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Q- Artificial Intelligence (AI) and Precision Farming have been proposed as solutions to improve the agricultural productivity in India. Critically analyse their feasibility and challenges in the Indian agricultural landscape.

Ans. Water scarcity, fragmented landholdings, climate change have made technology driven agricultural solutions crucial for India. Technologies such as AI, precision farming, IoT, remote sensing, machine learning have the potential to enhance productivity and sustainability.

Feasibility of AI and precision farming -

① Crop Yield Production —

AI models analyse weather data, soil health and crop growth to optimise yields.

② Water Use Efficiency —

IoT and sensor based irrigation systems improve water use efficiency, reducing the wastage.

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③ Pest and Disease detection —

AI based image recognition and remote sensing helps in early pest and disease identification.

④ Soil Health Mapping —

AI driven geospatial analysis supports real time soil fertility assessment

⑤ Drone based crop monitoring —

AI based drones equipped with cameras assess crop health, soil quality and water distribution.

⑥ Fertilizer application —

AI optimises nutrient application, reducing excessive fertilizer use and environmental damage. Nano sensors can be placed in the soil to continuously monitor conditions like moisture level, nutrient content etc.

⑦ Reduce labour costs —

Agricultural robotics automate labour intensive tasks. They increase efficiency, reduce labour costs and improve accuracy.

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⑧ Sustainable agriculture —

Microbial inoculants and biofertilizers enhance soil fertility and nutrient management promoting sustainable agricultural practices.

Challenges —

① Financial limitations —

In India 86% farmers are small and marginal and it is difficult for them to adopt expensive AI based drones, softwares

② Limited digital infrastructure —

Only 13% of rural India has reliable high speed internet affecting AI adoption.

③ Low digital literacy —

Over 50% of farmers lack the technical skills to use AI-powered tools effectively.

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④ Fragmented landholdings —

In India average landholding of farmers is 1.08 hectare limiting their large scale AI implementation.

⑤ Market access —

Inadequate market linkages and infrastructure limit impacts of usage of e-tech in post-harvest operations.

⑥ Regulatory hurdles —

Complex regulatory frameworks, bureaucratic procedures, ambiguous policies create obstacles in adoption of innovative agricultural technologies.

⑦ Resistant to change —

Farmers lack trust in AI-driven decision-making, preferring traditional farming practices.

⑧ Limited incentives —

Government initiatives focus on mechanisation, and not AI based and precision farming.

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WAY FORWARD -

- ① Focus on advanced agricultural practices as it will lead to significant growth in food production and farmers' income as suggested by Norman Borlaug.
- ② Foster entrepreneurship and encourage collaboration between farmers, startups and technology providers to develop agricultural technologies to cater to needs of farmers.
- ③ Promote right integration of farming and technology as it will lead to increased agricultural productivity and farmers' income leading to sustainable growth as suggested by Book - The Alchemy of Air
- ④ ~~Improve~~ Invest in research and development efforts to promote innovation in agricultural technology tailored to specific needs and conditions of Indian farmers.

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Q- Water scarcity is one of the major challenges in Indian agriculture. Evaluate the role of micro-irrigation techniques in addressing this issue and discuss the policy measures needed for their widespread adoption.

Ans. Water scarcity is a severe challenge in Indian agriculture with per capita water availability declining from 5178 m³ (1951) to 1544 m³ (2011). In India more than 60% land is dependent upon traditional flood irrigation leading to water wastage and affecting crop-productivity.

Role of Micro-Irrigation in addressing water scarcity -

① Improved Crop Productivity -

↳ Deliver water directly to the root zone of plants minimising water wastage through evaporation, run off etc.

↳ save significant amounts of water helping to conserve water resources in water scarce regions.

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② Enhanced nutrient management —

- ↳ Micro irrigation allows for precise and targeted application of fertilizers and nutrients directly to root zone of plants.
- ↳ Optimises fertilizer use and minimises environmental pollution.

③ Enhanced farmer income —

As per Dalwai Committee Report micro-irrigation can increase farmer's income by 50% and water savings by 40%.

④ Soil conservation —

- ↳ It reduces soil erosion and surface runoff.
- ↳ Helps maintaining soil structure promoting soil health and long term productivity.

⑤ Climate resilience —

- ↳ It enables precise control over irrigation scheduling, allowing farmers to adjust water application based on weather conditions and crop growth stages.
- ↳ This flexibility enhances resilience to

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climate variability including droughts and erratic rainfall patterns.

⑥ Water Use Efficiency —

Micro irrigation ensures 80-90% water use efficiency because water is applied efficiently according to crop need and surface runoff.

⑦ Flexibility and Adaptability —

↳ Micro irrigation can be tailored to suit various crop types, soil conditions and land topography.

↳ This flexibility enables farmers to diversify their crops.

Challenges —

① High investment cost —

Initial cost is ₹ 30,000 - 50,000 per hectare making them expensive for small farmers.

② Maintenance cost —

Farmers face difficulties in accessing timely and affordable maintenance services.

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③ Power supply —

The electricity availability for agriculture in hot summer is 8 hours out of 24 ~~hours~~ hours. This increase the cost of micro irrigation system as availability of continuous power is crucial for micro-irrigation.

④ Subsidies —

Delaying of subsidy, non-availability of subsidy when needed by the farmer are constraints for fast development of this technology.

Policy Measures —

- ↳ Expand NABARD's micro-irrigation fund to provide zero-interest loans.
- ↳ Need to expand the area covered under Per Drop More Crop scheme.
- ↳ Increase the annual coverage of irrigated areas by 2.5 million hectares by promoting micro irrigation.

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↳ Introduce special loan schemes specifically targeted at small and marginal farmers to facilitate their adoption of micro-irrigation technology.

↳ Make micro-irrigation mandatory for water-intensive crops like sugarcane.

Countries adopting smart irrigation can conserve water by 50% and yield by 25-30% as suggested by David Molden in Book - "Water for food water for life."
India also needs to adopt field level Water Management and Smart Irrigation Infrastructure.