation technologies due to depleting water tables.

It thus emerges from our humble attempt so far that the threat of food security in India has reincarnated itself into a nutritional crisis that requires urgent academic and policy thrusts. India is expanding at a phenomenal pace, with dynamic changes occurring in its macroeconomic and microeconomic landscapes every day. Even though there does exist a wedge between the development and growth paths of India, this gap is definitely narrowing down as people and policy makers continue to improve their understanding about the complexities of a large economy such as that of India. Indian agriculture sector continues to be a livelihood for millions of people with solid welfare and socioeconomic implications. The demands on the agriculture sector, and particularly on the crop sub-sector, are higher than ever before. Indian policy makers must account for the massive shifts in the consumption, production and technological functions underlying the food sector, particularly in the recent decade. It is hoped that our modest attempt opens up new avenues of making sense of the accumulated knowledge on the food security challenges facing India and motivates more exhaustive empirical assessments that probably delve deeper into the structural characteristics of the problem at hand while simultaneously attacking the cross-sectional and temporal forces governing the phenomena of food production, consumption, access, utilization and stability.

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