

**1. Examine the deleterious effects of India's current cropping pattern on the environment. What reforms are needed to incentivise sustainable cropping pattern? Discuss.**

**Approach-** Question is analytical in nature. In first part changes in cropping pattern after green revolution can be given. In second part of the body, after effects of unsustainable farming and reforms to contain this crisis can be provided with a way forward.

### **Introduction**

Cropping pattern in India is determined mainly by rainfall, climate, temperature and soil type. Technology also plays a pivotal role in determining crop pattern. The adoption of High Yield Varieties Seeds along with fertilizers in the mid 1960's in the regions of Punjab, Haryana and Western Uttar Pradesh increased wheat production significantly.

### **Body**

- The Green Revolution has transformed India to a food grain surplus country from a deficit one. No other activity has such immense impact on the socio-economic development of the people as the Green Revolution.
- But Intensification of agriculture over the years has led to overall degradation of the fragile agro-ecosystem. High cost of production and diminishing economic returns from agricultural practices are affecting the socio-economic condition of farmers.
- Loss of soil fertility, erosion of soil, soil toxicity, diminishing water resources, pollution of underground water, salinity of underground water, increased incidence of human and livestock diseases and global warming are some of the negative impacts of over adoption of agricultural technologies by the farmers to make the Green Revolution successful.
- Indiscriminate and disproportionate use of chemicals pollutes the soil, air and water and feed and fodders offered to animals. This may be one of the important etiologies of increased productive and reproductive health problems of livestock.
- Various scientific studies and surveys conducted on fertilizer and pesticide residues during last 45 years indicate the presence of residues of fertilizers and pesticides like nitrates, organochlorines, organophosphates, synthetic pyrethroids and carbamates at higher level than permissible limit in milk, dairy products, water, fodder, livestock feeds and other food products.
- Stubble burning in the winter months in northern states contribute to highest level of air pollution in areas around National capital region and has created severe impact on environment and health.

**What can be done?**

- The exponential population increase in recent decades has increased the practice of agricultural land conversion to meet the demand for food which in turn has increased the effects on the environment. The global population is still increasing and will eventually stabilize, as some critics doubt that food production, due to lower yields from global warming, can support the global population.
- Organic farming is a multifaceted sustainable agriculture set of practices that can have a lower impact on the environment at a small scale. However, in most cases organic farming results in lower yields in terms of production per unit area. widespread adoption of organic agriculture will require additional land to be cleared and water resources extracted to meet the same level of production.
- Conservation tillage is an alternative tillage method for farming which is more sustainable for the soil and surrounding ecosystem. This is done by allowing the residue of the previous harvest's crops to remain in the soil before tilling for the next crop.
- To address issue of stubble burning, both farmers and the government need to explore the Chhattisgarh Model. The Chhattisgarh model is an innovative experiment that has been undertaken by the Chhattisgarh government which involves the setting up of gauthans. A gauthan is a dedicated five-acre plot, held in common by each village, where all the unused stubble or parali is collected through parali daan (people's donations) and is converted into organic fertiliser by mixing with cow dung and a few natural enzymes.
- Zero Budget Natural Farming (ZBNF) envisaged in the Union Budget 2019-20 for sustainable agriculture. ZBNF is a set of farming methods, and also a grassroots peasant movement, which has spread to various states in India. It has attained wide success in southern India, especially the southern Indian state of Karnataka.
- Integrated farming system (IFS). The salient features of IFS include – innovation in farming for maximizing production through optimal use of local resources, effective recycling of farm waste for productive purposes, community-led local systems for water conservation, organic farming, and developing a judicious mix of income-generating activities such as dairy, poultry, fishery, goat-rearing, vermicomposting and others.

### Conclusion

India from 1960's drought hit country has travelled a long road to become a self sufficient nation. Techniques used during that time to improve farm produce was necessary to achieve food security. India is now producing more than it needs. We have to invent new methods to overcome unsustainable ways of agriculture that can feed a population of billion and also not harm environment.

**2. What are millets? What are their nutritional benefits? Discuss. Can millet cultivation be a viable solution to agrarian and nutritional challenges? Examine.**

**Approach**

Since question is asking you to Discuss, it necessitates a debate where reasoning is backed up with evidence to make a case for and against an argument and finally arriving at a conclusion.

**Introduction**

Over the past few years, the healthy food revolution has given way to discover the value of traditional millets. Especially with the increasing health consciousness among people, there has been a rise in the demand of nutrient rich cereals like millets.

**Body**

**WHAT ARE MILLETS?**

Millets are cereal crops and small seed grasses, which are widely used in African and Asian countries. Since ages, these small crops were used for human consumption as well as a fodder for animals. Majorly cultivated in the semiarid tropical regions of Africa and Asia, around 97 percent of world's overall millet production happens in these regions.

**What are their nutritional benefits?**

- Millets are extremely nutritious and good for health and they also need less water and can stored for years, as they have a long shelf life. Millets make for a perfect healthy meal. They are loaded with high amount of starch and proteins, which can be beneficial, if added to the daily diet.
- These little grains are a powerhouse of nutrition, which help in improving heart health and can effectively reduce coronary blockage. It is enriched with the goodness of magnesium, which can effectively reduce blood pressure and risk of stroke and heart attacks.
- Millets are a rich source of magnesium, which help in stimulating the level of insulin, thereby increasing the efficiency of glucose receptors in the body, which further helps in maintaining a healthy balance of sugar level in the body.
- Rich in fibre, millets make for a healthy cereal, which can help in digestion and can relieve bowel issues.
- Millets are loaded with the components such as curcumin, ellagic acid, Quercetin and catechins, which further help in removing foreign agents and free radicals and balance the enzymatic reactions in the body. These can naturally detoxify the blood.

**MILLET CULTIVATION AS A VIABLE SOLUTION TO AGRARIAN CHALLENGES**

- According to the report of the National Rainfed Area Authority (NRAA) even after realizing the full irrigation potential, about half of the net sown area will continue to remain rainfed. This alarms the need of shifting to the alternative of current cereal staples.
- Millets cultivation can be a solution to this problem as these can grow on shallow, low fertile soils with a pH of soil ranging from acidic 4.5 to basic soils with pH of 8.0. Millets can be a good alternative to wheat especially on acidic soils.
- Rice is very sensitive to saline soils and has poor growth and yield on a soil having salinity higher than 3dS/m. On the other hand, millets like pearl millet (*Pennisetum glaucum*) and finger millet can grow up to a soil salinity of 11–12 dS/m.
- Millets have a low water requirement both in terms of the growing period and overall water requirement during growth. The rainfall requirement of certain millets like pearl millet and proso millet (*Panicum miliaceum*) is as low as 20 cm, which is several folds lower than the rice, which requires an average rainfall of 120–140 cm.
- Most of the millets mature in 60–90 days after sowing which makes them a water saving crop. Barnyard millet (*Echinochloa frumentacea*) has the least maturation time of 45–70 days among millets, which is half to the rice maturation (120–140 days) time.
- Millets fall under the group of C4 cereals. C4 cereals take more carbon dioxide from the atmosphere and convert it to oxygen, have high efficiency of water use, require low input and hence are more environment friendly.
- Thus, millets can help to phase out climatic uncertainties, reducing atmospheric carbon dioxide, and can contribute in mitigating the climate change.

**MILLET CULTIVATION AS A VIABLE SOLUTION TO AGRARIAN CHALLENGES**

- Millets secure sixth position in terms of world agricultural production of cereal grains and are still a staple food in many regions of world. These are rich source of many vital nutrients and hence, promise an additional advantage for combating nutrient deficiencies in the third world countries.
- Millets are nutritionally similar or superior to major cereal grains. The additional benefits of the millets like gluten-free proteins, high fibre content, low glycaemic index and richness in bioactive compounds made them a suitable health food.
- The mineral content in millets ranges from 1.7 to 4.3 g/100 g, which is several folds higher than the staple cereals like wheat (1.5%) and rice (0.6%).
- Thus, the incorporation of millets in the diet can help to eradicate nutritional deficiencies.

**Conclusion**

Millets can easily thrive in extreme conditions like drought, and some wild varieties can even prevail in flooded areas and swampy grounds. These have low glycaemic index, abode gluten-free protein and are rich in minerals (calcium, iron, copper, magnesium, etc.), B-vitamins and antioxidants. These extraordinary traits make them nutritious and climate change compliant crops. These can not only serve as an income crop for farmers but also improve the health of the community as a whole. The inclusion of millet-based foods in international, national and state-level feeding programs will help to overcome the existing nutrient deficiencies of protein, calcium and iron in developing countries.



**3. Examine the benefits of drip irrigation. Which sort of crops are suitable to be irrigated by this technique? Discuss.**

**Approach:**

Question is very straight forward and simple in its approach students are expected to write about the benefits of drip irrigation in a detailed manner and in the second part mention about which crops are suitable for drip irrigation, then conclude by mentioning prospects and future importance of drip irrigation.

**Introduction:**

Drip irrigation is sometimes called trickle irrigation and involves dripping water onto the soil at very low rates (2-20 litres/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Water is applied close to plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile. With drip irrigation water, applications are more frequent (usually every 1-3 days) than with other methods and this provides a very favourable high moisture level in the soil in which plants can flourish. The main idea behind drip irrigation system is to assist in the growth of agricultural crops and plants by maintaining with the minimum amount of water required, suppressing weed growth in grain fields, preventing soil consolidation etc.

**Body:**

**Benefits of drip irrigation-**

- **Reduced Water Usage** – By directly targeting the root zone, water isn't wasted on areas that won't benefit the plant.
- **Healthier Foliage** – Overhead watering means the leaves of the plant stay wet long after irrigating. Wet leaves causes discoloring and spotting. With drip irrigation, the plants leaves remain dry.
- **Prevents Fungus** – Wet leaves can cause fungus such as powdery mildew to spread. Drip irrigation keeps foliage dry and prevents fungus.
- **Prevents Soil Erosion** – Drip irrigation is a gentle, steady drip and reduces the amount of runoff, therefor reducing soil erosion.
- **Reduces Weeds** – Since areas in between the plants won't be receiving water, weeds are less likely to grow.
- **Nutrient Runoff Minimized** – When there's a large volume of water running off the soils surface it depletes nutrients in that soil. Since drip irrigation reduces runoff it reduces the loss of nutrients.
- **Doesn't Require Lot of Levelling and Drainage** – Typical irrigation setups leave a lot of water on the soils surface. This means drainage and proper site leveling is required to prevent standing water. With drip irrigation this isn't as

necessary since less water is being used and the water is being directed directly to the root system.

- Works With Low Pressure – Low pressure is actually good for drip irrigation. Most overhead irrigation systems require pressure tanks if there are a lot of sprinkler heads.

**Suitable crops for drip irrigation technique-**

- Drip irrigation is most suitable for row crops (vegetables, soft fruit), tree and vine crops where one or more emitters can be provided for each plant. Generally only high value crops are considered because of the high capital costs of installing a drip system.
- Vegetable plants – Some vegetable plants suitable for the drip irrigation system are Tomato, Chilly, Capsicum, Cabbage, Cauliflower, Onion, Okra, Brinjal, Bitter Gourd, Ridge Gourd, Cucumber, Peas, Spinach, and Pumpkin, etc.
- Cash crops – Some of the cash crops suitable for the drip irrigation system are Sugarcane, Cotton. Areca nut and Strawberry etc.
- Flowers plants – Some of the flower plants suitable for the drip irrigation system are Rose, Carnation, Gerbera, Anthurium, Orchids, Jasmine, Dahilia, and Marigold, etc.
- Plantation crops – Some of the plantation crops suitable for the drip irrigation system are Rubber, Coffee, Coconut, etc.
- Spices – Some of the spices crops suitable for drip irrigation system are Turmeric, Cloves, Mint, etc,
- Oilseeds – Some of the oilseeds suitable for drip irrigation systems are Sunflower, Oil palm, Groundnut, etc.
- Forest crops- – Some of the forest crops suitable for drip irrigation systems are Teakwood, Bamboo, etc.

**Conclusion:**

water scarcity has now reached a new level in India. While severe drinking water scarcity is noticed commonly everywhere, farmers are facing a lot of difficulties in cultivating crops with reduced water availability in different regions. What is worrying is that water scarcity is expected to aggravate further in the near future. Projections made by the International Water Management Institute (IWMI) indicate that one-third of the world population would face absolute water scarcity by the year 2025. NITI Aayog's report (2018) on 'composite water management index' also underlined the depressing state of water stress. There is much scope for easing water scarcity in agriculture. The agricultural sector (irrigation) currently consumes about 80 per cent of water in India, drip irrigation can play an important role in easing the water stress in India its potential in increasing farm productivity also is well known.

**4. What are run off river hydropower plants? Are there environmental hazards associated with such plants? Examine.**

**Approach**

We need to define run off river hydropower plants and deliberate on how they impact environment. We need to examine both positive and negative impact of run off river hydropower plants on environment

**Introduction**

India is committed to have 40 per cent of its installed capacity from non-fossil fuel sources by 2030, and is pursuing a renewable target of 175 GW by 2022 and 450 GW by 2030. Therefore, hydropower is highly relevant for grid integration of renewable energy and for achieving well intended climate and developmental goals.

**Body**

- Run-of-river hydropower plant channels flowing water from a river through a canal or penstock to spin a turbine. Typically a run-of-river project will have little or no storage facility.
- Run-of-river provides a continuous supply of electricity (base load), with some flexibility of operation for daily fluctuations in demand through water flow that is regulated by the facility.
- The best sites for run of river projects are where there is strong year-round water flow and a large gravitational drop, or hydrostatic head.

**Run off hydropower plants are preferred over large dams due to following environmental benefit –**

- Lack of a major reservoir reduces the environmental footprint of run of river plants
- Unlike fossil fuel plants they do not emit greenhouse gases.
- Cause less harm to biodiversity.
- Can be built in difficult terrains like Himalayas and other hilly regions
- Provide electricity to population located at distant geographies.

In recent years, run-of-the-river hydropower projects have emerged as a viable, low-impact alternative to existing large-scale projects, India has number of ROR hydroelectric power stations such as Baglihar Dam, Nathpa Jhakri and Shringar Hydropower Station, Ratle Hydroelectric Plant, Maheshwar Hydropower Plant and Kishanganga Hydroelectric Plant are under construction.

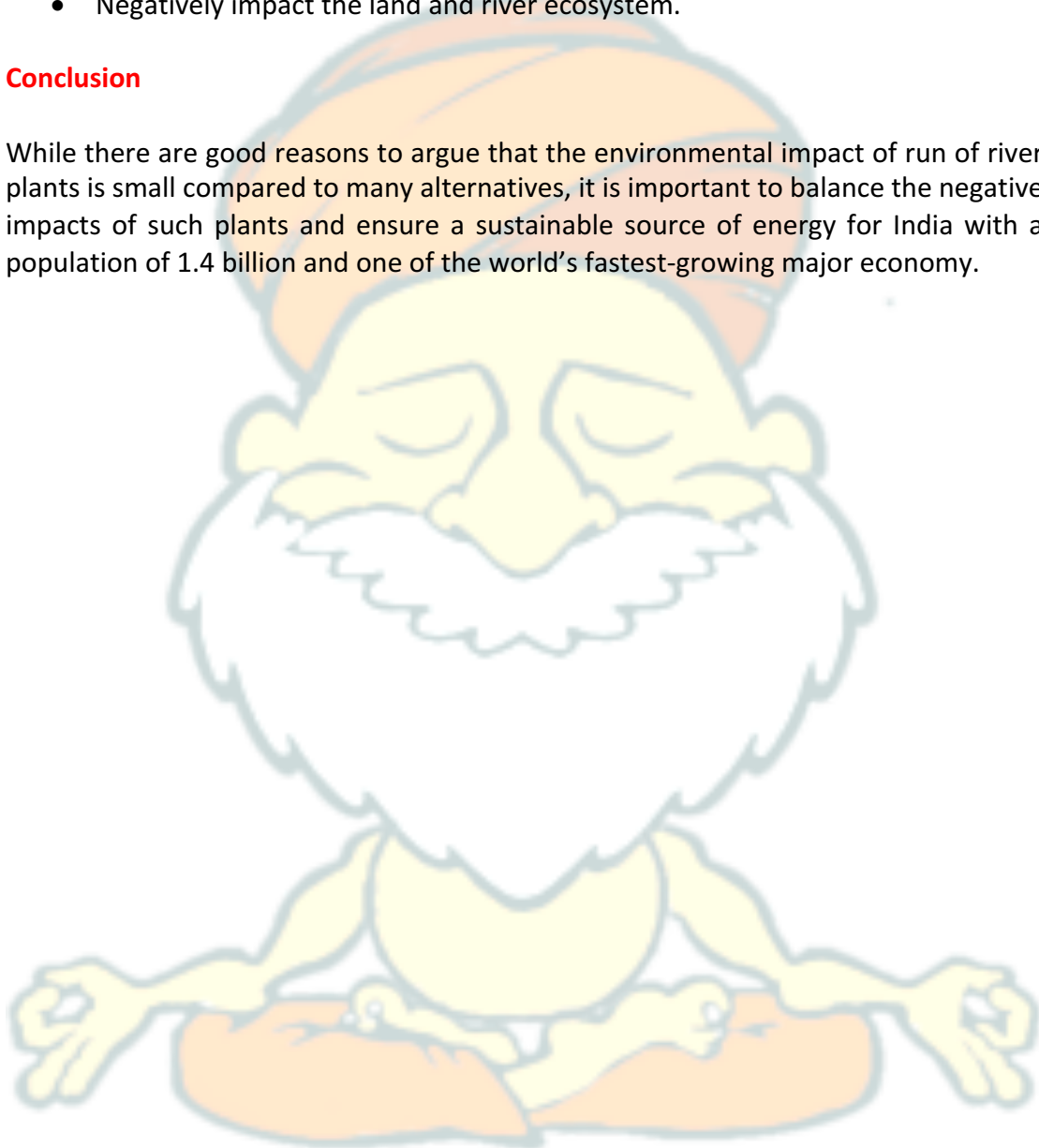
**However, run off river hydropower plants are associated with following environmental hazards:**



- They often cause drops in water flow and changes in water temperature which in turn drive declines in fish populations.
- Access roads and transmission lines cause habitat fragmentation and destruction
- Stretch of river in between diverted point and re-joining point suffers from water depletion and loss of vegetation.
- Increase sedimentation in the river.
- Negatively impact the land and river ecosystem.

### **Conclusion**

While there are good reasons to argue that the environmental impact of run of river plants is small compared to many alternatives, it is important to balance the negative impacts of such plants and ensure a sustainable source of energy for India with a population of 1.4 billion and one of the world's fastest-growing major economy.



**5. What are the challenges related to procurement, storage and transportation of agricultural produce in India? Analyse.****Approach**

Students are expected to write about agriculture sector in India and its weightage in India's economy and analyse about the challenges related to agriculture in procurement, storage and transportation.

**Introduction**

India's agriculture sector plays a crucial role in Indian economy. Over 58 % of rural-households depend on agriculture as their primary means of livelihood. Along with fisheries and forestry agriculture is one of the largest contributors to nations GDP.

**Body**

The 7500+ Agricultural Procurement and Marketing Committee (APMC) mandis provide a marketplace for the transaction and the Food Corporation of India (FCI) plays the role of the buyer, storing the procured produce in the relevant warehousing corporation's warehouse.

Challenges related to procurement, storage and transportation:

- **Flawed Agricultural Marketing Policies:** Due to restrictions imposed by Agricultural Produce Market Committee Acts passed by various states, Indian farmers today can only sell their produce at Farmgate or local market (haat) to village aggregators, APMC mandis and to government at the minimum support price (MSP).
- **Limited reach of mandis:** Also, this procurement system has failed to cover the entire country evenly back of the envelope calculation suggests that on an average, a farmer needs to travel 12 kms to reach the nearest mandi and more than 50 kms in NE India while according to the recommendations by National Farmers Commission, availability of markets should be within a 5 km radius.
- **Procurement problems:** Almost 2/3rd of the total cereal production is taken through the route of MSP, leaving only 1/3rd for open market. Hence, farmer can't take benefit of market prices and has to depend solely on the MSP. It prevents the farmer from earning of profits.
- **Too many intermediaries, information asymmetry:** The above mentioned problems have led to formation of long marketing channels, with multiple intermediaries, adding to the woes of the producers of perishable agri goods. These intermediaries have led to a cost inflation of 250% (over the cost of production) and have exacerbated the existing information asymmetries in agriculture, especially for non-MSP crops.
- **Inadequate infrastructure for storage:** As per agriculture survey has recently estimated the gap between agri-warehousing supply and demand at 35 mn MT. Currently, public sector agencies like the FCI, Central Warehousing Corporations (CWC) and the various State Warehousing Corporations (SWC)

have a storage capacity of 71 mn MT, while the private sector has close to 25 mn MT.

- Inefficient price signals: The government has been buying almost one-third of all rice and wheat produced in India through the PDS system, but in other kinds of grains, fruits and vegetables (both being highly perishable), the role of the government is limited. This leads to MSPs being ineffective as both price signals and as insulators from the perspective of the larger agricultural population.
- Skewed distribution of capacity: Skewed distribution of this capacity is another issue, with North India having access to 60% of the total storage infrastructure. Different survey has recently estimated the gap between agri-warehousing supply and demand at 35 mn MT.
- Lack of cold storage infrastructure: India's current cold storage capacity at 25 MT is barely sufficient for 10% of fruit and vegetables produced in the country. Indian farmers incur Rs 92,651 crore per year in post-harvest losses, the primary causes of which are poor storage and transportation facilities according to the high-level Dalwai committee report. Therefore various steps to tackle the challenges and wayforward are:

- The post-harvest losses can be substantially reduced if they are shifted to trains and flights for example recently government announced Kisan rail and Kisan udaan scheme.
- Reducing the information asymmetry with high mobile Internet penetration in rural India, Reuters Market Light and Fasal Intuit are working on the problem of information asymmetry for agricultural producers, by making personalized agricultural market information available to the farmers.
- Alternate marketplaces a young innovative company, eFarm, is providing a way to bypass the long chain of intermediaries by directly connecting buyers and sellers of agricultural produce.
- NITI Aayog is working on alternative mechanism. A counterpart of the MSP is the Market Intervention Scheme (MIS), under which the state government procures perishable commodities like vegetable items.
- Integrated cold chain solutions with PM SAMPADA and ColdStar Logistics provides customized solutions for cold storage and refrigerated transportation across India for fresh and frozen commodities.
- To provide an alternative, the government aims to set up 10,000 new Farmer Producer Organisations by 2023-'24 to encourage farmers to come together as shareholders to increase production and to market their crops more effectively. The finance ministry has set aside Rs 1 lakh crore to disburse easy loans to these Farmer Producer Organisations.

### **Conclusion**

Farmers' income can improve substantially if they are able to capture a greater share in the supply chain from farm gate to consumer. For this to happen, farmers must have the freedom to sell what they want, where they want, and when they want without any restrictions on sale, stocking, movement, and export of farm produce.