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Popular Article

The Nexus between Energy and Food Systems: What Lies Ahead for India

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Abstract

The whole food systems comprising of pre-production, production, and post-production activities consume a lot more energy and also emit Greenhouse gases. Therefore, energy and food systems have a complex nexus that needs to be interrogated and appropriate sustainable solutions must be aimed at from the perspective of current and future generations, not of India but the World as a whole.

Keywords: Food Systems; Energy Security; Climate Change; Nexus; Challenges; India

Abbreviations

CO_2: Carbon Dioxide; EJ: Exa Joule; $GtCO_2eq$: Giga Ton Carbon-Di-Oxide Equivalent; GMR: Gandhi Mallikarjun Rao; KUSUM: Kisan Urja Suraksha evam Utthan Mahabhiyan; MJ: Mega joules; USA: United States of America; UK: United Kingdom

Introduction

Understanding the nexus and its drivers

Energy is utilized from different sources to accomplish day-to- day activities by different sectors of the economy. It, however, is generated from several sources like electricity, crude oil and petroleum gas. According to the Energy Statistics 2020, released by the Ministry of Statistics and Programme Implementation of the Government of India; of the total consumption of electricity in 2017-18, industry sector accounted for the largest share (42.0%), followed by domestic (24.0%), agriculture (18.0%) and commercial sectors (8.4%).

Figure 1: The Nexus and its Drivers.

The consumption of electricity in agriculture increased at a rate of 5.63 per cent between 2009-10 to 2018-19. Groundwater irrigation accounts for 18 per cent electricity consumption in India. But irrigation is just a component of production sub system of food systems. The whole food systems consume a lot more energy and also emit Greenhouse gases. All this is driven by forces such as Urbanization, cultural and social beliefs and behavior, industrial development, technological innovations, population growth, climate change, policies, trade markets and process and agricultural transformation. There is a whole change in food systems due to all these drivers which call more energy absorption at each stage. Thus, we see that energy and food systems have a complex nexus that needs to be interrogated and appropriate sustainable solutions must be aimed at from the perspective of current and future generations, not of India but the World as a whole.

According to the BP energy outlook 2017, India's situation of energy consumption for various purpose by 2035 with respect to 2015 looks quite alarming in the sense that its consumption of all kinds of energies is going to expand as against other Nations which attempt to reduce their consumption (Table 1). This also highlights that being an expanding economy, India's production and consumption is set to soar higher for next few decades. A positive outlook is in favour of renewables where India, China and Russia will remain way ahead of other Nations by 2035. This scenario depicts a rise in price of energy and probably a transit to food prices in the near future if strong measures are not taken or energy and food systems are not planned to work in an optimal manner.

	Brazil	Russia	India	US	China	World
Oil*	15	15	121	-17	61	15
Gas*	43	-2	162	25	186	38
Coal	-16	-22	105	-50	-2	5
Nuclear	149	17	317	-2	644	59
Hydro	37	14	97	15	38	42
Renew-ables^	157	> 1000	712	182	673	291

Table 1: Per cent Change in Energy Consumption by 2035 wrt 2015.

Note: Data for oil is reported in Mb/day and for gas in Bcf/day; ^includes biofuels, Source: BP Energy Outlook, 2017.

Food systems and energy emissions

Food systems comprise of pre-production, production, and post-production activities. A food system is about backward linkages wherein the inputs are procured and utilized effectively and efficiently to be combined and get converted into an output backed by market demand, and also forward linkages wherein this output moves towards the consumer, through one or more value chains, each having its own strong supply chain. Energy is utilized at almost every stage of the food system, right from input supply till the product reaches consumer plate. According to the Food and Agricultural Organization of the United Nations, globally the food sector consumes approximately 200 EJ per year. Out of this, almost 45 per cent is consumed by the processing and distribution activities (post-production). The energy utilization in food systems worldwide is, however, considered unsustainable. Out of the World's available energy, 30 per cent is utilized by the food industry. Of this, 30 per cent goes in production activities and 70 per cent in post-production activities. Transportation plays a key role in the movement of goods. Various studies suggest that transportation consumes huge amount of energy and alone contributes to around 70 per cent to the overall costs in the agricultural production systems in India.

Furthermore, post production activities, especially value addition utilize significant amount of energy. The data from various literature suggests so. In 2010, parboiling and milling of paddy consumed around 3.10 MJ/Kg paddy in India. Dehydration of carrots consumed 86 MJ/Kg energy in the USA in 70s. In 2001, the manufacturing of tomato juice consumed 4.79 MJ/Kg of energy in Netherlands. In 2004, potato flakes manufacturing consumed 36 MJ/Kg of gas energy in UK, and in 2014, tomato puree packaging in glass jars consumed 11.04 MJ/Kg of energy in Italy.

As the activities in the food systems utilize energy, they also contribute to greenhouse gas emissions. Global agri-food sector emitted around 10GtCO_2-eq of total Greenhouse gases in 2010. The food industry alone generates around 20 per cent of the World's greenhouse gas emissions. Furthermore, the World wastes around one-third of the food produced which is loss of about 38 per cent of the energy consumed in food systems. The processing, packing, distribution and consumption of fruits and vegetables in India, The Philippines, China and the USA generate about 55 Mt of waste that could either be processed as feed resources for animals or turned into further value added products or vermicompost. The waste food or the food loss in the food systems further releases greenhouse gases as there is no timely action by most of the nations across the planet to convert that waste into wealth. Hence the relationship between energy and food systems is complicated. The food systems require energy to survive and develop, however this causes more additions to greenhouse gas emissions. As the consumer behaviour is fast changing throughout the World due to changing income levels, we find consumers' increased ability and willingness to pay for vast range of processed products, ready to eat products, etc. There is an increased demand for food from other countries, courtesy globalization. As people leave their local boundaries and get exposed to the food outside these boundaries, they create new demand. The food now travels continents to satisfy the demand of consumers sitting in some corner of the World. This expansion of food systems calls for an expansion of logistics and supply chain which will further add up to the demand for energy in the coming years to feed 9 billion by 2050. However, the sustainability goals, according to the European Commission suggest 80-95 per cent reduction in energy from the baseline period of 1990.

Challenges for food systems and ways to mitigate

In the coming years, as the food systems continue to expand, they will face some challenges too. The first from an increasing population and limited resources, second from the changing climate, and third from depleting fossil fuel energy resources. As the population continues to rise, India faces the challenge of feeding more stomachs in the coming years from limited resources, both fixed and variable. Several researches have suggested that due to climate change the crop yields are expected to be negatively affected. There are also chances of shift in production sites too due to changing rainfall and temperature pattern. The food may then be required to travel long to satisfy human demand for the same. In such an event, the transportation costs may increase further. We may end up as importer of major commodities while exporters of a few. Lastly, as the fossil fuel energy is on a decline and India's import basket is led by petroleum and petroleum products, the production, processing, and distribution activities in the food systems will be costlier than ever and may suffer in non-availability of an alternative energy resource. This depletion of natural resources may also lead to the decline in the availability of agricultural inputs especially fertilizer and irrigation facilities. This calls for usage of alternate sources of energy. Additionally, India must also find ways to reduce the food loss and wastage to minimum to release the pressure on existing resources.

Food systems, thus being energy intensive, contribute to greenhouse gases and climate change. The other way round also holds true. Changing climate parameters viz. rainfall and temperature have affected crop yield. It may lead to shrinking supplies and higher costs putting up inflationary pressure on the economy, further raising macroeconomic concerns. This may also hamper our efforts to address food and nutritional security. Not only the production, but processing and distribution may also face challenge in such situation. Industry cannot utilize full capacities due to low availability of raw material, and processing and distribution costs per unit of product tend to rise, reducing demand and leading to vicious cycle of poverty.

Hence the major question arises how far can we go with the current practices in agriculture or agribusiness? A deeper understanding of this complex nexus between food systems and energy will make the policy makers and researchers able to address several macro- economic issues like that of hunger and poverty, food and nutritional security, and income and employment. Also the issues related to harnessing and utilizing alternate source of energy will be easy to address through concrete policy framework. Additionally, the issues pertaining to food wastes and losses in the food systems must also be addressed as the reduction contributes positively to food and nutritional security and also reduces greenhouse gas emissions.

Predictions have already been there that we might not be able to feed the hungry world after a decade or so, as we will not be able to produce enough. Then, what strategies countries must follow? There is a need to explore alternatives to make food systems more efficient and effective in lieu of climate change. The combustion of fossil fuels had contributed around 40% increase in CO_2 concentration between 1750 (industrial revolution) and 2012, which definitely would have increased by now. India must try to save energy at every stage of food systems either by optimal utilization of our capacities or conserving the sources at hand using innovative technologies. Zero tillage farming, target fertigation, organic farming, enhanced use of solar energy for on farm operations etc., will help. Few novel techniques such as precision farming, nanotechnology, magnetic agriculture, hydroponics, vertical farms etc, if efficiently explored, will be of great help in ensuring environmental safety and addressing issues resulting to energy consumption and climate change.

Implementation of off-grid solar for irrigation in some states like Gujarat and Maharashtra, solar cooperatives like Dhundi and Majkuva in Gujarat, feeder level solarization of irrigation (SKY scheme in Gujarat), are emerging and useful business models for accelerating use of solar in agriculture. KUSUM scheme has the potential to promote sustainable use of water in agriculture. This scheme has the potential to double the farm income by harvesting solar energy. We must work on establishing effective supply chains and establish models which can give solution to find the pathways to reduce transportation costs and manage inventories just in time. This will help in reducing wastage to a good length. Another option could be investing in Clean Development Mechanism (CDM) projects. We have a few successful case studies to relate to. In India, GMR Industries of Sri Kakulam invested in CDM and earned carbon credits. This plant invested in Methane recovery and also generated power through a turbo generator to supplement its domestic needs. Another Indian Company EID Parry has been recognized for sustainable sugarcane cultivation and milling practices. Tapi food in Surat switched to usage of solar energy for steam generation which is then used in a steam jacketed kettle to heat and concentrate juice. Zero energy cool chambers technology has been promoted for storing fruits and vegetables to prevent income loss [1-11].

Managing the nexus and way forward to a desirable future

Acceptance sometimes gives a better solution and also the innovative ones. First and foremost is the need to accept that India's economy is expanding and so its hunger for energy is manifold. With population rise and changes in consumption pattern, several changes in the food systems are also expected. In such scenario, it is needed to manage complex nexus which can be address via

- **Creating shared value principles**: via community participation
- **Collaborative Actions**: of industry, academia and government
- **Ecosystem Based Approaches**: model approaches to resolve nexus issues as per the ecosystems
- **Assess risk and build climate resilience**: in terms of research
- **Reducing food waste, developing sound food habits**: we will be able to cut short on emissions and enhance resource use efficiency, including that of energy
- **Data/information to understand challenges**: right now we have data shortage and that too is not easily accessible by all
- **Policy alignment for sustainability**: exhaustive policies focusing food systems are already in place; the need is to monitor their timely implementation
- **Promote and adopt nexus thinking**: very little awareness as to what nexus is all about, it needs promotion right from the school level

- **Designing strategies based on evidences**: last but not the least, out all strategies must be based on evidences, and not merely what is happening in any other country. There is no single capsule to treat all ailments, after all.

Conflict of Interest

The authors declare that there is no conflict of interest.

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