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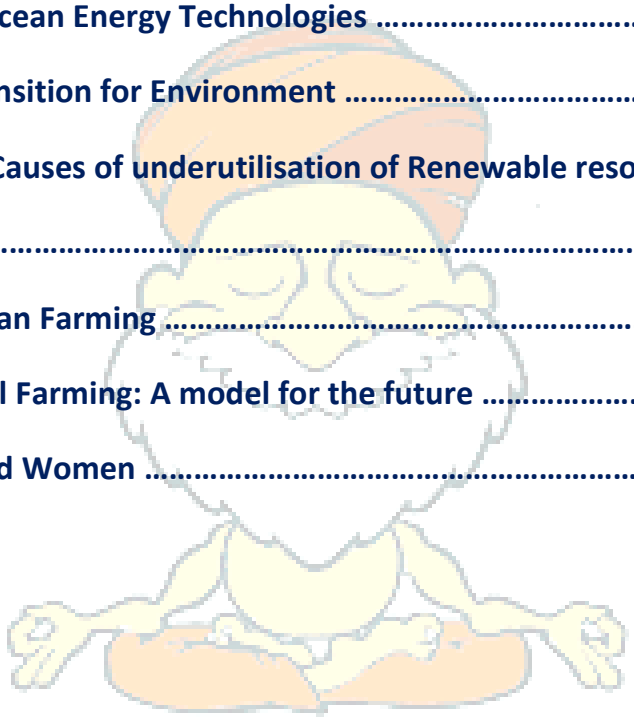

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KANISHAK KATARIA - AIR 1 (UPSC 2018)

Preface

This is our 50th edition of Yojana Gist and 41st edition of Kurukshetra Gist, released for the month of May 2019. It is increasingly finding a place in the questions of both UPSC Prelims and Mains and therefore, we've come up with this initiative to equip you with knowledge that'll help you in your preparation for the CSE.

Every issue deals with a single topic comprehensively sharing views from a wide spectrum ranging from academicians to policy makers to scholars. The magazine is essential to build an in-depth understanding of various socio-economic issues.

From the exam point of view, however, not all articles are important. Some go into scholarly depths and others discuss agendas that are not relevant for your preparation. Added to this is the difficulty of going through a large volume of information, facts and analysis to finally extract their essence that may be useful for the exam.

We are not discouraging from reading the magazine itself. So, do not take this as a document which you take read, remember and reproduce in the examination. Its only purpose is to equip you with the right understanding. But, if you do not have enough time to go through the magazines, you can rely on the content provided here for it sums up the most essential points from all the articles.

You need not put hours and hours in reading and making its notes in pages. We believe, a smart study, rather than hard study, can improve your preparation levels.

Think, learn, practice and keep improving! You know that's your success mantra ☺

Harnessing Sustainable Energy

The Future of Global Energy Security

India's Energy Needs: PM Modi

Called for

- A mutually supportive relationship between producers and consumers
- Optimal use of the neutral platform of the IEF to build a global consensus on 'responsible pricing', that serves the mutual interests of both producers and consumers

Said

- Country's refineries are on track to meet the ambitious target to produce clean and affordable fuel by April 2020
- India's energy consumption will grow 4.5 percent every year for the next 25 years. There is a need for a more transparent and flexible market for the oil and gas sectors. India imports 80 percent of its oil needs and is the third largest oil consumer in the entire world.
- The efforts at artificially distorting oil prices were self-destructing and affected developing countries like India. Thus, it is in the interest of oil producers that consuming markets grow.

India's energy vision comprises of four pillars –

1. Energy access
2. Energy efficiency
3. Energy sustainability
4. Energy security

India needs to –

- Establish an integrated planning process that factors in the implications of decisions concerning fossil fuels on renewables and vice versa, and develop a policy mind-set that enables the fulfilment of short-term objectives without compromising longer-term goals.
- Correct the imbalances in the energy value chain, to minimize avoidable losses and create a unified energy market.
- Redesign and restructure the institutions of energy governance to enable and facilitate holistic energy planning and an integrated energy market. As a first step in that direction, the government should consider legislating an omnibus "energy

responsibility and security act". This will raise public awareness on the interconnections between the various components of energy and between energy and the rest of the economy.

- Cities are the reasons for surging energy demand and air pollution. The government should devolve the energy administration of cities to an autonomous and constitutionally safeguarded "city energy ombudsman". These ombudsmen should be empowered to tackle issues related to energy efficiency, demand conservation, waste management, urban redesign and transportation and to develop and implement focused, small-scale and distributed solutions.
- There is a need to invest in supportive infrastructure, regulations, skills and innovation.
- While CNG buses have been introduced in various cities, the only way for a totally emissions-free public transport is by going all electric. Energy security would mean our ability to manufacture the full value chain in solar panels far more than getting access to equity oil or gas anywhere in the world. The sooner we match China's capacities in producing solar panels and storage batteries for electric cars, we will be better placed in handling our energy security in the years to come.
- Niti Aayog must carry out a detailed study on what will be required to shift from the incumbent fossil fuel energy system to a "clean energy" system.

How to boost the energy drive?

Today, every projection of India's energy future draws the same broad conclusion: energy demand will move on an upward curve, indigenous supplies will fail to keep pace, energy imports will rise, and the environment will face increasing stress. More specifically, coal will dominate, oil and gas will have significance; renewables, whilst on a rising trend, will account for a relatively inconsequential share and air pollution, depleting water tables and extreme weather conditions will invite ecological collapse.

The costs of transitioning to renewables are huge. And there are technological issues to overcome before clean energy can be brought to scale. And so, energy economics needs to be redefined.

We have to contemplate a "revolutionary" change. We have to ask the counterfactual and contemplate the counterintuitive — "What institutional, economic, technological, financial and collaborative steps must be taken to flip the ratio between fossils and renewables in the energy basket of emergent India?"

A few early steps must be taken by the new government to start this process. It must replace the lens that is currently used to look at the energy sector. A general equilibrium macro model is required that captures the linkages between the different components of energy (oil, gas, coal, renewables, nuclear, hydro, bio, non-commercial); and between fuel

usage, electricity, mobility, industry, and agriculture, on the one hand, and, ecology on the other. This will enable decision-makers to consider the systemic implications of changes in one or more of these variables.

A. Integrate energy and environment policy:

- The various ministries currently engaged with energy and the environment should be collapsed into one omnibus Ministry of Energy and Environment. This will perforate the current siloed approach to energy policy and enable the new government to view the sector through an integrated and holistic lens. It could more easily track and evaluate the systemic implications of changes in any one or more component variable.
- An "Energy and Environment Security Act" should be passed at the earliest possible opportunity. The objective of such an act should be to bring energy and environment into the national narrative; to set out the road map for managing and mitigating the emergent challenge of balancing economic development and energy demands with the goal of environmental protection; and, to mobilise public support for the policy and regulatory changes required to hasten the transition to a non-fossil fuel based energy system.
- Energy data is scattered across various government departments. This hinders policy and investment. The government should establish an integrated energy data centre, whose data should be regularly updated and made available to all players on commercial terms.

B. Decarbonisation, demand management and efficiency should be the watchwords of the new government's energy policy:

- The focus should be on generating electricity from solar and wind, incentivising electric vehicles, curtailing diesel consumption in agriculture, enforcing standards and emission norms, redesigning buildings and factories to make them carbon neutral and influencing behavioural change towards energy conservation. A multi-pronged throughst along these lines will weaken the current unhealthy relationship between economic growth, energy demand and the environment.
- The "clean energy fund" which is currently funded through a cess on coal production and is managed by the ministry of finance should be augmented through the issuance of "green bonds" and a clean energy tax. This is to intensify research and development on clean energy technologies (battery storage, carbon capture and sequestration, hydrogen, coal gasification, modular nuclear reactors, etc.) and to fund the transmission and distribution infrastructure required for absorbing the flow of clean energy. Its loci of administration should be handed over to those with domain expertise. This will be to safeguard the funds from sequestration into the consolidated fund and to ensure that the conditions are created for incubating innovation, and forging international R and D and technology partnerships.

C. Energy diplomacy

- The levers of energy and, in particular, oil policy, are today in the hands of autocratic leaders. This "personalisation" of energy politics would not have been an issue in the past when oil was traded mostly against long-term supply contracts. But today, against the backdrop of an integrated, liquid and fungible market characterised by short-term flexible supply deals, this is of relevance especially for import-dependent countries like India.
- The local actions of leaders now have global, supply-related ramifications. The new government should, therefore, look to develop a specialised cadre of "energy diplomats." It should contemplate lateral entrants at mid- and senior levels of government with relevant domain and international expertise.
- It should unshackle the energy public sector units from intrusive bureaucratic oversight to enable their management to respond with agility to unexpected market developments. And it should establish strong personal relations with the leaders of oil exporting states. At a crunch time, the latter could be the peg on which will hang India's supply security.

D. Intensify exploration and enhance recovery:

India's unattractive geology is the reason why the various bidding rounds for private sector investment in oil and gas exploration have not been a success. The government should not stop this effort but it should consider three changes to the current contract terms.

- One, it should replace the current revenue-sharing model with a production-sharing model for new exploration.
- Two, it should link investment in the marginal and smaller discovered fields with access to the domestic retail market and remove the condition that only companies that have invested Rs 2,000 crore will be eligible for a marketing licence.
- Three, it should contemplate bidding out Mumbai High and other major producing oil and gas fields to international players with proven enhanced oil recovery technologies. The current recovery rates of production from these fields are well below the global average.

E. Increase competition:

Coal India Limited (CIL) is a major producer of coal but faces huge legacy issues (labour unions, mafia, politics and organisation) which constrain its ability to fully and efficiently harness the country's indigenous coal reserves. These issues cannot be addressed without first redrawing the contours of India's political economy. The government can resurrect an earlier decision to allow private sector companies into commercial coal mining. The consequent pressure of competition will bear positively on the performance of CIL.

E. Natural gas:

This has also not realised its full potential. Five early initiatives should be contemplated.

- First, Gas Authority of India Limited (GAIL) should be unbundled into a monopoly gas pipeline company. It should be divested of its upstream (production/ re-gassification of LNG) and downstream (petrochemicals) operations. These can be merged into one or more of the existing PSUs.
- Second, the "common access" principle must be fairly enforced. Every player, private or public, must have equal access to gas pipelines.
- Third, the price of gas should be determined on the basis of market and competitive principles. This principle should apply across the gas value chain, except pipeline transport tariffs which should be linked to return on capital.
- Fourth, a gas trading hub should be expeditiously established.
- Finally, special energy courts should be established to expedite adjudication of disputes and ensure sanctity of contracts. The latter have been major deterrents to investment in the energy sector.

India is expected to drive almost a fourth of global energy demand in the next two decades. Not only should it be pulling its weight on global forums and influence global policy and choices (something that is beginning to happen), there needs to be significant investment in India-specific solutions: The country's medium-term growth potential could otherwise be at risk.

Steps to Achieve India's Solar Potential

India set an ambitious plan for **solar rooftop (SRT)** with a target of 40 gigawatts capacity by 2022. But so far, the achievement has fallen short of the goal.

According to the Union Ministry of New and Renewable Energy, only 2,158 megawatt of SRT systems had been installed in the country till December 2018. It is unlikely that the country is going to achieve the target within the given timeframe.

Further, most of the installed SRT systems are with commercial and industrial consumers, while residential consumers account for less than 20 per cent of total installed capacity.

Most developed economies started their solar programmes by targeting household rooftops; as a result, they now have a sizable share of installations in the residential rooftop segment. China and India, on the other hand, have used large-scale solar installations in an effort to quickly achieve scale and simultaneously push down costs. In the case of India, this focus on large utility-scale solar seems to have become an unintended obstruction in the development of the rooftop segment.

There are clear economic considerations behind industrial and commercial consumers' preference for rooftop systems: Solar rooftop power is cheaper than grid-supplied

electricity. These consumers have the financial resources to make the necessary investments, which are sizable, to install SRT systems.

Challenges

- Lacklustre growth
- Little consumer awareness
- Lack of innovative government policies or attention
- Bureaucratic hassles
- Limited support from discoms

The Way Forward

- Achieving significant capacity addition in rooftop solar would require close engagement with numerous small consumers, which is a challenging task in itself.
- Concerted effort would be needed for raising consumer awareness about the benefits of SRT systems and PV technology and their installation.
- Processes for approving net metering applications and disbursing subsidies will need to be efficient and painless to motivate consumers to invest in this new technology.
- Loans need to be made available, which requires significant capacity building of retail bank branches. Instead of these much needed policy initiatives and administrative interventions, the government has largely relied on subsidies (70 per cent for hill and north-eastern states and 30 per cent for other states) to drive SRT installation.

In recent years, the government has taken steps to improve the availability of loans for SRT projects. The Reserve Bank of India has identified solar rooftop as a priority sector for lending. Eight public sector banks have included SRT systems under their housing or housing improvement loans.
Multilateral banks are providing concessional loans against sovereign guarantee to public sector banks to support subsidised lending to the segment. Despite this, collective lending from them until 2017 for solar rooftop financing was only to the tune of $1.4 billion, just 3.5 per cent of the total required funding.

Steps to take Indian solar power industry to next level

Launch of International Solar Alliance, was a significant step to strengthen sector.

By setting up solar parks, providing viability gap funding support and introducing schemes like KUSUM (aiming to harness solar power for agriculture) and SRISTI (catalyzing adoption of rooftop solar solutions), Govt. has shown its keenness to fast track growth of solar industry.

Technology: Newer advancements in field like floating solar (solar panels mounted on Structures that float on water bodies) and BIPV (wherein conventional materials used for facades and roofs of buildings are replaced by photovoltaics systems) can play a vital role in increasing capacity.

Policy Push

- Considering that tariffs are now significantly lower than other sources of energy, we need to move towards healthier tariffs to help private players work with sustainable business models and attract a higher capital inflow.
- This will eventually lead to augmented supply and further lowering of prices for common people. Respective state government should accentuate rate of solar power generation with regular capacity addition.

Discom Health: Steps should be taken to strengthen discom such that they are able to support higher tariffs, honour RPOs and settle power provider's dues on time.

Financial Reforms Reforms in banking systems will go a long way in assisting renewable energy sector.

Enabling Ease of Doing Business

- Government's pursuit of reforms has created a more conducive environment for investments in India which reflects in our steady rise in Ease of Doing Business rankings over past couple of years.
- Achieving ambitious target of 100 GW solar power capacity by 2022 needs a collaborative effort from all stakeholders, including central and state government financers, discom and private players.
- Government has a key role to play not only by providing required policy support but acting as a central coordinator guiding and synchronizing effort from various stakeholders to catalyse solar industry's growth.

Solar Energy: To catalyse India's agricultural energy transition

The much-ignored Case*: An area that could be irrigated in 24 hours, ends up taking almost 4-5 nights to irrigate completely because the current energy consumption pattern of India's agricultural sector is mired in inefficiency.*

- Despite farmers being dependent on the sun for most farming activities, irrigation usually happens quite late at night. This is due to the practice of supplying subsidised electricity to farmers during the midnight hours.
- Done with the intent of reducing the strain on the grid, owing to the daytime loads, the practice inadvertently leads to increased water and energy wastage, as the pumps run throughout the night.
- Therefore, the energy wastage is compounded further, with disruption in farm yields and significant delays in irrigation of farms.

India's agricultural sector is responsible for the consumption of over 18% of overall national electricity usage. However, its contribution to the GDP is just over 5%. This discrepancy has been prevalent since the 1970s, when the Green Revolution was on. Well-intentioned reforms like subsidised electricity supply have had the adverse effect of increasing the

energy strain even further. Meant to alleviate the stress on farmers, low-tariffed or free-of-cost electricity has instead led to mounting losses for the distribution companies (discoms), exacerbated further due to high transmission losses. Electricity theft has emerged as another area of concern and has been on the rise due to non-metered electricity usage in the agricultural sector.

What is the solution then?

The solution, however, is not to curtail the power access to the agricultural sector, as it employs a large part of the population and is a key cog in India's growth engine. We need to provide the requisite energy to the sector, albeit **in a more sustained manner**.

With the agricultural sector's electricity demand set to double over the next decade owing to rising irrigation demand for larger cropped areas, newer crop varieties and rising mechanisation, there is a need for introducing focused measures. The continued agricultural subsidies will lead to piling losses for discoms, along with disruption of the entire energy value chain.

- First, we must ensure farms receive uninterrupted electricity supply during daytime.
- Second, we need to prevent the rising electricity demand from the agricultural sector to bleed discoms further.

'Solar energy has long been the beacon of India's energy transition and can provide a greener energy avenue for the agricultural sector.'

Solar agri-feeders installed by discoms to transmit energy to farms

A solar agri-feeder is a 1-10 MW community-scale solar power plant and is linked to a substation. These agri-feeders can provide largely uninterrupted and sustainable 8-10 hours of electricity during the day. It also obviates installation, maintenance and operation costs for farmers. Additionally, discoms can support farms when the power supply from the feeders is low due to sporadic sunlight, and can even use excess electricity produced by the feeders in case of low irrigation demand.

- Enable reduction of agricultural subsidy and do not require capital subsidies of their own, from the government
- Offer remarkable scalability, as a large number of small solar power plants can be swiftly installed in the open or unused land of substations across the country
- Eliminate the need for significant infrastructural costs, due to new large transmission lines, which is a challenge faced by large-scale wind and solar deployments. This results in affordable and sustained power supply for the agricultural sector during the day, aided by an easy-to-implement design for setting up the feeders.
- Lower agricultural demands from discoms also have the domino effect of enhancing energy access and affordability for industrial and commercial use. This is due to decreased dependence of discoms on the higher tariffs imposed on the industrial sector. India's 2 crore electric and 75 lakh diesel irrigation pumps contribute 26

million metric tonnes of greenhouse gas, which is 5% of the nation's total emissions. Solar agri-feeders can help alleviate this considerably.

The remarkable utility and viability of solar farm feeders is undeniable and has definite relevance in the government's roster of energy sector interventions such as smart metering, renewables proliferation, energy-efficient pumps, and pan-India energy access.

Energy Efficiency is Key for Sustainable Development

Government through Nationally Determined Contributions aims to reduce emission intensity of GDP to 33 - 35 per cent below what it was in 2005 by 2030. There is a need for a concerted move to ensure increased energy efficiency especially in 3 sectors

1. Industrial Sector

With an aim of energy efficiency improvement, Bureau of Energy Efficiency (BEE) is implementing Perform, Achieve and Trade (PAT) scheme under National Mission for Enhanced Energy Efficiency (NMEEE).

The **PAT scheme** is a market-based mechanism for large energy-intensive industries to improve energy efficiency. Under the scheme, three-year energy consumption targets are set for large industrial sectors. Industry units which consume lesser energy than their respective targets can sell energy saving certificates (ESCerts) to manufacturing plants which failed to do so. One ESCert is equivalent to one metric tonne of oil equivalent (Mtoe). Currently about 620 entities are engaged in ESCert trading.

2. Real Estate Sector

Real estate sector consumes over 30 per cent of total electricity consumption in India annually and is second only to industrial sector as largest emitter of greenhouse gases. BEE has two programs:

(I) Eco Samhita, Energy Conservation Building Code for Residential Buildings: Eco-Niwas Samhita (Part I: Building Envelope) aims to set minimum building envelope performance standards to limit heat gains (for cooling dominated climates) and to limit heat loss (for heating dominated climate with adequate natural ventilation and daylighting).

(II) Labelling for Energy Efficient Homes: To enable consumers to compare building performances from a sustainable energy point of view, a comprehensive labelling scheme is important. It is expected to save substantial energy through improving energy efficiency for houses nationwide.

- Shall act as an embryo to stimulate larger energy efficient materials and technologies market

- Housing value chain would encourage an additional set of professionals to expedite complete process of residential label granting.
- It will motivate material manufactures to invest in energy efficient material manufacturing in India.
- Labelling mechanism shall cause a reduction in energy bills.
- It helps nation in working toward fulfilment of Global Sustainable Development Goals 7 of United Nations: Affordable and Clean Energy.

3. Consumer Appliances

- Daily household electronic appliances like AC, Microwave, Washing machine etc.
- According to study of BEE, one degree increase in AC temperature showcases results in saving of 6 per cent of electricity consumed. 24 - 26 degree Celsius default setting has been recommended by BEE for saving energy and for reduction in greenhouse gas emission.

Biogas- A Story Untold

India is heavily dependent on expensive imported oil and gas imports as well as coal for meeting its energy requirements, it definitely makes more sense to look at alternative resources. Waste to Energy programme propagated to recover energy in form of Biogas, BioCNG, power from urban, industrial and agricultural wastes gains importance.

About 184 waste to energy plants based on urban, industrial and agricultural wastes have been set up in private sector with an aggregate capacity of 315.24 Mweq.

Compressed Biogas (CBG) has potential to boost availability of more affordable transport fuels, better use of agricultural residue and cattle dung, as well as to provide an additional revenue source to farmers. Called **Sustainable Alternative towards Affordable Transportation (SATAT)**, it is expected to benefit vehicle-users as well as farmers and entrepreneurs.

CBG can be produced from various bio mass and waste sources, including agricultural residue, sugarcane press mud, distillery spent wash, cattle dung and sewage treatment plant waste. Other waste streams, like rotten potatoes, dairy plants, chicken/poultry litter, food waste, horticulture waste, forestry residues and treated organic waste from industrial effluent treatment plants (ETPs) can be used to generate biogas. It has the potential to replace CNG in automotive, industrial and commercial uses in coming years.

- Responsible waste management, reduction in carbon emissions and pollution
- Additional revenue source for farmers
- Boost to entrepreneurship, rural economy and employment
- Support to national commitments in achieving climate change goals
- Reduction in import of natural gas and crude oil
- Buffer against crude oil/gas price fluctuations

Biogas: Best cooking energy option

Among the various fuel options available (firewood, pellet, biogas, kerosene, liquefied petroleum gas or LPG, piped natural gas or PNG) biogas accounts for the lowest effective greenhouse gas emission; PNG and then LPG are next

- Biogas and PNG are the best cooking energy options. LPG and kerosene are moderately cleaner.
- Firewood and pellet are the most polluting.

Key facts:

- Cooking fuels emit substantial amounts of toxic pollutants (respirable particles, carbon monoxide, oxides of nitrogen and sulphur, benzene, formaldehyde and polyaromatic compounds) which contribute to indoor air pollution.
- Household air pollution causes non-communicable diseases including stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer.
- Close to half of deaths due to pneumonia among children less than 5 years of age are caused by particulate matter (soot) inhaled from household air pollution.
- In households with limited ventilation — common in rural household and semi-urban areas — these pollutants could lead to severe health problems.

Initiatives taken to address in-house pollution: National level programmes to ensure that most switch to clean cooking fuels have been initiated since the 1980s.

National Project on Biogas Development (NPBD)

- It was launched in 1981-82 by the Ministry of Non-Conventional Energy Sources.
- Though the socio-economic and environmental impact of biogas is well recognized, NPBD has been receiving public attention and scrutiny in India because of its vast potential on the one hand and its poor performance, high mortality and non-functionality rates on the other.
- The programme has been hampered by mala fide practices, poor construction material, a lack of maintenance, misrepresentation of achievements and a lack of accountability and follow-up services.

What can work?

- To promote biogas in rural and semi-urban areas, **adopting the service-based enterprise model** with suitable resource availability offers a sustainable approach. It will also help self-drive the programme.
- The model is being successfully implemented in Hoshiarpur, Punjab using a 100 cubic meter biogas plant. The plant supplies clean and piped cooking biogas to 44 households and a school every day.

Such models can also generate employment significantly at the grass-root level an important additional benefit of running a biogas programme.

- Promoting and scaling up PNG in urban areas and making LPG just one of the options to choose from rather than it having an edge over others.
- To further enable a consumer to freely make cooking fuel choices, consumption-based subsidies need to be replaced with a functional subsidy that is provided on the basis of household income levels and local variables.

Possibility of leakages must also be eliminated by ensuring that subsidies of any kind are provided only through direct benefit transfer. Such an approach will provide a neutral throughst and promotion to different types of cooking fuels on the basis of their original virtues.

Gobar Dhan Scheme: Galvanising Organic Bio-Agro Resources-Dhan

Why: With the largest cattle population in the world, rural India has the potential to leverage huge quantities of gobar into wealth and energy.

- To make villages clean
- Generate wealth and energy from cattle and other waste

Benefits:

- New Biogas plants with new and better technology will come up to make the process more efficient
- Facilitate regular power supply to rural homes
- Lead to cleaner villages
- Generate an alternate source of income for the farmers
- Creation of opportunities for income and employment generation for other groups involved
- Improve fertility of the soil and thereby enhance productivity of crops
- Prevent diseases in the animals of the country
- Mainstreaming women in development activities of the village – collecting and packaging the 'gobar dhan' for transportation
- Reduction of pressure induced by waste on the environment as the emission of methane from the cow dung will be processed and will lead to a reduction in Carbon Footprint

Challenges:

- Aggregation of cattle waste and maintaining a regular supply to plant operators becomes imperative.
- The Biogas plants that were constructed was not able to keep up, both in terms of production as well as speed, leading to inefficiencies and losses. The Biogas plants that are being planned to be constructed should have better technology which

sustains, up scales and is widely accepted by farmers and women in rural areas. Adequate training should be provided to the workers.

- India is dealing with a deficient fodder for our cattle. Fodder production for the cattle need to be enhanced
- Farm Mechanization may pose challenges to the population of the cattle as the machines will replace the cattle. This might lead to ignorance on the part of the cattle's master.

Way Forward:

Incentivize Behavioral Change: Cattles are considered important and the fact that the gobar can be utilized and become a source of income needs to be engrained in the minds of the farmers. This will not just generate additional income, but will reduce the pains of gobar disposal, thereby leading to the communities becoming swacchh.

Generating wealth from waste in rural areas will require the involvement of all actors and sectors.

- Investments from the private sector and local entrepreneurs will be needed.
- Panchayats and village communities will have to play key roles to leverage the animal and organic waste that goes into water bodies, dumping sites and landfills.
- Informal sanitation service providers can be integrated into the system by training and licensing them.

Political will and strong public demand for cleaner, healthier living environments should definitely drive the way ahead.

Solve: Will 'Wealth from Waste' be able to drive Indians to the dream of 'Swacch Bharat'? Discuss.

Geo-Thermal and Ocean Energy Technologies

Ocean Energy

Ocean energy is energy harnessed from ocean waves, tidal range (rise and fall) and tidal streams, temperature gradients and salinity temperature gradients and salinity gradients. Around 536 MW of installed ocean energy capacity is in operation at end of 2016, with major share of two large scale tidal barrage plants i.e., 254 MW Sihwa plant in South Korea (completed in 2011) and 240 MW La Rance tidal power station in France (completed in 166).

World Scenario

Leading countries in Ocean Energy technology are UK, USA, Sweden, Canada, France, South Korea. Examples of few large scale Tidal (Barrage) Plants are 254 MW at France (1966), 20

Mw at Canada, etc. ocean Technology, such as Tidal (Current), Wave, Ocean, Thermal Energy Conversion (OTEC) are still at pre Rand d stage/kilo Watt level.

Indian Scenario

As per study conducted by IIT Madras, Theoretical Potential for tidal Energy in India is 12500 MW, Promising locations are Gulf of Khambhat and Gulf of Kutch (GJ), Sunderbans (WB), Western Ghats (MH), etc. theoretical Potential for Wave Energy In India is 41,000 MW, Promising locations are Western Coast of Maharashtra, Goa, Karnataka, Kerala, Kanyakumari, Southern tip of India, etc.

Technology

- **Tidal Energy:** Similar to hydropower generated from dams, tidal water is captured in a barrage across an estuary during high tide and forced through a turbine during low tide. Capital cost for tidal energy power plants is very high due to high civil construction that results in high power tariff.
- **Wave Energy:** Wave energy is generated by movement of a device either floating on surface of ocean or moored to ocean floor by force generated by ocean waves.
- **Current Energy:** Ocean current is ocean water moving in one direction. This ocean current is known as Gulf Stream. Research focuses are on two types of PTEC technologies to extract thermal energy and convert it to electric power: closed cycle and open cycle.
- **Ocean Thermal Energy Conversion (OTEC):** Research focuses are on two types of PTEC technologies to extract thermal energy and convert it to electric power: closed cycle and open cycle. In closed cycle method, a working fluid, such as ammonia, is pumped through a heat exchanger and vaporized. In open cycle system warm surface water is pressurized in a vacuum chamber and converted to steam to run turbine.

Geothermal Energy

Geothermal Energy is a mature renewable energy technology that has a potential to provide clean and reliable energy for power generation and direct heating with cooling.

Geothermal Energy can be utilized for both electric power production and direct heat applications including Ground Source Heat pump (GSHP) for space or district heating, generating hot water for domestic/industrial use, running cold storagesand green house, horticulture, etc.

World Scenario: Total Installed Capacity for Geothermal Power is around 13.5 GW.

Indian Scenario

- There are around 300 geothermal hot springs in India.

- Promising geothermal sites for electric power generation are Puga Valley and Chummathang in Jammu and Kashmir, Cambay in Gujarat, Tattapani in Chhattisgarh, Khammam in Telangana and Ratnagiri in Maharashtra.
- Promising geothermal sites for direct heat use application are Rajgir in Bihar, Manikaran in Himachal Pradesh, Surajkund in Jharkhand, Tapoban in Uttarakhand and Sohana region in Haryana

Technology: There are three types of geothermal power plants:

- **Dry Steam Plants:** Uses geothermal steam directly; Dry steam power plants use very hot (> 235°C) steam from geothermal reservoir.
- **Flash Steam Plants:** Uses high pressure hot water to produce steam. Flash steam power plants use hot water (> 182°C)from geothermal reservoir.
- **Binary Cycle Plants:** Uses moderate temperature water (107 to 182°C) from geothermal reservoir.

Other thermal applications:

- Space/District Heating
- Geothermal Heat Pump/Ground Source Heat Pumps: Geothermal heat pumps use a system of buried pipes linked to a heat exchanger and ductwork into buildings. These heat pumps function as both air conditioning and heating systems.

Future Roadmap: Projects for space cooling and industrial process heating using GSHP technology may be supported through subsidy preferential through subsidy, preferential tariff from power companies as technology is energy/water efficient.

Driving a Green Transition for Environment

India has its own vision for electric mobility: as a member of eight- country Clean Energy Ministerial, a high level forum to promote clean energy policies and programmes, India aims to achieve a 30 per cent electric vehicle penetration by 2030.

Going electric for environment

According to National Green Tribunal (NGT), vehicular emission is one of major sources of India's urban pollution. Electric vehicles have zero tail pipe emissions, simply because they do not use an internal combustion engine (ICE). India can reduce 64 per cent of energy demand for road transport and 37 per cent of carbon emissions by 2030, by pursuing a shared, electric and connected mobility future.

Adopting Electric vehicles (EVs): Challenges and Way ahead

Acknowledging the challenge of rising vehicular pollution in Indian cities, Piyush Goyal, then Union Minister for Power, said that from 2030, India would completely shift to using electric vehicles (EVs).

The push for electric mobility was backed by the government think-tank, NITI Aayog, which has estimated that the nation can save up to Rs. 4 lakh crore by rapidly adopting EVs.

Benefits:

While transitioning from an internal combustion engine (ICE)-based regime to an EV-based one is challenging, the long-term benefits could outweigh the hardships significantly in the wake of India's ambitious renewable energy plans.

- Jobs and the economic impact- India is the world's fourth largest fifth auto market, where over 25 million motor vehicles are produced. The sector is estimated to provide direct and indirect employment to about three crore people and accounts for 7.1% of the nation's GDP. The industry is estimated to grow to $300 billion in annual revenue by 2026, creating 65 million additional jobs, and contributing over 12% to the GDP.
- In October 2017, the Lancet Commission on Pollution and Health, attributed to air pollution an estimated 6.5 million premature deaths globally, with 1.1 million being from India. The database also placed 10 Indian cities in the 20-worst list. EVs will help check this vehicular pollution.

Addressing fundamental issues:

Ensuring coordination among stakeholders:

EVs, unlike ICE vehicles, involve several actors at the *national, State and city levels*, respectively. In the first, it needs multiple ministries such as Road Transport and Highways, Housing and Urban Affairs, Heavy Industries, Power, New and Renewable Energy, External Affairs as well as national institutes such as NITI Aayog.

State and city-level players need to be involved so as to address several technical and infrastructural needs.

Coordination between all three is crucial in driving the EV agenda.

Figuring out the best mode forward:

- China has focussed on the use of electric buses as a catalyst for EV penetration. It is the largest electric bus manufacturer in the world, with most in use in the country. In 2016 alone, about 80,000 electric buses were added to China's roads.
- The Netherlands, on the other hand, has captured the EV market using a simple yet well-crafted strategy of creating charging infrastructure and encouraging investment in charging technology by providing incentives to EV buyers. Today, it has the densest charging infrastructure in the world and is a major exporter of this technology.

These two case studies show that sustained growth is possible only due to positive economic impacts of EVs.

Solving the battery challenge:

The assumption that anyone who controls the battery will control electric mobility is true in the current scenario.

India does not produce lithium-ion (Li-ion) batteries currently, and companies making battery packs are dependent almost exclusively on imports from China. This is a cost-saving strategy as setting up a cell manufacturing unit in India would be expensive.

Solution:

- Accelerating EV use in India should be linked to the "Make in India" goal and domestic battery production.
- Investment is required for **research and development in battery-making** and exploring alternative technologies.

Charging infrastructure:

EV charging is more than just using electricity. It involves exchange of information requiring a communication protocol. There is no unique or single-charging technology for EVs. The three major EV users, China, Japan and the European Union, have their own charging technologies which are often conflicting and not interchangeable. The absence of a standard global infrastructure is a major deterrent for EV penetration in India, as creating infrastructure can be cost-intensive.

Solution: For this, the government needs to select or develop appropriate charging technology that avoids multiplicity and reduces the cost of infrastructure, while making it convenient and safe for users.

Conclusion:

EVs have the potential to disrupt the mobility ecosystem, and, if implemented well, could have a positive impact on the economy as well as the urban environment. India, however, needs a road map, with timelines, processes, well-researched impact studies, bold initiatives and robust investments in technological research to turn its EV dream into reality.

Solve:

1. While adopting Electric Vehicles (EVs), India is surely to face multiple challenges. What are these challenges and what is the way out?
2. Discuss India's potential in the field of renewables.
3. Energy crisis cannot be solved, it can only be managed. Discuss.

SAMPLE ANSWER: Causes of underutilisation of Renewable resources in India

Developing Country – India is a developing country and we have limited funds. They are being allocated in sectors like manufacturing, infrastructure etc. So we are still relying on conventional sources of energy.

High initial cost – This point is related to previous point. Installation of apparatus to generate electricity through wind, water or sunlight is very costly and hence there is reluctance.

Low research and development – In India the level of research in this field is low. We are dependent on many developed countries for technology and equipment.

Monopoly of big business houses – installation of renewable power plants is also a business opportunity. Here many big business houses like Adani and Reliance have created a monopoly and it's difficult for small businessmen to invest in this sector.

Requirement of large area – To install a wind farm or to make hydel power project a large area is required. This may lead to loss of habitat and relocation and migration of local people.

Lack of trained professionals – Renewable energy is a new field where a lot of exploration has not been done in India. Hence skilled workforce is hard to find.

Cost benefit ratio – there are many pockets from which renewable energy can be harnessed like geothermal energy, energy from waste etc. but it is difficult to use it on commercial scale. The input cost is much higher than the benefits and there will be a long breakeven point.

(*You can add many more points like this keeping your answer under 200 words. Conclude the answer on a positive note*.)

Rural Development

Organic Farming

It is a method of farming system which primarily aimed at **cultivating the land and raising crops** in such a way, as to keep the soil alive and in good health **by use of organic wastes** (crop, animal and farm wastes, aquatic wastes) **and other biological materials** along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment.

As per the definition of the United States Department of Agriculture (USDA) study team on organic farming "organic farming is a system which **avoids or largely excludes the use of synthetic inputs** (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection".

FAO suggested that "Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs".

Principle of organic Agriculture:

- The Principle of health
- The Principle of Ecology
- The Principle of Fairness
- The Principle of Care

Characteristics of Organic Farming: -

- Protecting the long term fertility of soil by maintain organic matter levels, encouraging soil biological activity and careful mechanical intervention.
- Providing crop nutrients indirectly using relatively insoluble source which are made available to the plant by the action of soil micro –organisms
- Self- sufficient in nitrogen through use of legumes and biological nitrogen fixation and effective recycling of organics materials including crop residues and livestock manures.
- Weed disease and pest control by relying primarily on crop rotations, natural predators' diversity, organic manuring, resistant varieties, and limited thermal, biological and chemical intervention.
- Extensive management of livestock, paying full regards to their evolutionary adaptations, behaviour need and animal welfare issues with respect to nutrition, housing, health, breeding and rearing.

- Careful attention to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats.

Organic Farming for Sustainable Agriculture Development

Sustainable agriculture integrates the main goal to sustain biodiversity enhance the quality of nature resources, economic profitability and social equity.

Organic agriculture provides high nutrient food to human beings and animals for their wellbeing. Raising awareness, increasing market requirement, nurturing the attitude of the producer to become organic, increasing research and Government support has resulted into good development in organic agriculture

*In 2016, **Sikkim** became **1st organic state of India**.*

Organic farming involves various techniques:

- **Crop Rotation:** A technique of growing different crops in the same area according to the sessions to avoid pests and to maintain soil fertility.
- **Using Green Manures**: Plant leaves and waste material of plants
- **Biology Pest Control:** Using living organization to protects plants from pests instead of synthetic chemicals
- **Vermicomposting**: A process of composting using different worms for preparation of compost w/the mix of kitchen waste and other vegetables waste.

Retailing, packaging and labelling of organic products are also vital components in the promotion of organic products.

Real challenge that India is facing is lack of policy

Some of the policy initiatives to promote organic farming and exports include

- Development of an organic regulation for exports by the Agricultural and Processed Food Products Export Development Authority (APEDA)
- Removal of quantitative restriction on organic food exports
- Providing subsidies to farmers under the Paramparagat Krishi Vikas Yojana (PKVY) in partnership with the state government
- Other schemes such as the Mission Organic Value Chain Development for North Eastern Region

Despite these initiatives, a recent survey-based study covering 418 organic farmers across different states of India suggests that a move to organic farming methods may not be that easy and organic farmers are not getting the expected premium price for their produce.

The study highlights five key issues faced by organic farmers that are affecting their livelihood and income –

1. The supply chain is underdeveloped and small and mid-sized farmers located in hilly regions and tribal belts find it extremely difficult to access the market.

- There is a shortage of pack houses and refrigerated vehicles, which leads to spoilage. Organic products have to be stored separately from conventional products to avoid cross-contamination and the existing supply chain does not often provide that facility.
- Companies mostly source from farmers in regions with a well-developed supply chain and only a few of them are sourcing from the Northeastern states and tribal belts, despite their high potential in organic farming.
- While the government is supporting organic product marketing through fairs and exhibitions, it does not give farmers a steady market. In a number of cases, the middlemen take away most of the profits and farmers are not able to earn a premium price. Direct linkages to processors and retailers could have helped farmers to get a better price, but farmers lack the right linkages and hence have to depend on middlemen and mandis.

2. While the government is subsidising farmers under the Participatory Guarantee System (PGS) for India, which is a self-certification process supported through the PKVY scheme, these farmers are not allowed to export.

- In fact, the APEDA has made it mandatory to have a third-party certification for exports. This is despite the fact that globally more than 100 countries, mostly developing countries, recognise the PGS.
- Unless farmers under PGS India are allowed to export, they cannot earn the premium price. Therefore, ideally, farmers should have the **right to decide** where they want to sell the product—domestic market and/or export market—and the government policy should support the same.

3. As a farmer converts his/her land from conventional chemical-based farming to organic farming, there is a risk of loss in yield due to the withdrawal of chemical inputs and high-yielding varieties of seeds.

- A number of countries, such as the United Kingdom, have carefully designed subsidies to compensate for the yield loss during the conversion period. However, in India, there is no such subsidy.
- Further, a majority of the government budget and subsidies are targeted towards chemical-based inputs and, in many states, less than 2% of the budget is allocated to organic farming. Given India's low rank is Sustainable Developmental Goals Index, it is important for the government to allocate more funding to organic farming and sustainable agriculture practices.

- In the case of organic, the cost of laboratory testing and third-party certification is high and subsidy can definitely help. A number of states, such as Gujarat, Karnataka and Sikkim, have already set up their third-party certification bodies. Other states may also do the same.

4. There is a serious shortage of good quality organic inputs, which increases the risk of loss of yield.

- The available organic fertilisers are much below the required quantity, and there are a number of spurious players in the market too. Similarly, there is a shortage of good quality organic seeds. Some inputs companies have taken initiatives to go for third-party certification. However, there is need for a policy on input standardisation.
- Further, different varieties of crops are grown in different regions of the country, and they are faced with different issues related to pest infestation and soil quality. Hence, there is a need for more crop-specific and region-specific research and development (RandD) on organic inputs.
- Farmers need access to equipment such as netting and poly houses to protect their crops against insects. Fruit flies have led to destruction of crops such as oranges in the state of Sikkim. Here, we can learn from the government of Bhutan, which provides equipment at subsidised rates—and the same can be replicated by Indian government as well.

5. The biggest challenge faced by organic farmers is the lack of an organic policy for the domestic market and imports.

- In the absence of regulation on labelling standard for organic production and logo, it is not possible to distinguish an organic product from a conventional product. This has led to fraudulent practices and genuine players are not getting the premium, which the consumers of organic products are willing to pay.
- While the absence of a policy makes it difficult to punish fraudulent players, the government cannot enforce punishment on the basis of a voluntary certification process. Therefore, over 79% of the farmers opined that the certification process should be mandatory and the government should help farmers under PGS India to get the mandatory certification once their land is converted to organic.
- In fact, over 91% of survey participants pointed out that there should be a uniform logo for organic, which will help in product identification. The study further highlighted that if the right policy measures are taken, then organic farming is expected to grow at 20% in the next five years and the farmers will see a rise in their income.

Way ahead: Training the farmers

Organic farming should begin with training the most important people behind the big picture: the farmers.

- Farmers need to be informed about the latest technological and scientific developments in this area.
- Incorporating organic tools and techniques into their daily operations in an efficient and effective manner will require ongoing training.
- Farmers will need to be weaned off quick-fix chemical methods and reintroduced to our long lost indigenous knowledge. They need to be trained afresh on aspects such as soil building, pest management, inter-cropping, and compost and manure preparation.
- Agronomists must be deployed in the field to monitor the quality of produce and give timely advice to farmers.
- Certification programmes such as the Indian government's National Centre for Organic Farming (NCOF) and Participatory Guarantee Scheme (PGS) need to be made mandatory.

Solve: Discuss the various benefits and limitations of organic farming. Do you think that Organic Farming can totally replace the conventional method of agriculture? Critically analyze.

Biofertilizers in Indian Farming

Biofertilizers and green manures are important pillars of organic farming that support higher yield and maintain soil health. Biofertilizers is a very cost–effective solution for providing nutrients to crop in a sustainable manner, unlike chemical fertilizers which are costly and need repeated application.

Green manuring utilizes lean period between 2 main crops and improve soil fertility by providing fixed nitrogen and improving organic matter of the soil.

- Biofertilizers are products of beneficial microorganisms which increase agricultural production by way of nutrient supply especially nitrogen and phosphorus. Biofertilizers can fix atmospheric nitrogen for plant use and can mobilize unavailable phosphorous pool which can be used by plants.
- These biofertilizers are inexpensive, simple to use and have no problem of environmental pollution.
- Use of biofertilizers not only help in sustaining productivity and soil health but also in reducing subsidy burden on the government by reducing the consumption of chemical fertilizers.

Types of Biofertilizers:

- Concept of microbial inoculation started with legume Rhizobium first patented by Nobe and Hiltner in 1896.
- In development countries like USA, UK, France, Australia, Biofertilizers is restricted to Rhizobium, whereas in Brazil, China and India it has been diversified and a large number of bacteria, fungi and actinomycetes are included in this group.

Nitrogen-fixing Biofertilizers:

- Rhizobia
- Azotobacter
- Azospirillum
- Blue Green Algae (BGA)
- Phosphate, potassium and Zinc Solubilizing microorganisms
- Arbuscular Mycorrhizae (AM)
- Plant Growth Promoting Rhizobacteria (PGPR)
- Azolla
- Carrier based formulations
- Liquid formulation: Liquid formulation is prepared by maxing bacteria with additives, stabilizers and nutrient solution that support bacterial population for a longer period.
  - They are easy to apply as they can be directly applied to seed.
  - They can be stored for a longer period.
  - They require smaller space for storage compared to carrier based formulations

Benefits of application of different Biofertilizers:

- Biofertilizers provide various nutrients to plants like N, P, K etc. either by fixing elemental form (N) or by solubilizing unavailable nutrients like P, K and Zinc. VAM (AM) fungi benefit plants by mobilizing nutrients from a larger root area.
- Azolla not only fixes N but also adds organic matter to soil.
- Biofertilizers not only provide nutrients to plants but also protect plants from plant diseases as they secrete many antibiotic compounds which suppress the growth of disease–causing pathogens.
- Besides providing nutrients and suppressing diseases, biofertilizers also secrete some plant growth promoting hormones like auxins and gibberellic acid which makes plant healthy.
- Many biofertilizers like VAM and PGPR also help plants in avoiding water stress by secreting some polysaccharide which helps in soil aggregation and conserving moisture for longer times.
- Once the biofertilizers are established in the filed after 2 - 3 year of continuous application, does of biofertilizers may be reduced.

Constraints

Some of difficulties faced by government and extension agencies popularizing biofertilizers especially for organic farming are:

- Timely supply of cultures in remote corners of the country where organic agriculture is practiced
- Lack of knowledge of farmer regarding biofertilizers and proper measures taken by extension department in demonstrating benefit of inoculants farmers
- Though mechanisms exits under fertilizer control order to looks after quality control of biofertilizers, persons involved quality control are not versed with proper tools and techniques of handling biofertilizers sample.

Zero Budget Natural Farming: A model for the future

Andhra Pradesh is the first state to implement a ZBNF policy.

Natural farming: *Subhash Palekar*, an Indian agriculturist who practiced and wrote many books about Zero Budget Natural Farming, developed the ZBNF after his own efforts at chemical farming failed. He identified four aspects that are now integral to his process:

- Seeds treated with cow dung and urine.
- Soil rejuvenated with cow dung.
- Cow urine and other local materials to increase microbes.
- Cover crops, straw and other organic matter to retain soil moisture and build humus.
- Soil aeration for favourable soil conditions.

These methods are combined with natural insect management methods when required.

How is ZBNF beneficial?

- In ZBNF, yields of various cash and food crops have been found to be significantly higher when compared with chemical farming.
- Input costs are near zero as no fertilizers and pesticides are used.
- Profits in most areas under ZBNF were from higher yield and lower inputs.
- Model ZBNF farms were able to withstand drought and flooding, which are big concerns with regard to climate change.
- The planting of multiple crops and border crops on the same field has provided varied income and nutrient sources.

- As a result of these changes, there is reduced use of water and electricity, improved health of farmers, flourishing of local ecosystems and biodiversity and no toxic chemical residues in the environment.

The programme can have a positive effect on many of the sustainable development goals through improvements in soil, biodiversity, livelihoods, water, reduction in chemicals, climate resilience, health, women's empowerment and nutrition.

Different from organic farming:

In early 2016, Sikkim was declared India's first fully organic State. But organic agriculture often involves addition of large amounts of manure, vermicompost and other materials that are required in bulk and need to be purchased. These turn out to be expensive for most small farm holders.

Model for other States:

- Over the years, Andhra Pradesh has supported and learned from its many effective civil society organisations such as the Watershed Support Services and Activities Network, Centre for Sustainable Agriculture and the Deccan Development Society.
- Farmer-to-farmer connections as vital to its success. Farmer's collectives such as Farmer Producer Organisations need to be established and these would be critical to sustaining the programme.
- A step-by-step increase in the area covered. The scaling up relies primarily on farmers and local groups — all in all, very much a bottom-up process.
- The approach taken to monitor the improvements is vital to understanding the outcomes of large-scale changes that are under way; this is critical to expanding the ZBNF to other States.

With its combination of delta regions, arid and hilly tribal areas, districts in Andhra Pradesh are similar to those in other parts of the country and could therefore serve as a model for replication.

Conclusion:

The world is at critical junctures on many planetary boundaries and establishing a system that shows promise in improving them while supporting people sustainably is surely one worth pursuing.

Solve: What do you understand by 'zero budget natural farming' (ZBNF)? Discuss its benefits over conventional form of agriculture.

Organic Farming and Women

Areas of focus they deem necessary to promoting the role of women in global agriculture:

- Women need to occupy a greater number of agricultural research positions in order to enrich the available body of research with women's perspectives and self-identified objectives.
- Women need more access to technical training. This includes training with farm equipment, but also a re-examination of how institutions like the U.S.'s extension service support and train farmers.
- Women need access to capital funds for land and equipment, as well as financial support to purchase things like tools, seeds, and other farming inputs.
- Agriculture needs more policies that target a reduction of the gender gap in farming and farm earnings, and supporting action to ensure such policies work toward meaningful change.
- Agriculture needs to cultivate more women leaders, both to inspire a continued increase in women farmers and to steer action, research, and access in a direction that is supportive of and accessible to women.

In some parts of the country, the tribal women prefer growing food crops rather than cash crops because their priority is to meet their family's nutritional requirements. They've formed groups bringing together landholders and the landless poor on the basis of equal sharing: patches of land are leased out for organic farming.

In order to promote traditional organic farming, the government of India has created the Paramparik Krishi Vikash Yojana programme. Under the scheme, over 600 extra hectares of land will be farmed organically by 1370 farmers from 30 clusters of tribal hamlets starting from this monsoon crop season, which usually spans from June to October. In this way, tribal farmers especially farmers who are women, have set another example justifying the urge to shift from intensive to organic agriculture.

It seems obvious, but maybe history just hasn't been paying attention: women make up half of the world's population, so sustainable economic growth (and all of the social and environmental benefits that stem from that) could be as easy as inviting more women to the conversation. In the words of former U.N. Secretary-General, Kofi Annon, "there is no tool for development more effective than the empowerment of women."

Women farmers are fully poised to benefit from and contribute to that process of empowerment, and it's time to start recognizing their contribution.

All the Best! ☺

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