

Agriculture and sustainable development goals: an overview and issues

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1 Background

Since long, poverty, hunger and malnutrition have attracted considerable attention of policymakers, academicians and civil society organizations across the world. The latest initiative, in the form of sustainable development goals (SDGs) of the United Nations Development Program built on the success of the millennium development goals (MDGs), is a global call to act towards ending poverty, hunger and under-nourishment and bringing peace and prosperity to all by 2030. Of the total 17 SDGs, seven are directly linked to agriculture. For example, the goals of 'no poverty and zero hunger' depend heavily on the performance of agriculture, which is directly influenced by technological change, markets, institutions, climate change and policies. It is, thus, meaningful to assess the contribution of agriculture and allied activities towards achieving these goals.

The theoretical perspectives on poverty hypothesise that agricultural growth is essential for poverty reduction, especially in a country like India where a large proportion of poor live in rural areas and depend on agriculture directly or indirectly for their sustenance. The efforts towards improving agricultural productivity through application of various techniques and technologies have quantifiable benefits of reducing the need to ratchet up cultivated area to feed the growing population. In this background, the Agricultural Economics Research Association (India) decided to organize its annual conference around these issues. The response was overwhelming; a total of 178 research

articles were received from India and abroad. Salient observations and issues emerging from these are summarized below around five broad themes: (i) poverty, food insecurity and inequality, (ii) technology adoption and mechanisation, (iii) agricultural markets, prices and value chains, (iv) sustainable resource use and risk management, and (v) policies and institutions.

2 Poverty, food insecurity and inequality

The research papers classified under this theme focus on an analysis of poverty, incomes, inequalities, food and nutrition security, wage, employment and labour productivity. Raya Das has shown that 60% of India's marginal farmers are unable to earn a subsistence livelihood. The situation is worse in Jharkhand, Odisha, Uttar Pradesh, Madhya Pradesh and Bihar. On the other hand, a study by Chaudhary & Sirohi shows that the income levels of the marginal and landless farmers in Haryana are 48-89% lower than the state average, and there are significant disparities in income distribution across regions. In Uttarakhand, the incidence of poverty is found to be higher in the plains compared to that in the hills (Kharwal et al.). Another study by Kumar et al. concludes that accessibility and affordability of food though is essential but not the sufficient condition for protein consumption. According to this study, the most important driver for household protein deficiency is the consumption unit size. Other determinants include women's participation in decision making, household's expenditure level, landholding size in the farming systems proportion of millets and legumes and landholding size.

While Das's study shows that farmers with diverse livelihoods are better off, Bijla & Sirohi's analysis of data from the Indian Human Development Survey (IHDS) shows that livestock development can be a pathway for poverty reduction, in terms of both preventing households from falling into poverty and also escaping from poverty. From an analysis of a typical dairy farm in Haryana, Saha et al. also conclude that doubling of farmers' income is possible through intensification of dairying via increasing the herd size and improving milk yields, provided financial support is available initially. A primary study in Bihar by Pandey shows that debt-to-asset ratio has significant positive correlation with poverty, but it is not correlated with inequality. His analysis shows that household size, gender, educational level, dependency ratio, land owned, ownership of pump-sets and milch animals have significant effects on farm poverty. Subash et al. used satellite night light data and found that machine learning algorithms (artificial neural network) are better than other imputation models in terms of predictive performance and these can be useful in case of data limitations.

A few papers analysed issues of achieving food and nutrition security. Khed et al. find lower income and price elasticities for cereals, pulses, edible oils and vegetables than for milk and milk products, fruits and meat, fish and eggs. This study shows that income effect among non-farm households and production effect among farm households play important roles in their consumption decisions. Raman et al. find positive income elasticity for liquid milk, curd and ghee and negative for baby food, milk powder and butter. In case of own price elasticity, they find substitution between milk powder and baby food; curd and baby food; ghee and curd; butter, baby food and curd, and complementarity between curd and ghee. These and some other studies recommend that farmers need to diversify towards animal husbandry and horticulture for higher income and nutrition security.

There exists gender discrimination in labour market in the form of wage differentials and types of jobs in Odisha report Swain et al. Similar findings are reported from Rajasthan (Newar et al.). Balaji et al. test the theory that wage equals productivity in a perfectly competitive labour market in a Walrasian framework. Their results seem to confirm the theoretical relationship for most years. The co-integration results

show significant long-run association between wage-productivity gap, inflation, agricultural prices and speed of structural change.

3 Technology adoption and mechanisation

Several papers quantified the potential of existing and frontier technologies in enhancing the farm incomes, reducing costs and risks and improving food quality and nutrition. These focus on total factor productivity (TFP) and impacts of technologies and mechanisation on agricultural productivity and farm incomes.

TFP and efficiency: Some papers addressed the crucial issue whether agricultural sector can sustain its TFP growth, and if it does whether this will be driven by technical change or efficiency change or both. TFP for rice and wheat declined in major producing states during 2002-15 over 1991-2001 report Ankhila et al. According to them, TFP change is associated more with technical change. It, however, varies over time across states. For instance, Das & Kumar find positive and significant TFP growth for rice in West Bengal, while another study show that TFP increased in some states and declined in others and technical change counterbalanced the decline in technical efficiency in states experiencing positive growth in TFP. Sheekha and Kannan observe robust growth in TFP in India, yet it is less compared to that in China, Indonesia and Malaysia. This study also shows little convergence of TFP growth across the Asian countries. Nevertheless, it suggest that technological change can be an important pathway to achieve SDGs.

Another set of papers focuses on analyses of resource use efficiency and productivity levels. Kumari et al. find sub-optimal use of resources in paddy production (except in Punjab, Haryana and Tamil Nadu), and show an improvement in resource-use efficiency can raise yield by 17%. In almost all the states, human and animal labour are over-used. The finding of suboptimal resource use is corroborated by Roy et al. from a district in West Bengal and indicate that there is scope for further increase in inputs in several crops, including paddy. The analysis on resource use efficiency in banana in Tamil Nadu by Kumar & Paramasivam shows that there exists a possibility for enhancing yield of banana by increasing human labour, farmyard manure and organic inputs. In an interesting paper, Singh et al. find that Machine Learning based Mnlgit

classification minimizes error of resources inventory and increases reliability and global uniformity at global level.

Technology adoption and farm incomes: Several authors have analysed the technology adoption and its impacts on farm incomes. Rice is identified as the most innovation prone crop by Upadhyaya et al. Gujarat, Himachal Pradesh, Odisha and Karnataka are observed to be laggards although agro-ecological conditions there are conducive to cultivation of paddy. Nirmala et al. find a 12% yield advantage from adoption of a drought-tolerant variety improved Sambha Mashuri of rice in Telangana. The study by Afrin et al. also find huge benefits from cultivation of aerobic rice in Karnataka. The System of Rice Intensification (SRI) in Haryana is found to yield significant economic returns (Kumari & Chouhan). Abirami and Senthilnathan from their analysis of resource-use efficiency conclude that there is scope to increase nitrogenous fertilizers and labour use in SRI. The laser-levelling technology is identified to improve crop yields of paddy and wheat (Sapkal et al.). Organic chilli growers associated with FPOs in Telangana realized 14% higher gross returns due to their enhanced access to technology, finance and markets through FPOs (Manaswi et al.). Organic farming is also shown to bestow higher net returns by virtue of lower variable costs of cultivation in Punjab (Chhina) and Tamil Nadu (Kumar & Paramasivam) despite low yields relative to conventional method. On the other hand, Kiran shows that both the area under certified organic farming and consumption of fertilisers and pesticides have been rising simultaneously. Major hurdles in organic farming are huge subsidies for fertilisers, lack of government initiative and support, lack of awareness and local market because of lack of certification. Some papers also analysed benefits from adopting improved practices and technologies, and these relate to land management practices (Mandal et al.), tank irrigation (Minithra and Suresh Kumar), and ICT applications (Nikam et al.)

Farm mechanisation for enhancing farmers' income: Several authors analysed the impacts of mechanisation to show its potential to contribute towards achieving SDGs. The increase in machine labour use is expected to bring down cost of production by substituting human labour and improving resource-use efficiency. However, this does not seem to be

happening on the ground as shown by Satyasai & Balanarayana. They explain this with the fact that the farm machineries used in several parts of the country do not suit farm characteristics and that there are lacunae in custom hiring services also. Kumar finds significant positive income effects of mechanization on farm income but more on the larger farms. Lower cost and higher yield in the mechanised maize farms are also reported from Telangana by Prashanthi et al.

The utility of location- and crop-specific machines and equipment is highlighted by Shaheen et al. and Gangwar et al. The study by Shaheen et al. shows how innovative machines designs for difficult terrains can generate higher returns from horticulture. For sugarcane, Gangwar et al. show that developing suitable machinery can generate huge surpluses. For small farm mechanization, evolving custom hiring services is crucial (Hiremath et al.)

4 Agricultural markets, prices and value chains

In this section the papers address range of issues related to market integration, marketing efficiency, market reforms, value chains and their implications for farmer's income. Most of the studies on value chain suggest that farmers' income can be substantially enhanced by improving their efficiency. For example, a study on paddy value chain in Thangadurai district of Tamil Nadu by Nagarethinama & Angles shows possibilities of enhancing net value addition to rice to the extent of Rs. 9530 per tonne, that will benefit all the stakeholders. Similarly, the study on organic finger millet in Tamil Nadu by Manisha & Anjugam shows that by adopting organic cultivation of finger millet, farmers get net income of Rs. 86015/ha in the value chain. A study on red chilli in Thoothukudi district of Tamil Nadu by Muthupandia et al. shows that farmers incur a cost of Rs 47,277 per ha and receive net returns of Rs 7,065 per ha. Also, a study on guava in Uttar Pradesh by Shruti et al. reveals that the processing units get net return of Rs 5,733 per quintal, which is higher than that received by farmers.

Several studies indicate that strengthening physical infrastructure and market intelligence can contribute to higher incomes for farmers. For example, the study on price discovery mechanism and dynamic relationship between spot and future prices of sugar in

India by Gamit et al. reveals that a sustainable long-term equilibrium can be achieved by closing the gap between futures and spot prices. Similarly, the study on price volatility in major tomato markets in India by Durga & Swaminathan underscores that improved storage and processing infrastructure is essential to reduce price fluctuations and stabilize farmers' incomes. The study on price behaviour and co-integration of green gram in Gujarat by Devi et al. finds that markets for green gram are integrated. So are the markets for finger millet in Karnataka (Bellundagi et al.).

Similarly, the study on price forecasting and farmers' perception by Kumari et al. reveals that bringing more awareness among the farmers about market intelligence and motivating them to use price information will be critical to raise their incomes. Establishment of market intelligence units in the state agricultural universities in coordination with state departments can play a crucial role in this regard. The study on price volatility and integration across cluster bean markets in Rajasthan by Baldodiya & Awasthi observes a long run equilibrium relationship and co-integration among markets, and they suggest facilitating effective markets information through price forecasts within different markets and public investment in warehousing, processing and other infrastructure to sustain efficiency of cluster bean markets.

The study on price discovery mechanism of potato in India by Sreepriya & Sidhu finds the mechanism a complex process, influenced by number of factors such as, production, arrivals, and prices. Factors like pest and disease attacks, weather irregularities and marketing aspects like transportation, storage, inadequate and costly cold chain facilities also influence potato prices. Future price signals are intercepted in the main potato markets like Agra market which transmit these to all other important potato markets across the country which are highly co-integrated among themselves as well as the main potato consuming markets like Delhi, Mumbai, Kolkata and Chennai. A cobweb type demand-supply phenomenon is prevalent in the potato production and marketing system creating volatility in potato prices.

The studies on marketing suggest that strengthening infrastructure and cooperative marketing institutions, publicizing benefits of e-NAM, diversification to cultivation of fruits and vegetables and market

information can contribute towards enhancing farmers' income. For instance, the study on production and marketing of vegetables in Kangra district of Himachal Pradesh by Chaudhary et al. finds that the development of infrastructure including roads and efficient transport facilities along with strengthening of co-operative marketing institutions for vegetables will contribute towards improving efficiency of vegetable marketing. Similarly, the study on agricultural marketing reforms and e-NAM by Bisen & Kumar emphasizes on addressing the challenges in its implementation to achieve the goal of doubling farmers' income and seeks amendment in the state APMC Acts to accommodate for e-tendering operations and wider publicity of benefits of e-NAM among farmers via various public forums to increase intake of e-NAM. The study on marketing of fruit and vegetables in Udhampur district of Jammu and Kashmir by Bhat et al. reveals that farmers realize maximum benefits by diversifying into fruits and vegetables. The study on integration of vegetable markets by Revathy & Paramasivam shows that market integration helps reduce the loss at farm level itself, thereby increasing the farmers' income. Similarly, the study on market structure and efficiency in Karnataka by Vedamurthy et al. shows that market intervention through information, innovations and institutions are of paramount importance to ensure remunerative price to the farmers.

5 Sustainable resource use and strategies for risk management

Several papers have focussed on natural resource management and risk reduction for achieving the SDGs. Rao et al. map natural resources for 458 districts and conclude that fertiliser use, adoption of HYVs, irrigation, market density, and electrification have helped regions in coping with poor resource base and performance of agriculture. Their conclusions are based on the fact that several districts in the country perform well in terms of agricultural outcomes despite having poor natural resource base. According to them, natural resource base is low in Rajasthan, Gujarat, Punjab, Haryana, Andhra Pradesh, Tamil Nadu and West Bengal. On the other hand, agricultural performance is poor in states like Bihar, Jharkhand, Odisha and eastern Madhya Pradesh despite having better natural resource base. The study by Feroze complements this study by analysing the vulnerability in the north-eastern

region through a vulnerability index that takes into consideration the exposure, sensitivity and adaptive capacity. It shows Manipur the most vulnerable state due to high exposure to climatic factors and lower adaptive capacity; and Tripura the least vulnerable with high adaptive capacity. From the field level evidence from Tamil Nadu, Felix et al. show that temperature and rainfall significantly affect net revenue, and augmentation of irrigation can ameliorate the negative effects of climate change.

In Vidarbha and Marathwada regions of Maharashtra there is high incidence of environmental risks such as irregular rainfall and pest and disease outbreaks. This study by Thorat & Sirohi concludes that risk management strategies are discriminatory against households belonging to lower socio-economic status. In a systematic study using modified Holt and Laury Lottery method for measuring risk and attitudes in Odisha, Senapati shows that off-farm income helps risk-aversion.

Srivastava et al. examine trends in the groundwater level and identified states facing depletion of groundwater resources. Accordingly, Punjab, Haryana and parts of Rajasthan continue to be the hotspots of depletion, while eastern region has significant potential for water development despite some areas showing signs of stress. From a study of irrigated coconut farmers in the relatively water-stressed region of Kerala, Senath et al. show that gross income is low for farmers engaged in exploratory water extraction compared to those following demand management through drip irrigation. This study also identifies determinants of adoption of drip irrigation. Kumar et al. also find increased farm profits due to sprinkler irrigation in Rajasthan.

Chemicalization of groundwater is emerging as a big issue. Malhotra analyses the use of arsenic contaminated water and finds evidence that farmers in arsenic affected areas have adopted a cropping pattern that is relatively less sensitive to arsenic impacts on crop yields and net returns. A large number of papers have argued that SDGs can be achieved by adopting region-specific crop plans. These studies show that inclusive development can be fostered with the cultivation of crops like kinnow in the north-west region, cotton and wheat in Gujarat, pineapple in Manipur, paddy in Andhra Pradesh, and collection of

non-timber forest products in Chhattisgarh. On the other hand, Jayasekhar et al. argue that the plantation sector in general is far off from inclusive growth, as most of the global value chains are buyer-driven and the production node is characterised by the lowest value share accumulation. Collective bargaining power can be harnessed to improve the situation.

6 Policies and institutional arrangements

Agricultural development has the potential to contribute significantly to achieving the SDGs and this can be realized with policy support and strengthening of appropriate institutions. Several papers in this volume address these issues by evaluating various governmental programmes at the central and state levels, and analysing diversification strategies, insurance and credit arrangements.

An innovative study on government schemes for climate-smart agriculture by Kishore et al. finds that all the schemes taken together can reduce greenhouse gas emissions by 3%, save irrigation water by 2%, lower fossil fuel and fertilizer consumption by 3% and 6% respectively and improve farm income by 8.4%. Their study shows that 15% of the total expenditure on agriculture is spent on climate-smart interventions. It is argued that increase in public expenditure will attract additional investments from farmers and private sector and this can be further amplified through convergence among different programmes and farmers' participation in these. The scheme of 'soil health cards' has been hailed to improve soil fertility and farmers income. Grover et al. from their study in Punjab show that there is a slight decline in the use of chemical fertilisers especially nitrogen and phosphorous and an increase in the use of potassic fertilisers as a fallout of soil testing. They also observe a slight increase in crop yields. The main problems in implementing the scheme include difficulties in understanding the reports and delayed delivery of reports.

Recently, the government included provision of supplying nutri-cereals through PDS. In this context, Sangeetha et al. examine rural households' preference for specific attributes of nutri-cereals using a discrete choice experiment in Haryana and Uttar Pradesh. Their results reveal sorghum to be the most preferred nutri-cereal, followed by pearl millet. Respondents expressed their strong preference for once-in-a month' supply in

the form of flour and as an extra supply rather than substituting these with rice or wheat; and they are willing to pay for these provisions. These findings help prepare appropriate strategies for successful implementation of the scheme. Peter and Martuthi find significant increase in the assets such as cattle sheds, farm ponds, and orchards through participation in MGNREGS and also an improvement in farm income.

Prime Minister's Fasal Bhima Yojana (PMFBY) though has improved insurance coverage, and the economic loss would have been larger in absence of it report Cariappa et al. Authors argue that tailoring insurance policies to insure revenue or income as in the USA would increase farmers' acceptance. Singh et al. assess impacts of participation in the ICAR-KVK supported farmers' clubs in Manipur and find significant positive impacts in terms of adoption of improved rice varieties and subsequently increase in farm income. The advantages for members of these clubs include access to credit, judicious use of fertilisers, use of improved farm equipment, seed selection and expert contacts. Somasekharan and Thomas' study on fisheries find that the new-found standards and dynamic food safety environments are becoming detrimental to sustainability of fisheries with gradual disappearance of independent pre-processing node. Suresh and Shinoj argue for infusion of greater capital in fisheries sector for its sustainable growth.

Several state governments have formulated new schemes to achieve the goal of doubling farmers' income. These schemes are often studied in isolation. In this context, Amarendra Reddy makes an effort to study all the existing schemes available in a village in Telangana and finds that majority of the households benefit from PDS, universal farmers' income (Rs.4000/acre), MGNREGA, loan waiver, seed and fertiliser subsidy, and mid-day meal scheme. *Bhoochetana* (reviving soils) is a novel mission mode project to improve productivity of rainfed agriculture by bridging yield gaps in Karnataka. Hamsa et al. find that this scheme has significant impact on yield and income. Uttar Pradesh government started Direct Benefit Transfer (DBT) scheme since 2014-15. The paper by Kishore analysed the process of availing benefits from DBT scheme and finds that 157 lakh farmers have registered on the portal and on average received Rs.1663 per beneficiary. Their analysis shows that marginal farmers to have benefitted to a lesser extent.

Shah and Shroff from a concurrent evaluation of the Agri Clinics and Agri Business Centres (ACABC) scheme in Maharsashtra find the scheme successful in increasing farm incomes.

There are other papers that analyse institutions like land-lease farming, trade, outmigration, and credit. Thomas and Devi from their study in Kerala show that land-lease is an effective institution for achieving SDGs. Sharma et al show that subsidies to farmers in US distort cotton markets around the world, while developing countries like Nigeria try to protect themselves from onslaught of cheaper imports as indicated by Abu and Obekpa. Outmigration still constitutes a way for mitigating adverse livelihood situations and for smoothening consumptions. Bhandari and Reddy in their study show that outmigration reduces inequalities and increases household income.

Diversification for farmers' income: A number of papers suggest strategies and policies for diversification of farmers' income sources, and there is unanimity in their conclusions that crop production alone cannot lift farmers out of poverty. Waghmare et al. analysed livelihood strategies of small farmers in Maharashtra and find that farmers earn only 37% of their total income from agriculture and 48% from non-agricultural sources. Vatta et al. attempt understanding regional dimensions of income diversification, and the factors influencing diversification. They find that middle-income regions are more diversified, relative to the poor and the rich regions, and diversification is more in case the primary income source is riskier. Further, they notice that diversification is mostly distress-driven. Pani, et al. conclude that 78 per cent farmers have diversified engaging in horticulture production and integrated and mixed farming. Geetha and Lokesh find a positive and significant impact of participation in non-farm activities by marginal farmers on their capital investments and incomes.

7 Issues for discussion

Some of the issues that merit further discussion are as follows:

- Accessibility and affordability of food is essential but not a sufficient condition for improving the nutritional security. There is a need to deliberate on various factors that determine actual nutritional outcomes.

- There are limited studies on gender dimensions of food and nutrition security. Since women and children are more vulnerable, it is important to study intra-household resource allocations in addressing food and nutrition insecurity
- Disparities (regional, caste and gender) in the level of nutrition intake are a serious threat. A concentrated efforts are needed to eliminate these disparities.
- Farm incomes alone are not sufficient to lift the smallholders out of poverty. Serious engagement is needed to enable them through policy and institutional support to embrace multiple pathways.
- Livestock sector is the nearest diversification pathway and has the potential to smoothen the intra-year consumption patterns. However, the sector does not receive policy and institutional support it deserves.
- Inequality in incomes in rural areas pose a significant threat to achieve SDGs. The issue has not received much attention in the research. This needs to be taken forward.
- Can custom hiring services be the most viable option for scaling up the level of farm mechanization to raise crop productivity, especially on the tenant and women operated holdings. Some deliberations along with the possibility of extending institutional loans without making land as collateral would be useful.
- Growth in total factor productivity (TFP) is still way below the best achieved by Asian neighbours. Deliberations are needed to prioritize the technological, policy and institutional measures to accelerate TFPs of crops, livestock, horticulture and fisheries.
- Some studies show that mechanisation is adding to the cost of production without compensatory decline in labour spending and this is attributed to the lack of customized machineries to specific crop and terrain. What are the effective ways of handling this and provision of hiring services?
- Doubling farm income is conditional on improving the fragmented value chains. Few initiatives in the form of e-NAM and reforming APMCs are being implemented. How far these changes help in overcoming inefficiencies and bring higher prices to the farming community? Do private initiatives and supermarket procurements have a role to play in this?
- There is a need to deliberate on institutional mechanism to establish market intelligence cell at state level to improve farmers' income.
- The measures to improve the supply chain including infrastructural facilities are making some headway. However, more vigorous efforts are required to tackle the humongous problem.
- Several institutional innovations like Farmers Producer Organizations/Producer Companies/Self-Help groups/new generation cooperatives are operating in agricultural sectors. We need to understand the governance, dynamics and effectiveness to strengthen the value chains.
- Depleting natural base with climatic changes have adverse effects on agricultural performance. What can be done to ameliorate the situation?
- Groundwater management has to rely more and more on demand side strategies. What is the way forward in terms of farmers' strategies and policy framework?
- As climate change progresses, efforts have to be made to improve climate-smart agriculture through various initiatives. How can the present policy architecture be geared up to this task? What new institutions can be envisioned?
- There is a need to improve the performance of various central government schemes like PMFBY, soil health card scheme, nutri-cereals etc. The learning from initiatives of individual states like universal farmer income scheme of Telangana, *Bhoochetna* of Karnataka and DBT of Uttar Pradesh can be helpful in this regard.
- Diversification away from agriculture to non-agriculture is the need of the hour. But, the evidence shows the process at the juncture is distress-driven. How to make the transition smooth?

