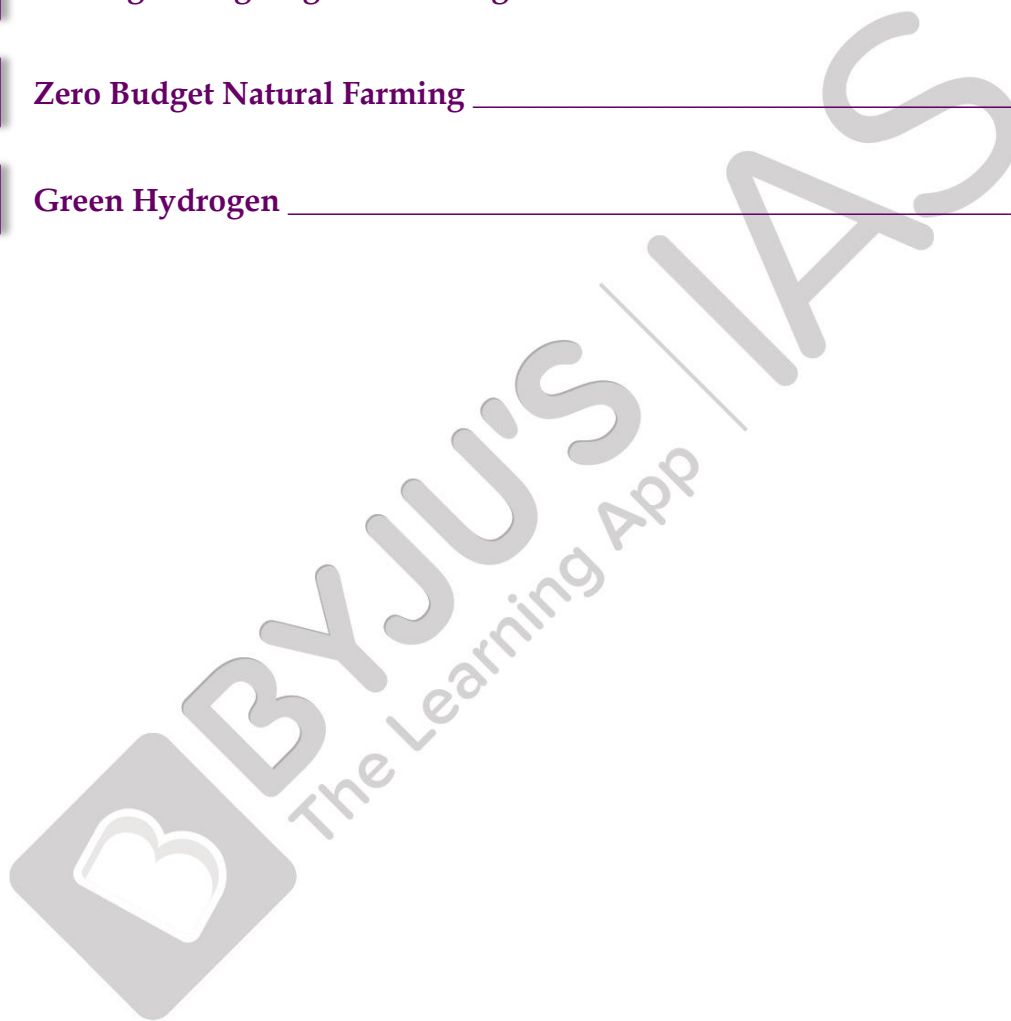


CONTENT

DECEMBER 2021 (3rd WEEK)

01	India's Defence Scenario _____	02-04
02	50 years of 1971 war _____	05-07
03	Raising the legal age for marriage _____	08-10
04	Zero Budget Natural Farming _____	11-13
05	Green Hydrogen _____	14-16



1. India's Defence Scenario

Context: In recent years, India's defence exports have risen remarkably while the budget allocations, as a percentage of total budget expenditure, are going down.

Details:

- **Defence Exports:**
 - **More than 5 fold increase:** India's defence exports have increased from ₹1,521 crore in 2016-17 to ₹8,434.84 crore in 2020-21.
 - It also touched a high of ₹10,745 crore in 2018-19.
 - India's tremendous growth in Defence exports is in accordance with the government's ambitious target to achieve annual exports of about ₹35,000 crore (\$5 billion) in aerospace and defence goods and services by 2025.
- **Defence Expenditure**
 - In the last decade, the budget of the Ministry of Defence has grown at an annual average rate of 8.4%.

Mains Paper

General Studies 2 Syllabus:

- Government policies and interventions for development in various sectors and issues arising out of their design and implementation

General Studies 3 Syllabus:

- Indian Economy and issues relating to planning, mobilization of resources, growth, development and employment.
- Security challenges

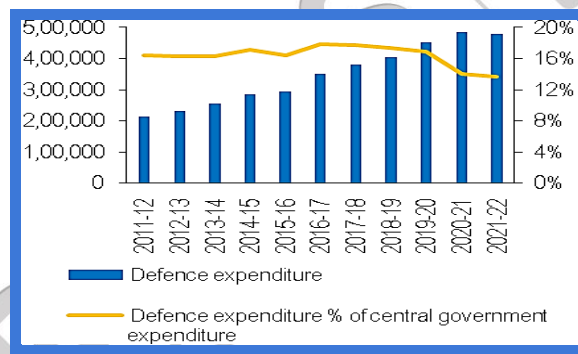


Figure: Defence expenditure Pattern of Past decade.
Source: PRS

- However India's defence spending in terms of total govt expenditure for 2021-22 is the lowest in six years and has been decreasing since 2016-17 as shown below.

Year	Defence expenditure as percentage of expenditure
2016-17	17.8
2017-18	17.73
2018-19	17.43
2019-20	16.86
2020-21	14.05
2021-22	13.73

- According to the Stockholm International Peace Research Institute (SIPRI), India was the third-largest defence spender in absolute terms in 2019 (after USA and China)

Reasons for boost in Defence exports: The turnaround of defence exports has many reasons. Prominent ones are as follows:

- **Government Steps to boost exports:**
 - Simplified defence industrial licensing.
 - Relaxation of export controls and grant of no-objection certificates.
 - Specific incentives were introduced under the foreign trade policy.
 - The Defence Ministry has also issued a draft **Defence Production & Export Promotion Policy 2020**.
 - **Capacity building of domestic Industries:**
 - **Through Positive List of procurement:** To boost indigenous manufacturing, the Government had issued two “**positive indigenisation lists**” consisting of 209 items that cannot be imported and can only be procured from domestic industry.
 - **Through budget allocation:** For the year 2021-22, a substantial portion (63%) of the capital outlay of the defence budget has been reserved for procurement from domestic industry.
- **Role of Diplomacy tools:**
 - **Line of credit aid:** The Ministry of External Affairs has facilitated Lines of Credit for countries to import defence products.
 - Defence attaches in Indian missions abroad have been empowered to promote defence exports.
 - **Net security provider in Indian ocean:** India under its policy of net security provider in Indian ocean encourages the Indian Ocean littoral nations to seek low cost defence goods to enhance their national security.
- **Stellar Performance of Domestic Defence companies:** According to the latest report of the SIPRI, three Indian companies figure among the top 100 defence companies in the 2020 rankings – HAL, the Ordnance Factory Board and BEL.
- **Comparative Advantage:** Low labour and production costs along with quality production make Indian defence exports competitive and attractive especially for smaller developing countries.

Significance of rising Defence Exports:

- **Forex earning:** India’s forex reserves can increase.
- **Employment opportunities:** Defence is an employment intensive sector both quantity and quality wise.
- **Increase in Investment in R&D of defence technologies:** Increased exports will increase the investment by domestic firms in expansion and research and development. Creating a virtuous cycle of *Exports-R&D led quality enhancement-Exports*.
- **Soft power:** India’s International relations will improve, especially among developing nations.
- **Creation of a self-sustaining Military-industrial complex:** Export led profits will help create a state of the art Military-industrial complex on the lines of USA and France. It will help the domestic defence ecosystem to create products at competitive prices.
- **Reduced burden on Government:** Procurement from efficient domestic entities at competitive prices will result in lots of savings of public money. Inefficient public defence manufacturing results in wastage of public money.

Challenges ahead for the Defence Economy:

- **Bad Timing of decrease in percentage of Defence Expenditure in budget:**
 - Currently India is facing twin challenges of aggression from China and Pakistan.
 - The Indo-pacific strategy hinges on the credible strength of India. This requires an increase not reduction in defence budget proportion.
 - Reduction in Defence expenditure as a percentage of government expenditure can discourage FDI and Domestic investments.
- **Red Tapism:** India’s defence economy is still marred with red tape and many prohibitions.
- **Debt-trap diplomacy of China in India’s Neighbourhood:** Through its Belt and Road Initiative debt traps China influences decisions of nations worldwide especially in India’s neighbouring regions. It can influence their buying decisions from India.
- **Competition from already established players like the USA, France, European Union will be stiff.**

Way Ahead: To achieve the target of USD 5 billion defence exports following things are critical

- **Commensurate increase in defence expenditure** according to rise in GDP and budget expenditure as of now. Slowly when an efficient defence ecosystem is in place defence expenditure will automatically reduce.
- **Creation of Non Lapsable funds for defence acquisitions.** Large defence imports with Technology transfer and indigenous manufacturing conditions can also boost India exports
- **Using Reverse String of Pearls:** Targeting South China sea's small countries for defence exports as they are threatened by an aggressive rising power there.
- **Further liberalisation of the defence sector for domestic entities:** A dedicated policy to enable domestic entities to become global MNC and Unicorns can be initiated on the lines of startup India.
- India can **leverage the Indo-pacific Strategy** and collaborate with the UK, France, USA, Japan and other like minded countries to strengthen its defence manufacturing capabilities.

Conclusion: Today almost no major power except India, relies on defence imports. A long term defence exports policy with focus starting from low end defence products to state of the art products is the need of the hour to boost India's Defence exports and reduce our dependence on imports.

Q1. Which of the following statements is/are correct?

1. Defence expenditure of the Union Government, as a percentage of total expenditure, has steadily decreased during the last 5 years.
2. India's defence exports have steadily increased between 2016-17 and 2020-21.

Choose the correct answer using the codes given below:

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Answer: (a)

Statement 1 is correct: The percentage is consistently going down as shown below

Year	Defence expenditure as percentage of expenditure
2016-17	17.8
2017-18	17.73
2018-19	17.43
2019-20	16.86
2020-21	14.05

Statement 2 is incorrect: While the defence exports have been rising but not consistently. For eg in 2018-19 it went to a high of 10 thousand crores and in 2020-21 it was around 8 thousand crores.

Q2. India is experiencing a phenomenal growth in defence exports. Discuss the significance of this phenomenon. How can India reach its target of USD 5 billion worth of Defence exports by 2025?

(15 Marks, 250 Words)

2. 50 years of 1971 war

Context: The year 2021 marks 50 years of India pulling off the biggest and most decisive military win it has achieved.

The 1971 Indo-Pak war:

Origin:

- Soon after the partition, the discord between East and West Pakistan began in February 1948, when the Pakistani government declared **Urdu as the official national language**. This decision annoyed Bengali-speaking East Pakistan and so the people revolted.
 - The first protest against this decision broke out at Dhaka University where Sheikh Mujibur Rahman, a university student at the time, was a key participant.
 - **Note:** Mujibur Rahman further went on to become the first President of free Bangladesh.
- The differences grew between East and West Pakistan during the tenure of Gen. Ayub Khan (who became Pakistan's president in a coup in 1958). However, the point of inflexion came during the tenure of Gen. Yahya Khan when he refused to convene Parliament after the 1970 elections in which the Awami League of East Pakistan, led by **Mujibur Rahman**, decisively won against Pakistan Peoples' Party's Zulfikar Ali Bhutto.
- Further, West Pakistan hatched the **Larkana conspiracy** - a cruel and comprehensive plan involving genocide to crush the resistance in the east and dismember the region once and for all. It aimed at depriving East Pakistan of a successor government and abandoning it to anarchy so that West Pakistan could take it over.
- On 25 March 1971, the Pakistan Army officially launched its campaign of genocide called '**Operation Searchlight**', unleashing death squads that reportedly slaughtered 7,000 unarmed, innocent Bengalis in a single night.
 - This continued for days. Later, they began to actively target the female Bengali population through rape in the hopes of psychologically breaking the men and women of Bengali society.
- As days passed, lakhs of refugees started pouring into India from East Pakistan which turned out to be catastrophic for India. Thus, India now had to interfere.

Role of the Indian armed forces:

The Indo-Pak war of 1971 is the only war that saw all three wings of the Indian defence (the Army, Air Force and the Navy) fighting together in multiple theatres.

- **Role of the Indian Air force:**
 - The war was officially declared on **3 December** when the Air Force of Pakistan launched pre-emptive strikes against Indian Air Force bases along the western borders.
 - In response, the IAF carried out multiple attacks in both parts of Pakistan.
 - IAF played a crucial role during the 1971 war as it tipped the scales in India's favour in the eastern sector and ensured that the Pakistani jets remained in a defensive role in the western sector.
- **Role of the Indian Army:** During the war, there were numerous battles that remain etched in history as some of the finest moments of bravery of the Indian Army. One such battle was the **Battle of Longewala**, where a small group of just over 100 Indian soldiers defended the Longewala border post in Rajasthan by fighting against nearly 2,000 Pakistani soldiers with over 40 tanks.

Mains Paper

General Studies 1

Syllabus:

- Modern Indian history include significant events, personalities, issues during the middle of the eighteenth century until the present.
- Redrawing of national boundaries

General Studies 2

Syllabus:

- India and its neighborhood- relations

General Studies 3

Syllabus:

- Role of external state and non-state actors in creating challenges to internal security.
- Various Security forces and agencies and their mandate

• **Role of Indian Navy:**

- The offensive of the Indian Navy started on December 4th when aircraft from INS Vikrant and ships under the Eastern Fleet struck military targets in East Pakistan.
- The Navy carried out '**Operation Trident**' and inflicted heavy damage to the port city of Karachi in Pakistan on **December 4** (celebrated as the **Navy Day**).
- '**Ghazi**'- the Pakistani submarine that was trying to home in on INS Vikrant, was sunk off the coast of Visakhapatnam.
- The Navy strangled Pakistan on both sides, choked their sea lines of communication and successfully cut off their escape routes.

Role of Mukti Bahini: The Mukti Bahini was an armed organisation consisting of a regular army and civilians in Bangladesh who fought alongside the Indian army against West Pakistan. Supported and trained by the Indian forces, It played a key role in the Bangladesh Liberation War of 1971.

- The war finally ended on **16 December** (celebrated as **Vijay Diwas** in India) 1971 when nearly 93,000 Pakistani military and government officials, led by Lt Gen. A.A.K. Niazi surrendered before the Indian Army.
 - This was the largest surrender by an army since World War II.
- Thus the war culminated in the division of Pakistan and the creation of a new country - Bangladesh.

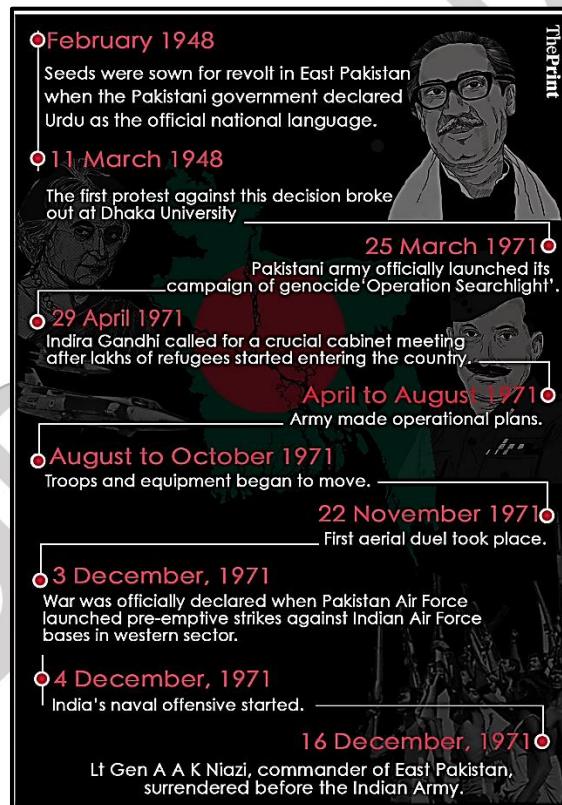


Figure: Course of 1971 war
Source: The Print

Role of Russia (Soviet Union then) in the war:

- During the war, the U.S. in support of Pakistan dispatched the aircraft carrier 'Enterprise' to the Indian Ocean.
- Shortly thereafter, having signed the Indo-Soviet treaty of Peace, Friendship and Cooperation in August 1971 itself, the Soviets warned the U.S. against involvement or interference in the war.
- The Soviet also dispatched its Pacific fleet towards the Indian ocean.
 - The Soviet vessels were armed with anti-ship cruise missiles and were capable of destroying U.S. warships.

- The US also raised the issue in the United Nations Security Council to bring about a ceasefire. However, the Soviet Union vetoed the resolution in favour of India.
 - Thus, the significance of the Indo-Soviet Treaty was made clear in the unfolding situation.
- Further, the US also tried to involve China in the war against India. However, China feared that even limited coercive actions against India would invite immediate reprisals from Moscow and thus abstained.
 - Thus, the partnership crafted with the Soviets by the Indian policymakers was able to successfully offset what was a formidable U.S.-Pakistan-China front.

Conclusion:

50 years later, as India aims for the theaterisation of its military, the 1971 Bangladesh Liberation War is considered the finest example of cohesive warfighting.

- Q1. With reference to the 1971 Indo-Pakistan war, consider the following statements:
1. Operation Searchlight was conducted by the Indian Army to free East Pakistan.
 2. The Soviet vetoed the cease-fire resolution of the United Nations Security Council during the war.
- Which of the statements given above is/are correct?
- (a) 1 only
 - (b) 2 only
 - (c) Both 1 and 2
 - (d) Neither 1 nor 2

Answer: (b)

Explanation:

Statement 1 is incorrect: On 25 March 1971, the **Pakistan Army** officially launched its campaign of genocide called '**Operation Searchlight**', unleashing death squads that reportedly slaughtered 7,000 unarmed, innocent Bengalis in a single night.

Statement 2 is correct: The Soviet vetoed the cease-fire resolution of the United Nations Security Council during the war, thus supporting India's cause.

- Q2. The role of Russia in the 1971 Indo-Pakistan war is a shining example of the significance of the Indo-Soviet treaty of Peace, Friendship and Cooperation. Elaborate.

(15 Marks, 250 Words)

3. Raising the legal age for marriage

Context: Recently the Union Cabinet cleared the proposal to raise the legal age of marriage for women to 21 years.

Background and details:

- According to a 2017 United Nations report, as many as 27 percent of Indian girls were married before they turned 18. Thus, India was struggling to stop child marriages and improve the health of its mothers.
- The Ministry for Women and Child Development had set up a task force headed by Jaya Jaitly in June 2020 to look into the correlation between the age of marriage with issues of women’s health and nutrition, Infant Mortality Rate (IMR), Maternal Mortality Rate (MMR) and other social indices.
- The committee among other things has recommended the age of marriage be increased to 21 years from the current age of 18.
 - **Note:** The law is needed to essentially outlaw child marriages and prevent the abuse of minors.

Mains Paper

General Studies 1

Syllabus:

- Role of women and women’s organization, population and associated issues
- Social empowerment,

General Studies 2

Syllabus:

- Issues relating to development and management of Social Sector/Services relating to Health, Education, Human Resources

Note: Other recommendations of Jaya Jaitly committee:

- Better access to schools and colleges for girls, including their transportation to these institutes from far-flung areas.
- Imparting skill and business training.
- Imparting sex education in schools.
- Awareness campaign on the increase in the age of marriage so as to encourage social acceptance of the new legislation.

The committee also observed that unless the above are implemented and women are empowered, the coercive measures of law will not be much effective.

- Given the cabinet approval, the next step of the government would be to introduce an amendment to various Acts: Prohibition of Child Marriage Act, 2006, Special Marriage Act and personal laws such as the Hindu Marriage Act, 1955 among others.

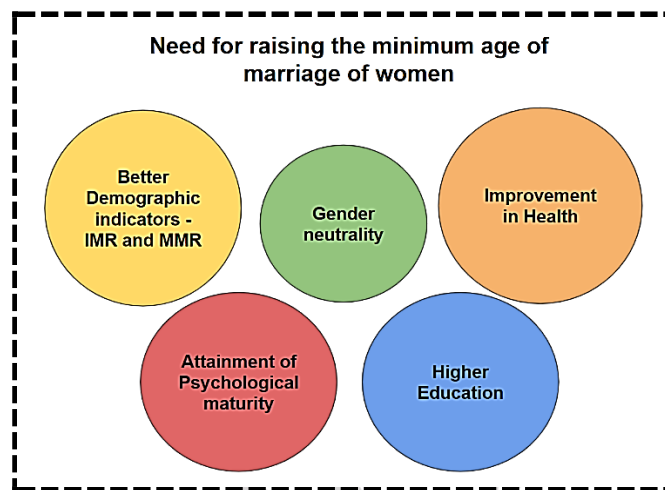
Minimum age for marriage:

- **To deal with marriage, various religions have their own personal laws and own standards, often reflecting their customs:**
 - Hindus: The Hindu Marriage Act, 1955 sets 21 years as the minimum age for the groom and 18 years as the minimum age for the bride.
 - Islam: In Islam the marriage of a minor who has attained puberty is valid.
 - The Special Marriage Act, 1954 and the Prohibition of Child Marriage Act, 2006 also prescribe a minimum age limit for marriage for women (18 years) and men (21 years).

These laws are expected to be amended to implement the new age of marriage.

Need for raising the minimum age:

- **Gender-neutrality:** Since the minimum age of marriage for men is set at 21 years, raising the age of marriage for women to 21 would make it gender-neutral.
- **Health:** An early age of marriage, and consequent early pregnancies have impacts on the nutritional levels of mothers and their children, and their overall health and mental wellbeing.
- **Demographic indicators - IMR and MMR:** Early marriage also negatively impacts Infant Mortality Rate and Maternal Mortality Rate. The law seeks to mitigate such impacts.
- **Education:** The age revision would also empower women who are cut off from access to education and livelihood after an early marriage.
- **Psychological maturity:** It will also result in women attaining psychological maturity before marriage, exercising better reproductive rights and a better place in life skills including family planning, use of contraceptives etc.



Issues with raising the age of marriage:

- **Criminalisation of marriages:** According to family planning experts and child and women’s rights activists such legislation would render illegal the marriages of a large portion of the population who are married before the age of 21.
- **Coercive measure:** The law, in particular, would negatively impact marginalised communities, such as the Scheduled Caste and Scheduled Tribes by making them law-breakers and would thus end up being coercive.
- **Autonomy of women:** The move leads to further control over women’s autonomy (right to marry on their own terms).

Conclusion:

The raising of the minimum age of marriage of women is a step in the right direction towards protecting the health of women. However, the legislation must be supplemented with other measures as recommended by the Jaya Jaitly committee to achieve women empowerment.

- Q1. With reference to the legal age of marriage in India, consider the following statements:
1. The legal age of marriage for women is the same across all religions in India.
 2. The Jaya Jaitly committee has recommended raising the legal age of marriage to 21 years for women.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Answer: (b)

Explanation:

Statement 1 is incorrect: The legal age of marriage for women is not the same across all religions in India. For example, it is 18 years for Hindu women whereas it is the age of puberty for Muslim women.

Statement 2 is correct: The Jaya Jaitly committee constituted by the Ministry for Women and Child Development in 2020 has recommended raising the legal age of marriage to 21 years for women.

- Q2. There is a lot of consternation over the proposal to raise the minimum age of marriage for women in India. In this context, discuss the need for raising the minimum age of marriage for women and also the issues associated with it.

(10 Marks, 150 Words)



4. Zero Budget Natural Farming

Context: Zero Budget Natural Farming is back on top of the government's agenda as it is set to be highlighted at the national conclave in Gujarat.

Mains Paper

General Studies 2

Syllabus:

- Government policies and interventions for development in various sectors and issues arising out of their design and implementation

General Studies 3

Syllabus:

- Major crops cropping patterns in various parts of the country
- Science and Technology- developments and their applications and effects in everyday life

Background:

- So far **no large-scale scientific study** has yet provided proof of ZBNF's effectiveness.
- There has been an **increasing number of farmers adopting the ZBNF method especially in Gujarat and Andhra Pradesh**, which indicates its benefits.
- **Andhra Pradesh has been aiming at bringing one lakh additional hectares** of land under ZBNF, followed by Chhattisgarh and Gujarat.
- However, there have been **a few cases of complaint in Maharashtra about a drop in yields, productivity, and income over time**, which caused the adopters to abandon the experiment to return to conventional agricultural methods.
- The **Indian Council for Agricultural Research** has been conducting studies on the impact of ZBNF methods with respect to **productivity, economics, and soil health** at multiple locations in the grain basket States of North-Western India, but has not yet released any results.

What is Zero Budget Natural Farming?

- **Developer:** ZBNF is a technique of farming developed by Padma awardee Subhash Palekar of Maharashtra,
- **Aim of the method:** The ZBNF aims to bring down input costs by making farmers rely on natural inputs and shift away from agricultural chemicals.
- **Main Components:** It mainly relies on **an admixture of urine and dung** of native Indian cows.
- **Core Idea:** The core idea is that almost 98% of nutrients needed by crops, like CO₂, nitrogen, water, and sun, could be availed naturally and free of cost, whereas the remaining nutrients could be absorbed from the soil.
- **Four Pillars:** ZBNF recommends the **"four pillars": Bijamrit, Jivamrit, Mulching, and Whapasa** and three methods of insect and pest management: Agniashtra, Brahmastra, and Neemastra (all different preparations using cow urine, cow dung, tobacco, fruits, green chilli, garlic, and neem).



Figure: Four Pillars of ZBNF
Source: Tractorjunction.com

- Bijamrit is the microbial coating of seeds with formulations of cow urine and cow dung.
- Jivamrit is the enhancement of soil microbes using an inoculum of cow dung, cow urine, and jaggery.
- Mulching is the covering of soil with crops or crop residues.
- Waaphasa is the building up of soil humus to increase soil aeration.

Advantages of ZBNF:

- **Zero Cost of Production:** One of the major characteristics of Zero Budget Natural Farming is that the cost of production is zero because farmers do not have to buy any inputs to initiate the method of ZBNF.
- **Water Efficiency:** When compared to the conventional methods, the Zero Budget Natural Farming uses only 10 percent of the water that is used in the conventional method.
- **Promotes Local Breed:** ZBNF promotes the use of the Indian local breed of the cow for its urine and dung that supports the Indian farmer's income.
- **Increase in Income:** One can earn an approximate income of ₹6 lakh an acre in irrigated areas and ₹1.5 lakh in non-irrigated areas by practising ZBNF.
- **Wider Applicability:** All kinds of agro-climatic areas can be covered under the ZBNF, hence it is mentioned to be suitable for all kinds of crops
- **Relief from Debt:** Zero Budget Natural Farming is also promising to ease out the debt pressure on the farmers since they don't need to take loans for buying any inputs for their farming.
- **Soil Ecosystem Improves:** Since there is no usage of harmful chemicals and fertilizers, the soil ecosystem improves in the long run.

Challenges Associated with ZBNF:

- **Lack of Acceptance:** The concept of Zero Budget Natural Farming is not well-accepted by the scientific community. National Academy of Agricultural Sciences scientists mentioned that India cannot rely on Zero Budget Natural Farming as there is no scientific validation of the techniques used in Zero Budget Farming.
- **Difficulty to Maintain Local Breed:** The maintenance of the local cow breed is difficult as compared to those that are used currently.
- **Organic certification** of the crops planted by the Zero Budget Natural Farming will face another hurdle and it might lead to a difficulty in selling the products to the organic brands.
- **No Assured Study:** Till now there has been no large scale scientific study proving the benefits of ZBNF.

Conclusion: ZBNF could be a promising method towards sustainable farming, soil enrichment, water conservation and biodiversity preservation.

Q1. Which of the following characteristics belong to Zero Budget Natural Farming?

1. Usage of cow dung and cow urine
2. Heavy usage of Chemical fertilizers
3. Promotion of local cow breed

Select the correct answer using the codes given below:

- (a) 1, 2 and 3
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1 only

Answer: (b)

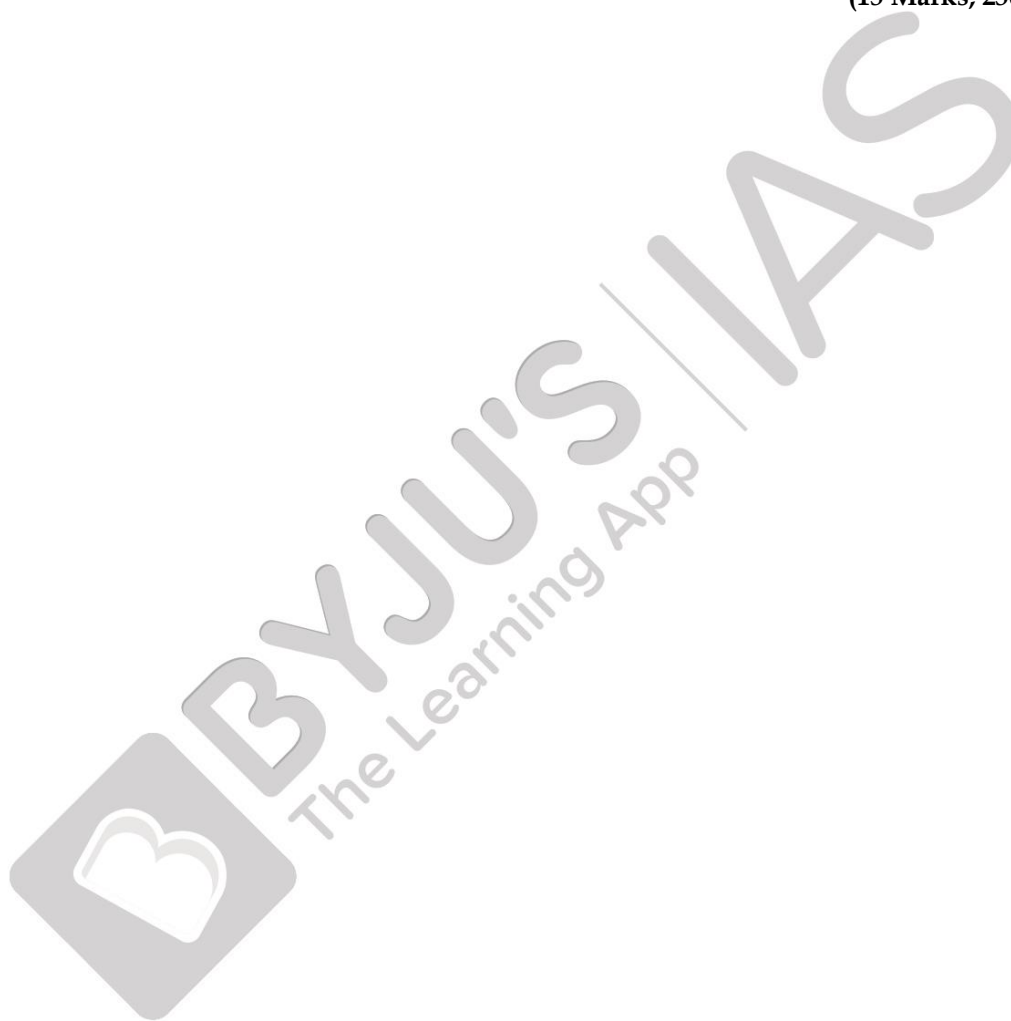
Explanation:

Statement 1 and 3 are correct: ZBNF promotes the use of the Indian local breed of the cow for its urine and dung that supports the Indian farmer's income.

Statement 2 is incorrect: ZBNF does not promote usage of chemicals, rather it calls for natural ingredients. The core idea is that almost 98% of nutrients needed by crops, like CO₂, nitrogen, water, and sun, could be availed naturally and free of cost, whereas the remaining nutrients could be absorbed from the soil.

- Q2. Discuss the advantages and challenges associated with Zero Budget Natural Farming in the context of India.

(15 Marks, 250 Words)



5. Green Hydrogen

Context: India's first and one of the world's largest Green Hydrogen Microgrid Project is set to be launched at Simhadri near Visakhapatnam by the National Thermal Power Corporation Limited (NTPC).

Details:

- The project would be a precursor to large-scale hydrogen energy storage projects.
- It would be used to study and deploy multiple microgrids in various off-grid and strategic locations of the country.
- The production of hydrogen would be done using the advanced 240 kW Solid Oxide Electrolyser by taking input power from the nearby Floating Solar project.
- The hydrogen produced during sunshine hours would be stored at high pressure. It would be electrified using a 50 kW Solid Oxide Fuel Cell.
- The system would work in standalone mode from 5 PM in the evening to 7 AM in the morning.
- This unique project configuration has been designed in-house by NTPC.
- It is a unique project for India since it would open doors for decarbonising the far-off regions of the country like Ladakh, J&K etc, currently dependent on diesel generators.

Mains Paper

General Studies 2

Syllabus:

- Government policies and interventions for development in various sectors and issues arising out of their design and implementation

General Studies 3

Syllabus:

- Infrastructure: Energy, Ports, Roads, Airports, Railways etc.
- Science and Technology- developments and their applications and effects in everyday life
- Indigenization of technology and developing new technology.
- Conservation, environmental pollution and degradation, environmental impact assessment

Green Hydrogen refers to Hydrogen generated from renewable sources of energy like solar and wind. In this process, **electricity splits water into hydrogen and oxygen.** This is the cleanest form of hydrogen generation as the by-product generated is just oxygen.

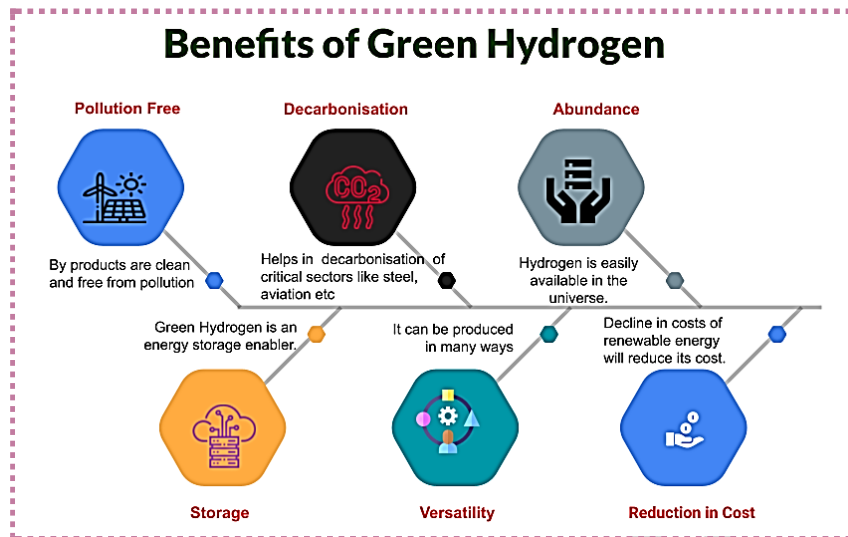
Recent Initiatives of National Thermal Power Corporation (NTPC):

- NTPC has been aggressively pushing for greening its portfolio.
- It has been promoting usage of green hydrogen-based solutions in sectors like mobility, energy, chemical, fertilizer, steel etc.
- It has revised its target of achieving 60 GW renewables capacity by 2032, almost doubling the earlier target.
- NTPC has commissioned India's largest floating solar project of 10 MW at Visakhapatnam.
- NTPC Ltd has already floated a global expression of interest for setting up two pilot projects for a standalone fuel-cell based backup power system and a microgrid system with hydrogen production using electrolyzers.

Benefits of Green Hydrogen

- **Pollution-free:** Hydrogen, when used as fuel, leaves no byproduct other than water and is hence pollution-free.
- **Diverse Applications:** Green hydrogen-based solutions have diverse applications in sectors like mobility, energy, chemical, fertilizer, steel and food processing etc. It also can be used for long distance mobilisation such as in railways, large ships, buses or trucks, etc
- **Helps in Decarbonisation:** Sectors like aviation, shipping, long-distance trucking and concrete and steel manufacturing, are difficult to decarbonize because these sectors require high energy density fuel or intense heat and Green hydrogen could meet these needs.

- **Helps in achieving the targets of the Paris Agreement:** Green hydrogen energy helps India to meet its Nationally Determined Contribution (INDC) targets and ensure regional and national energy security, access and availability.
- **Versatility in production:** Hydrogen energy is very versatile, as there are many ways of producing it; it can be used in gas or liquid form and can be converted into electricity or fuel.



- **Abundance:** There is more hydrogen in the universe than any other element and it's been estimated that approximately 90 percent of all atoms are hydrogen.
- **Cost:** The rapidly declining cost of renewable energy will bring down the cost of producing green hydrogen.
- **Energy storage:** Unlike batteries that are unable to store huge quantities of electricity for extended periods of time, hydrogen can be produced from excess renewable energy and stored in large amounts for a long time.
- **No geographical limits:** It can be produced wherever there is water and electricity.
- **Fuel cells:** Hydrogen can also be used with fuel cells to power anything that uses electricity like electric vehicles and electronic devices.

Challenges:

- **Economic Sustainability:** Producing hydrogen from low-carbon energy is costly at the moment. For example, the maintenance costs for fuel cells post-completion of a plant are very costly.
- **Nascent stage of Technology:** The technology used in production and use of hydrogen like carbon capture and storage (CCS) and hydrogen fuel cell technology are at nascent stage and are expensive. This will increase the cost of production of hydrogen.
- **Lack of Proper Infrastructure:** The development of **hydrogen infrastructure is slow and holding back widespread adoption** as it requires huge investment in R&D of such technology and infrastructure for production, storage, transportation and demand creation for hydrogen.
- **Concerns with Regulation:** Regulations currently limit the development of a clean hydrogen industry as **multiple regulatory authorities** regulate use of hydrogen energy. Excessive regulation might act as an **unnecessary barrier to investment**.
- **Flammability:** Compared to gasoline, natural gas, and propane, hydrogen is more flammable in the air.
- **Transportation:** As hydrogen is not dense, it is difficult to transport.

Conclusion: The project is in-line with the vision of Prime Minister Narendra Modi for becoming carbon neutral by 2070 and making Ladakh a carbon neutral territory.

- Q1. With reference to Green Hydrogen, consider the following statements:
1. The by-products of green hydrogen are clean and pollution free.
 2. There is only one way of producing green hydrogen which makes its production difficult.
- Which of the above statements is/are correct?
- (a) 1 only
 - (b) 2 only
 - (c) Both 1 and 2
 - (d) Neither 1 nor 2

Answer: (a)

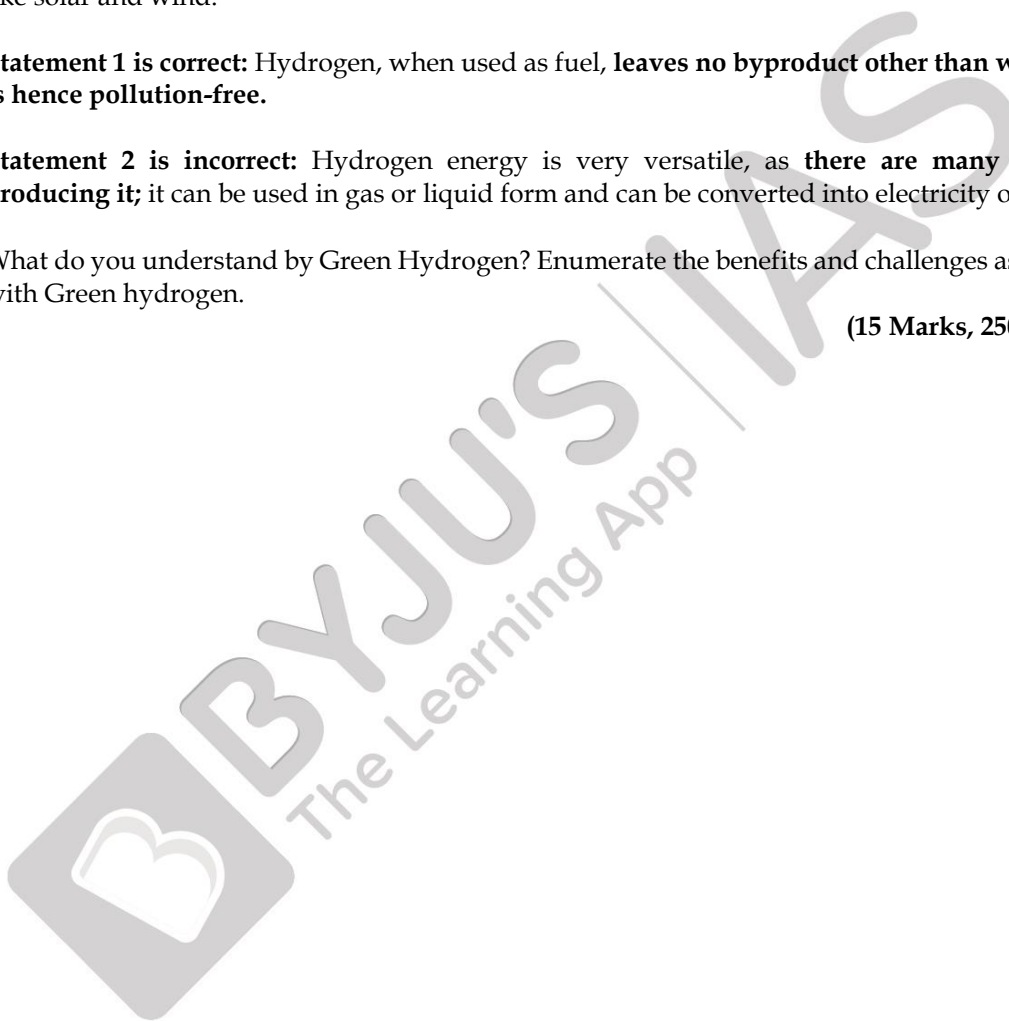
Explanation: Green Hydrogen refers to Hydrogen generated from renewable sources of energy like solar and wind.

Statement 1 is correct: Hydrogen, when used as fuel, leaves no byproduct other than water and is hence pollution-free.

Statement 2 is incorrect: Hydrogen energy is very versatile, as there are many ways of producing it; it can be used in gas or liquid form and can be converted into electricity or fuel.

- Q2. What do you understand by Green Hydrogen? Enumerate the benefits and challenges associated with Green hydrogen.

(15 Marks, 250 Words)



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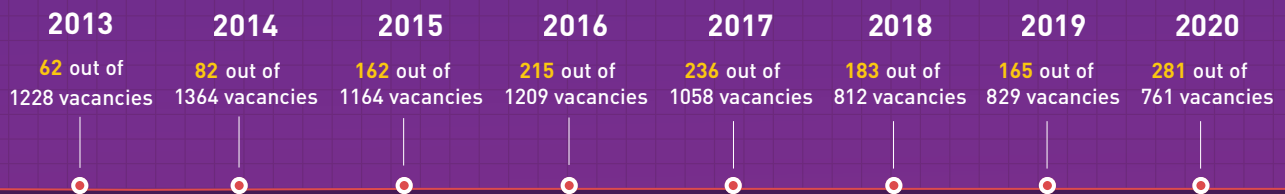


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