WILL INDIA BE FOOD SECURED IN 2047?

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Towards Farmers' Prosperity

INDIA'S SUSTAINABLE FOOD SECURITY IN 2047

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India's Sustainable Food Security in 2047

Trade-off between Shrinking per capita Agriculture Land availability and need for the Technology Intensification

Agriculture is the foundation of the civilization, culture and heritage of India. Indian Agriculture is unique, diversified and vast providing livelihood and income to more than half of our population. During the last 75 years, the country has marched from a ship-to-mouth to self-sufficient to a food exporting nation. It achieved science- and policy-backed agri-revolutions including Green, White, Blue, Yellow, Golden, Silver, Brown, Grey and rainbow revolutions, which transformed Indian agriculture. Food production increased by 6 to 70 times since 1950 with only 1.3 times increase in the net cultivated area. This trend must continue to address emerging challenges due to growing population, climate change and rising demand for other economic activities.

Food Security in India

In order to provide the Right to food to every citizen of the country, the Parliament of India, enacted legislation in 2013 known as the National Food Security Act, 2013. Also called as the Right to Food Act, this Act seeks to provide subsidised food grains to approximately two-thirds of India's 1.41 billion population.

Food security refers to ensuring adequate food supply to people, especially those who are deprived of basic nutrition. Food security has been a major concern in India. According to the UN, there are nearly 195 million undernourished people in India, which is a quarter of the world's hunger burden. Also, roughly 43% of children in India are chronically undernourished.

India ranks 68 out of 113 major countries in terms of Food Security Index 2022. Though the available nutritional standard is 100% of the requirement, India lags far behind in terms of quality protein intake at 20% which needs to be tackled by making available protein-rich food products such as soybeans, lentils, meat, eggs, dairy, etc. at affordable prices.

The Human Rights Measurement Initiative finds that India is doing 56.8% of what should be possible at its level of income for the right to food.

Food availability is not that reliable for the growing population of India. The challenge to produce more and more for the growing population is becoming increasingly hard for a country of its size and economic growth.

Since the land in India is a shrinking resource for agriculture, the production rate for agriculture needs to be higher per unit of land and irrigation water. Over 60% of the Indian population depend on agriculture for their daily meals. The cultural knowledge in India allows them to have a very nutritional and balanced diet.

The demographic growth, accelerated urbanisation, the non-sustainable consumption of non-renewable resources, climate change, the changing of food consumption pattern (e.g., increase in overall calorie intakes; diet structure changes towards increase of meat, eggs, among others products) will put important challenges in food security.

Population growth is expected to increase under-nourishment, while the intensive exploitation of resources may lead to land degradation and reduce soil productivity. The increase of extreme events (e.g. droughts and floods) and the increasing frequency of pests and diseases associated with climate change can be responsible for crop failure or destruction.

Global food security concerns have been aggravated by the COVID-19 pandemic and climate change. This requires multi-layered solutions to safeguard the global food security and nutrition by strengthening our efforts towards sustainable agriculture and food systems by leveraging science, technology and innovations.

Finally, the changing of food patterns and the demand for more products is increasing the demand for land and water resources, exhausting the resources and increasing the uncertainty regarding food security. Therefore, the food and nutrition security agenda calls for urgent national and international efforts with effective global food security insurance.

Significance of Agriculture in Sustainable Development

Agriculture provides the largest share of food supplies and ensures a critical number of ecosystem services (e.g., food provisioning). Therefore, agriculture is vital for food security and supports the Sustainable Development Goal (SDGs) & SDG 2 - Zero Hunger as other SDGs.

Since the 1996 World Food Summit (WFS), massive efforts have been made in increasing agriculture, food production and security. The United Nations (UN) set the 17 Sustainable Development Goals (SDGs), where an essential goal is Zero Hunger (SDG 2).

According to FAO, the great efforts carried out in the last decades in developing strategies and policies towards the achievement of global food security. Nowadays, approximately one in ten persons worldwide are suffering from severe levels of food insecurity.

Recalling the 2030 Agenda of the Sustainable Development Goals (SDGs) and G20 Matera and Bali Declarations, recognized the importance of research and innovation and called for sharing knowledge, experience and best practices voluntarily with agreeable terms in sustainable agriculture and food systems. The endeavour should be to intensify research and its implementation in agriculture and related sciences to improve the capacity of stakeholders, including local communities; indigenous people as applicable; women; youth; smallholder; family and marginal farmers.

An effective collaboration between national and international research organisations for sustainable agricultural development.

Need to address the growing food security risk

Climate change could have damaging effects on agricultural productivity, leaving many countries with significant agricultural sectors, particularly vulnerable. Adverse weather in summer months could lead to higher food prices; the destruction of productive capital may also cause a decline in agricultural productivity. It is important to build resilience in agriculture which can have a net positive impact on employment and economic growth.

Land under Various Crops

According to government of India data, the land under various crops is given below.

Land Use	Crop Wise land use in the year (2021)	Row No.	Area (in x1000 Ha)
Food Grains (Thousand Hectares)	Rice	2	50,443.00
	Jowar	3	4,369.00
	Bajra	4	7,749.00
	Maize	5	9,764.00
	Ragi/Marua	6	1,200.00
	Wheat	7	35,449.00
	Barley	8	538.00
	Other Cereals & Millets	9	436.00
	Total Cereals & Millets (Row 2 to 9)	10	109,947.00
	Gram	11	9,195.00
	Tur or Arhar	12	4,518.00
	Other pulses (Excl. Gram & Tur or Arhar)	13	12,629.00
	Total Pulses (Row 11 to 13)	14	26,343.00
	Total Food Grains (Row 10 +14)	15	136,289.00
Sugarcane, Condiments, Fruits & Vegetables	Sugarcane	16	5,865.00
	Total Condiments and Spices	17	4,382.00
	Total Fruits & Vegetables	18	12,407.00

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and OilSeeds (Thousand Hectares)	Other Food crops	19	337.00
	Total Food Crops (Row 15 to 19)	20	159,279.00
	Groundnut	21	6,075.00
	Castorseed	22	885.00
	Sesamum	23	1,857.00
	Rapeseed & Mustard	24	6,334.00
	Linseed	25	117.00
	Coconut	26	2,086.00
	Other Oilseeds	27	13,569.00
	Total Oilseeds (Row 21 to 27)	28	30,923.00
Fibres,Plantation and other NON-FOOD Crops (Thousand Hectares)	Cotton	29	13,227.00
	Jute	30	623.00
	Other Fibres	31	103.00
	Total Fibres (Row 29 to 31)	32	13,953.00
	Indigo	33	1.00
	Opium	34	4.00
	Tobacco	35	372.00
	Tea	36	617.00
	Coffee	37	437.00
	Fodder Crops	38	7,569.00
	Other Non-Food Crops	39	2,950.00
	Total Non-Food Crops (Row 28 + 32 to 39)	40	56,828.00
Total	Total Area under crops (Row 20 + 40)	41	216,107.00

Total Land and Land Use in India

Land Use Classification			
	Land Use	**Row No.**	**Years (20-21)**
	Geographical Area	2	328,747.00
	Reporting area for land utilisation statistics (Row 4+7+11+14+15)	3	306,981.00
	Forests	4	71,979.00
Not available for cultivation	Area Under non-agricultural uses land	5	27,726.00
	Barren and unculturable land	6	16,684.00
	Total (Row 5+6)	7	44,409.00
Other uncultivated land excluding fallow land (Thousand Hectares)	Permanent pastures & other grazing lands	8	10,327.00
	Land Use Misc.tree crops & groves (not incl.in net area sown)	9	3,012.00
	Culturable waste land	10	11,905.00
	Total (Row 8 to 10)	11	25,244.00
Fallow Lands	Fallow lands other than current fallows	12	10,818.00
	Current Fallows	13	12,986.00
	Total (Row 12+13)	14	23,804.00
Thousand Hectares	Net area Sown	15	141,544.00
	Total cropped area	16	216,107.00

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	Area sown more than once (Row 16-17)	17	74,563.00
	Agricultural Land/ Cultivable land /Culturable land/ Arable land (Row 9+10+14+15)	18	180,266.00
	Cultivated land (Row 13+15)	19	154,530.00
	Cropping Intensity (% of Row 16 over Row 15)	20	152.70

Points where we need brain storming:

- At the best we can use 12 million Ha cultivable waste land to ensure food security. Will this be enough for the national needs?
- We are importing 70% of edible oil requirements, we are short of fodder, pulses and timbers, etc.

Growing Estimated Demand for Basic Food Items

Year		2023	2047
Population	in millions	1400	1670
Food item	Minimum RDA (in ml or gms)	2023 (in million tons)	2047 (in million tons)
Milk	300	153	183
Sugar	50	26	30
Cereals	310	158	189
Pulses	60	31	37
Vegetables	400	204	244
Fruits	150	77	91
Edible Oils	50	26	30

There is average minimum growth of 20% sustainable production in all crops in the shrinking land and required natural resources will add serious challenges.

Agricultural land : A critical but shrinking resource

Agricultural land provides the largest share of food supplies and ensures an essential number of ecosystem services (e.g., providing food, fuel and fibre) Mainly, agricultural land contributes (directly or indirectly) to approximately 90% of food calories and 80% of protein and fats (livestock production). Therefore, agricultural areas support food security and SDGs achievement. Also, Agriculture especially when practised sustainably, is dependent, connected or essential to improve other SDGs. Agriculture contributes to the increase of urban areas' livability and access to green spaces (e.g., urban gardens, green roofs), reduce the impact of natural hazards and pollution and ensure food security. Agriculture friendly practices contribute to the efficient management of natural resources (e.g., soil and water) and reduce food waste and waste production and to reduce the greenhouse gases emissions and mitigate the impacts of climate change-related events and also and to reduce the intensive agriculture practices (e.g., deep tillage, agrochemicals application), deforestation and land degradation.

Unsustainable agricultural practices that may lead to resource exhaustion or land degradation may trigger conflicts. Therefore, sustainable land management is key to reducing the conflicts resulting from the lack of food.

For instance, it is vital to understand the SDG and agriculture interface to address food security challenges.

- To reduce poverty (SDG Goal 1-No poverty; e.g., targets 1.4 and 1.5).
- Increase population wellbeing (SDG Goal 3-Good Health and Wellbeing; e.g., target 3.9) and
- Support knowledge and R&D (SDG Goal 4-Quality education; e.g., target 4.7).
- Improve water quality and use efficiency (SDG Goal 5- Clean water and Sanitation; e.g., targets 6.3 and 6.4),
- energy efficiency and investment in clean energy (SDG Goal 6- Affordable and Clean Energy; e.g., targets 7.2. and 7.3).
- Also, it is essential to improve the farmers working conditions and resource efficiency use (SDG Goal 8- Decent work and economic growth; e.g., targets 8.2, 8.3 and 8.4),
- support small scale farmers and promote innovation (SDG Goal 9- Industry Innovation and Infrastructure; e.g., targets 9.3 and 9.4) and improve a fair trade between producers and consumers (SDG Goal 10- Reduced Inequalities; e.g., target 10.a).

- SDG Goal 11- Sustainable Cities and Communities; e.g., targets 11.5, 11.6, 11.7 and 11.a).
- SDG Goal 12- Sustainable Cities and Communities; e.g., targets 12.1, 12.2, 12.3, 12.4 and 12.5),
- SDG Goal 13-Climate Action; e.g., target 13.1), to decrease the agrochemicals application and the pollution of surface water bodies
- SDG Goal 14- Life Below Water; e.g., target 14.1)
- SDG Goal 15-Life on Land; e.g., targets 15.1; 15.2; 15.3, 15.4 and 15.5).
- SDG Goal 16- Peace Justice and Strong Institutions).

Trade-offs between SDGs while achieving food security:

Although agriculture has an essential role in improving an important number of SDG's, several works highlighted the existence of tradeoffs between SDG's. For instance, the increase of food production to support No Poverty (Goal 1) or Zero Hunger (Goal 2), may have negative implications in the achievement of other goals such as Climate Action (Goal 13), Life Below Water (Goal 14) and Life on Land (Goal 15).

To minimise the tradeoffs associated with agriculture impacts, it is vital to invest and develop new technologies for data acquisition (e.g., remote and proximal sensing) and create robustly validated models that consider data from multiple sources. The poverty, population and urbanisation growth rates, climate change effects, vulnerability to extreme events, and food insecurity varies in different parts of the world. This will be essential to identify accurately where the agriculture areas are more productive and where they can have more detrimental impacts on the ecosystems. This will be vital to have better agricultural land management.

Several driving forces and processes, acting individually or coupled affect agricultural land use changes, were identified and analysed in the context of different scenarios. They are mainly related to the functioning of local and national financial markets, demographic trends, environmental factors, and internal and external policies.

Different factors (e.g., human and environmental) on agricultural land productivity and food production received important research attention.

Three measures are generally mentioned in the literature:

1. Agricultural production (the net produce or output of cropland),
2. Agricultural crop yield (the amount of crop harvested per unit area of land), and
3. Agricultural productivity (income produced per unit area of land or person employed, , i.e. the market value of the final output).

Agricultural efficiency and productivity have been synonymously and interchangeably used. This is explained by the fact that agricultural productivity (measured in terms of the amount of output (referred to as yield) per unit of area of input) refers to the productive efficiency sector of the total agricultural efficiency. Thus, agricultural productivity is a part of agricultural efficiency, a broader concept expressed in crop productivity levels per unit area or other inputs or nutrition provided per unit area yield. These measures are used to assess the positive or negative influence of operational and structural factors in agricultural land production at different scales

Land suitability for agriculture & food security is another challenge

Insights towards “a better and more sustainable future for all” Boosting agricultural production and productivity of agricultural land currently under production is a recognized strategy to enhance and maintain food supply and reduce hunger. The efficiency of the agricultural systems is a relevant field of research, where the influence of different factors on agricultural land productivity is evaluated to meet food needs.

According to the World Bank Group, an increase of 1% in food production reduces 0.48% and 0.72% of the poverty in South Asia and sub-Saharan Africa. In addition, the increase in agricultural efficiency of the main crops could substantially increase farmer's income and stimulate domestic trade in the countries (SDG 8 - Decent Work and Economic Growth) and promote good health and wellbeing (SDG 3 - Good Health and Well-being).

It is necessary to incorporate different factors (environmental, institutional, organisational, and socio-economic) to have more efficient agricultural management and reduce the impact on ecosystem services. For instance, factors such as pests and pathogens are estimated to be responsible for reducing about 35% of crop yields. This may influence the progress towards the achievement of SDG 2.

Expanding genetically modified crops or applying organic pesticides could be viable solutions for decreasing crop yield losses associated with pests & diseases. Nevertheless, the use of genetically modified plants can raise concerns regarding human health and biodiversity loss. In addition, there are several shreds of evidence that herbicide-resistant crops do not provide better yields or decrease the application of herbicides.

This needs serious scientific evaluation to address public debate in the society so that agriculture production and food security should not suffer.

Climate change and biodiversity loss increase pest and disease frequency. Overall, the efforts carried out to increase food security and improve SDG 2 may be detrimental to the achievement of another (e.g., SDG 3 – good health and wellbeing; SDG 15 - life on land).

Likewise, providing information on available and suitable land for agricultural production can contribute to the identification of the best areas for crop production, establish a sustainable intensification and maximise food production which is in line with the SDG 2. Therefore, land suitability for the agriculture field of research is very relevant from a land management perspective, promoting proper, efficient, rational land use. This is highly relevant to the achievement of SDG 1 (no poverty), SDG 2 (zero hunger), SDG 6 (clean water and Sanitation), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land).

From this perspective, assessing the land potentially can also be an effective strategy to implement sustainable agriculture, which would strengthen population health (SDG 3-good wealth and wellbeing).

Agriculture covers approximately 38% of the land surface. However, in some areas (e.g., urban and peri-urban areas), food security is decreasing.

Therefore, evaluate the changes in agricultural lands, and the drivers responsible for such changes are the motivation of the dynamics of the agricultural land field of research. The agriculture spatiotemporal changes will support food production and safety policy decisions, in line with SDG 2.

Moreover, spatially and temporally accurate information contributes to effective land management, which is a key towards sustainable land use and important for meeting SDG 6, SDG 7 (transitioning to clean energy), SDG 13 (Climate action) and improving the ecosystems (SDG 15).

Meeting global food supply demand for a growing population is one of the 21st-century challenges that will be exacerbated by climate change. Moreover, the areas threatened by climate change and high population growth are located in the same geographical area (Sub-Saharan Africa and Southeast Asia, including Indian subcontinent.).

Despite technological progress, food production will be negatively affected by the changing climate patterns and increases in the frequency and intensity of extreme weather events. Therefore, the effect of climate change in the agriculture field is key to develop essential knowledge to forecast agricultural production under different climate scenarios and improve food safety, better health, and strengthen resilience to climate variability (SDGs 2, 3 and 13), as well as improve the ecosystems (SDG 15).

The production of food is also developed outside the rural areas. The research focused on this topic is timely. According to the UN, Since 2018, more than half of the human population has lived in urban environments, and by 2050 this proportion is expected to increase to 68%. As the urban and peri-urban agriculture movement field of research suggests, agriculture in urban and peri-urban contexts is a global trend that has been enforced as a strategy to combat climate change (SDG 13), increase food security (SDG 2) and make the urban areas more liveable (SDG 11).

Agricultural activities in urban and peri-urban areas have many benefits. Contributes to meet nutritional needs by providing access to fresh and healthy food products (SDG 2), improving human health and wellbeing (SDG 3), generates local food economies contributing to poverty alleviation (SDG 1) and promotes local education (SDG 4 – quality education).

Moreover, urban and peri-urban agriculture have relevant ecological and social functions in air quality regulation, soil erosion regulation, floods regulation, increase the population accessibility to green spaces, and promote efficient water management (SDGs 6, 11, and 15), increasing the sustainability of the urban areas.

The response to our right to food and security depends on the interests and motivations of local land use decision-makers. While the government puts policies and design incentives to induce changes in individuals' behaviour, the farmer manages the farm according to their interests. The farmer's motivations and decisions in agriculture is a very relevant field of research since it puts in perspective the farmer's management decisions and supports SDGs. Specifically, it will contribute to improving the income and livelihood levels of farmers, reducing rural poverty (SDGs 1 and 8) or enhancing the local and regional food production needs (SDG 2). In addition, more informed decisions can be taken to evaluate food system vulnerability, reduce the impacts on climate factors (SDG 13), and foster sustainable agricultural practices and natural resources exploitation (SDGs 6 and 12).

Global trade-offs dilemma need careful local evaluation

For the coming decades, agricultural areas need to double the food production to ensure a stable and accessible food supply. However, the current agri-food systems (e.g., agricultural practices, food preferences and consumption shifts) are increasing greenhouse gases emissions and ecosystem degradation (e.g., soil degradation & water scarcity). This agricultural expansion and the associated impacts (e.g., greenhouse gases emissions and ecosystem degradation) are evident in areas near the subtropical and tropical forests (e.g., Amazon, etc.).

The tradeoffs associated with agriculture may cause a global crisis in food security or environmental degradation at an unprecedented scale. As a result, any progress achieved in food security and SDG-2 may not represent an increase in the sustainable environment because it can be very detrimental to the environment. Therefore, important decisions must be made to minimise the tradeoff between increasing food production and reducing greenhouse gas emissions and biodiversity loss from agriculture due to land requirements for food production.

This is a challenge faced by the agri-food sector since a reduction in food system greenhouse gas emissions, water use, biodiversity loss, and soil degradation is key to decrease the agriculture footprint. The wide implementation of well-known solutions is needed such as reduce food waste, water reuse, agriculture intensification (e.g., tillage, pesticides and herbicides use), meat consumption and invest in sustainable practices based on no-tillage, crop diversification, use of organic fertilisers, increase rotation periods and cover cropping that are beneficial to increase the crop resilience to pests and can increase yield, as observed in several works.

In addition, more efforts are needed to increase food quality, a target that can be achieved using sustainable agriculture practices. Nevertheless, the concept of sustainable development is multidimensional in time and space and is achieved if there is socioeconomic development and environmental protection. Remarkably, the solutions to the long-term sustainability and food supply require adopting sustainable agricultural practices as an effective strategy with reduced environmental impact. It is essential to promote local, diverse, and sustainable agriculture that respects the environment and understanding international trade as a complement to local production. The local and national systems need to be strengthened to adapt to the climate crisis and diversify the farmed products. Crop diversity can reduce crop vulnerability to pests and diseases risks, open markets for different food crops, break their dependence on commercial

crops, increase biodiversity, and reduce the impacts on climate change. In addition, the success of agricultural transformation depends mainly on smallholders' capacity to adopt sustainable practices and adapt to climate change in the available land for food production.

All in all, the effectiveness of research, policies, planning, and investment to build a resilient agricultural system and increase food production depends on local and global challenges and how they mitigate the tradeoffs caused by food production.

Way forward to ensure food security

India stands on the crossroad of multiple challenges and opportunities as it aims to ensure food and nutrition security for its rapidly growing population. Balancing the complex interplay between development and sustainability is pivotal.

The Socioeconomic Landscape: Drivers of Food Demand

In the next decade, India's burgeoning population and economic growth will significantly amplify the demand for food. Projections suggest that crop production must grow by 43% to 55% to meet the food security challenges, according to the Indian Council of Agricultural Research's “Vision 2050”. The correlation between socioeconomic factors and food demand is multi-faceted and complex, deserving a closer examination to inform policy decisions.

Population Growth

India is home to over a 1.4 billion people making in the world's most populous country in the world. This population will increase to 1.66 billion by 2050. Population growth directly translates to increased food requirements. This pressure is not only about quantity but also about the diversity of food needed to meet the nutritional requirements of a diverse population.

Economic Growth and Changing Diets

As the Indian economy continues to grow, so does the average income. Rising incomes generally lead to dietary shifts, often towards higher consumption of protein, fruits, and vegetables. This shift puts additional demands on the agricultural sector, not just in terms of grain crops but also for livestock products, dairy, and horticulture. There will be growing demand from industrial sectors as well because of a shift towards biodegradable materials. This will further add pressure on shrinking land availability.

Globalization and Export Demands
India's aspiration for agricultural exports, including staples like wheat, rice and other grains and horticulture crops and spices and plantation products like tea and rubber, impose the multiple challenges of meeting global and domestic demand from the available agriculture production resources.

The Influence of Policy and Subsidies
Agricultural policies and subsidies influence the farming landscape, often leading to imbalances in food production. While aimed at affordability, these policies can sometimes cause overproduction of certain crops, thereby affecting market diversity.

> **Understanding the socioeconomic drivers of food demand is fundamental in crafting policies that are both responsive and proactive. Given the multiple factors at play—from demographic changes to global market pressures—solutions must be multi-dimensional, robust, and flexible to adapt to a landscape that is in constant flux.**

Urbanization: Encroaching Upon Agricultural Lands
With over 50% of the population projected to live in cities by 2050, urban sprawl is an issue that can't be ignored. The rapid growth of cities often comes at the expense of valuable agricultural land. Urban expansion doesn't just take up cropland but also leads to increased demand for water, further straining an already scarce resource critical for agriculture.

Planning for vertical growth of cities, and the development of urban agricultural initiatives can be some ways to counteract this challenge.

Industrialization: Another Claimant of Land Resources
Industrialization, while crucial for economic growth, also requires land. Industrial complexes and zones are often set up at the outskirts of cities, further eating into potential agricultural areas.

Balancing industrial growth while preserving agricultural land is a tricky but necessary act. Zoning laws that demarcate specific areas for industry, agriculture, and urban development could be a way forward.

Climate Change: The Unseen Adversary
In India, the scarce availability of land adds layers of complexity to the already daunting challenge of ensuring food security. The situation is compounded by various factors such as urbanization, industrialization, and the need for pasture lands. Climate change aggravated the threat to

India's food security. This is also making agriculture land unproductive in many regions due to flooding and other natural calamities. Its impact on agriculture necessitates substantial investments in climate-resilient technologies. These technological advancements should be explored to offset the projected losses in crop and livestock productivity.

Pasture Lands: The Overlooked Aspect

As livestock production is expected to more than double, the demand for pasture lands will also escalate. These lands often compete for the same space as potential croplands and are also impact rich in biodiversity adversely.

Overgrazing and unsustainable pastoral practices can lead to land degradation, affecting both food and livestock feed production. To mitigate this, rotational grazing practices and integrated farming systems that combine crop and livestock farming could be adopted.

> **Each of these factors—urbanization, industrialization, and pasture needs—add different pressures on the scarce land resources in India. Addressing them requires an integrated land management approach that not only focuses on optimizing agricultural yields but also takes into account the necessity to allocate land responsibly for urban development, industrial growth, and sustainable pastoral practices.**

SDG Goals challenges for high population density countries like India

One of the most challenging aspects of policy formulation in the context of agriculture and food security in India is the need to balance various competing goals, especially those outlined in the United Nations' Sustainable Development Goals (SDGs).

Food Production and Zero Hunger (SDG 2)

While increasing food production is an obvious route to achieving zero hunger, this intensification often conflicts with other SDGs such as responsible consumption and sustainable use of terrestrial ecosystems (SDG 12 and SDG 15).

Biodiversity and Ecosystem Health (SDGs 14 & 15)

Agricultural intensification and land-use change often come at the expense of biodiversity and ecosystem health. Thus, methods to integrate biodiversity conservation into agricultural practices must be devised.

Clean Water and Sanitation (SDG 6)
Intensive agriculture often leads to water pollution due to the runoff of fertilizers and pesticides. Water-efficient irrigation methods and better wastewater treatment can help align this aspect with SDG 6.

Sustainable Cities and Communities (SDG 11)
The rapid urbanization in India further complicates the land-use equation, eating into agricultural lands and thereby potentially exacerbating food security issues. Urban planning must, therefore, be coordinated with agricultural policy.

> **By understanding and addressing the trade-offs and potential synergies among these different goals, India can move toward a balanced, holistic approach that serves both its population's immediate needs and long-term sustainability.**

Achieving Affordable Food Security for India: Complex Multifaceted Challenge

Enhancing Yield and Productivity - The Central Pillar of Food Security

Closing yield gaps is of paramount importance. Our analyses indicate that over 90% of projected crop growth must come from yield enhancement, positioning it as the linchpin for realizing SDG 2 (Zero Hunger).

Shifting from traditional small-scale farming to intensified, large-scale operations can bring about significant productivity gains. This transition, supported by policy and financial mechanisms, can make yield enhancements sustainable and widespread.

Collaboration Among Small Farmers

Smaller farms often lack the capital and resources to invest in modern farming techniques. Cost of labour is also going up. However, if these farmers were to pool resources and collaborate—perhaps facilitated by forming producer organizations (FPO) —they could collectively invest in modern farming technologies and practices.

Technology Adoption

Introducing modern technology like data analytics for precision farming, machinery for planting and harvesting, and supply chain improvements can result in significant yield improvements and loss reductions. Government initiatives could provide subsidized technology and training to small farmers to accelerate adoption.

Soil heath
Soil health is fundamental for crop production. Nutrient replenishment is necessary to ensure sustained crop production. Crop health should be ensured by ensuring balance between various micro and major nutrients including carbon content in soil.

Seed
Better genetics is required to produce more crops per drop and per unit area. Climate change will also impact plant physiology and this will impact seed germination, seed setting rates, crop yield, insect and disease incidences, and related challenges as we are witnessing in declining wheat yield in Punjab. To overcome these challenges, we need better genetic material to overcome these challenges.

Responsible Use of Crop Protection Chemicals & Fertilizers
Farming intensification often brings along higher usage of nutrients i.e. fertilizers and agrochemicals. Without them agriculture yield will reduce further and hence it is important that the government should encourage new innovative and sustainable solutions. A holistic approach is required to create a framework to implement sustainable chemical management, and this must be an integral part of our agricultural strategy.

Leveraging Farmer Mechanization to Boost Productivity
Accelerating the mechanization of agriculture can reduce manual labor, improve efficiency, and contribute to increasing overall productivity. Mechanization can make technology more accessible to small-scale farmers, especially women farmers. Mechanization will also attract youth towards agriculture which is also becoming a challenge for food production. This will also help in addressing the growing cost of labour which is becoming unaffordable for farmers.

Financial Resource Pooling
Farmers can benefit from shared access to financial resources. Government and private institutions could provide low-interest loans and grants to producer companies or cooperatives, aimed specifically at implementing modernization and sustainability measures.

Feed security for Livestock sector
Often sidelined in discussions about food security, the issue of animal feed security is integral to a comprehensive agricultural strategy. Livestock production is projected to more than double, and this necessitates a critical look at the requirements and sustainability of animal feed.

Animal Feed Crops

The cultivation of feed crops like corn and soybean also competes with food crops for land and resources. This issue is further complicated by the fact that these crops are also used for biofuel production, adding another layer of competition for land use.

The Expansion of Pasture Lands

Expanding pasture lands seems like an immediate solution to meet rising livestock demands. However, in a land-scarce country like India, where cropland is also under pressure from urbanization and industrialization, pasture land availability becomes a critical issue. Additionally, the expansion of pasture into set-aside lands, which are often rich in biodiversity, can have a significant negative impact on local ecosystems and in turn food security.

Pasture Intensification through Stocking Densities

Given the land limitations, it is imperative to make existing pastures more productive. One way to achieve this is through pasture intensification, where stocking densities are increased to maximize yield per unit of land. This strategy, however, comes with its risks, including overgrazing and land degradation, which require careful management.

Role of Set-Aside Lands

The most conversions to pasture take place on set-aside lands, consisting of extensive farming and remaining natural vegetation. These lands are often rich in biodiversity and serve as carbon sinks. The conversion of these lands to pasture needs to be weighed against their ecological value and the potential impact on climate change goals.

Environmental and Biodiversity Impacts

The strongest negative impact on biodiversity is generated by agricultural intensification, which includes pastures. Practices such as removal of biomass, trampling and destruction of root systems, and replacement of wild grazers by livestock are driving factors. These can not only lead to biodiversity loss but also disrupt the soil structure and water cycle, having far-reaching environmental implications.

“Given these multifaceted challenges, a balanced and sustainable approach to animal feed security is essential. Strategies could include rotational grazing practices, integration of livestock with crop farming systems, and the promotion of sustainable feed crop cultivation practices. Moreover, technological interventions such as precision agriculture could be employed to manage pastures more efficiently, thereby contributing to both animal feed security and broader sustainable food security goals.”

Conclusion

Food security in India requires an agile, multi-faceted policy approach that captures the nuances of various challenges, from climate change to urbanization and from crop yield to animal feed security. Through integrated policy measures and synergistic strategies that align with global SDGs, India can both ensure food security and make strides toward a more sustainable future.

Considering the reduced per capita land availability and shrinking natural resources like water table and soil health for affordable food and feed security it is vital to continue to explore better technological options in all aspects of the value chain in the agri-food system.
It will be useful if all important activities like genetic planting material, crop protection chemicals and nutrient management gets due attention while considering sustainability agenda.

Proper post harvest management technologies will also contribute to food security which can be affordable and sustainable as well.

KAKV will continue to produce discussion papers in this regard to create a meaningful dialogue between various stakeholders for logical discussion so that a food security action plan can be ensured for all.

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KRISHI ANUSANDHAN & KISAN VIKAS FOUNDATION (in brief will be known as Kisan-Vigyan Foundation) is a not-for-profit organization registered under section 25 of the Companies Act 1956 on 19th December 2010 in Delhi.

Vision

To support the national cause of enhancing rural livelihood by focusing on farmers income growth as well as sustainable and affordable food and feed security with the help of relevant technology and policy innovations.

Mission

- To promote technology and policy interventions by which the economic welfare of the farmers can be improved while ensuring sustainable and affordable food and feed security.
- To promote programs and policies to make Indian agriculture and agro-based industries systems globally competitive.

Way Forward Action Plan

1. **Kisan-Vigyan Foundation** will undertake studies to identify the issues impacting farmers' income and global competitiveness of Indian agriculture.

2. **Kisan-Vigyan Foundation** will undertake policy advocacy based on studies and after brainstorming various established and innovative ideas to support farmers income and sustainable and affordable food and feed security.

3. **Kisan-Vigyan Foundation** will also promote technology demonstration and document success stories from all over the world to establish alternate workable models.

4. **Kisan-Vigyan Foundation** will disseminate the information and its findings via all digital and print options for maximum reach in multiple languages & we will also organize events like seminar, conference, exhibition and related activities.

5. **Kisan-Vigyan Foundation** will disseminate and share its findings, observations, experience, and expertise to any agency working for the economic welfare of the farmers via technology and policy interventions.

Power of Partnership

Kisan-Vigyan Foundation will develop strong working relations with all the relevant agencies and work in partnership with agencies including:

- Farmer groups
- Union and State Governments
- Non-government agencies
- Private sector companies
- Foreign partners and agencies
- Multilateral and Intergovernmental agencies
- Any other agency within India or outside India which is working in line with the objective of the KAKV.

Governing Council

Vijay Sardana
Chairman, Governing Council

IIMA Alumnus & Advocate, Supreme Court of India, NGT & Delhi High Court; Spl. in Techno-legal, IPR & Contracts Matters; Corporate Governance Trainer for Independent Directors; Member-Corporate Boards & Expert Committees

N.K. Arora
Secretary, Governing Council

An accomplished professional with 45 years of experience in Agri Input industry with having diverse leading role. Holding unanimously elected position of President-Agri Alumni Association of Pantnagar since its inception in 2008

Ashok Dalwai
Agriculture & Farmers Welfare

Presently serving as CEO of National Rainfed Area Authority (NRAA) in the Ministry of Agriculture and Farmers Welfare, in the rank of Secretary to Go

Anil Jaysing Ghanwat
Farmer Representative

Anil Ghanwat (B.Sc. Agriculture), 63 years old, is a farmer from SriGonda in Ahmednagar district in Maharashtra. Since 1985 he has been involved with the Shetkari Sanghatana

Dr. Arvind Kapoor
Seed Expert

Ph. D in Plant physiology bearing over 3 decades of experience in National and Multinational Seed Industry. He is also a prominent member of various business associations like CII, FICCI, Assocham, and PHDCCI, chairs of the APSA IP Committee

Dr. H.V.S. Chauhan
Crop Protection

Ph. D Agronomy Weed science specialist HAU Hisar
Ex President - Indofil - NPCC
Had been on the board of Crop life, Crop Care federation of India.

Dr. Ramendra Singh
Crop Nutrition

Dr. Ramendra Singh, a Soil Scientist, has over 45 years' experience in Natural Resource Management (NRM) for sustainable agriculture .

Dr. R.K. Malik
Agronomist

Dr. Ram Kanwar Malik, Ph.D in Agronomy is a renowned Agronomist with more than 45 years of experience. He has successfully implemented many projects in association with CIMMYT, IRRI, ACIAR, DFID, ICAR (NATP and NARP) and FAO

A.V. Srinivasan
Farm Machinery

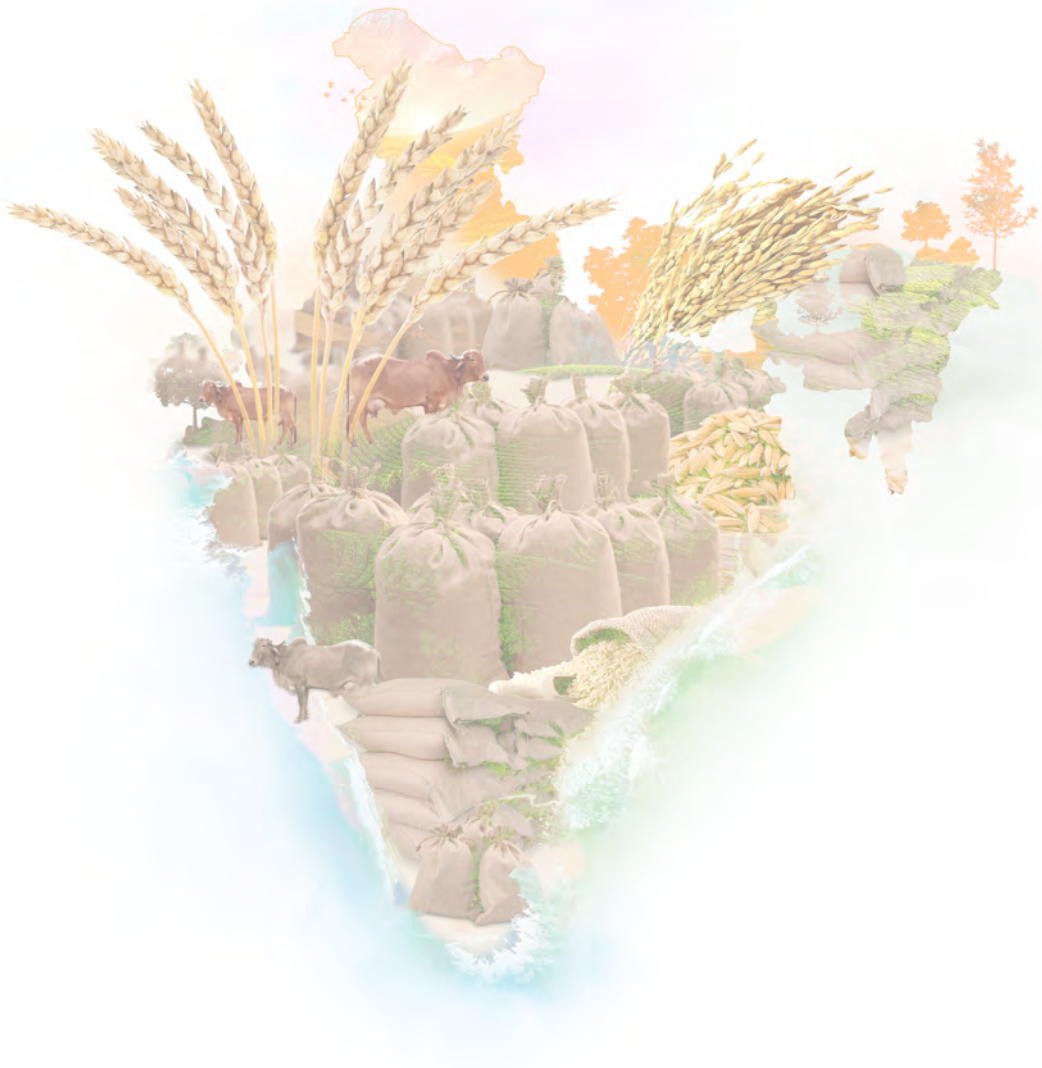
Mr. Srinivasan, an IIT Graduate and MBA has more than 3 decades of experience in marketing, sales & service and product development of tractors, harvester combines, sugarcane harvester, diesel engines in companies like Eicher, Escorts, Escorts Class.

Dr. R.S. Sodhi
Dairy & Co-operative

Dr. R.S Sodhi, President, Indian Dairy Association, Delhi .
Ex Managing Director GCMMF (Amul)
Chairperson, NIFTEM -T

Nimish Gangrade
Media Representative

Nimish Gangrade is an experienced professional in the field of Agriculture. He is currently Director at Krishak Jagat – The National Agriculture Newspaper. He is an accredited journalist by the Government of India.



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