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Stubble waste management: Policies and programmes in India

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Abstract
India is a major agricultural producer in the world, generating more than 500 million tonnes of agricultural waste per year (World Bank, 2012). The generation of stubble waste (agricultural waste) is rising rapidly, which leads to mismanagement of stubble, increasing pollution, and other negative effects on the country's economy and community. The country presently practices various methods for reducing stubble waste but the efforts are not satisfactory. The review paper was prepared from information gathered through discussions with farmers in Northern States of India and secondary research on programmes and policies available in the country for stubble waste. The government of India has launched numerous programmes and policies at State and National level to benefit farmers and manage stubble in the most effective and appropriate ways possible. However, the underlying reality of the government's policies and programmes was found to be mainly limited to few sectors. It is imperative to reduce pollution and increase economic remittance by managing stubble waste in an adequate and competent manner.

Keywords: Stubble waste, stubble waste management, government programmes and policies

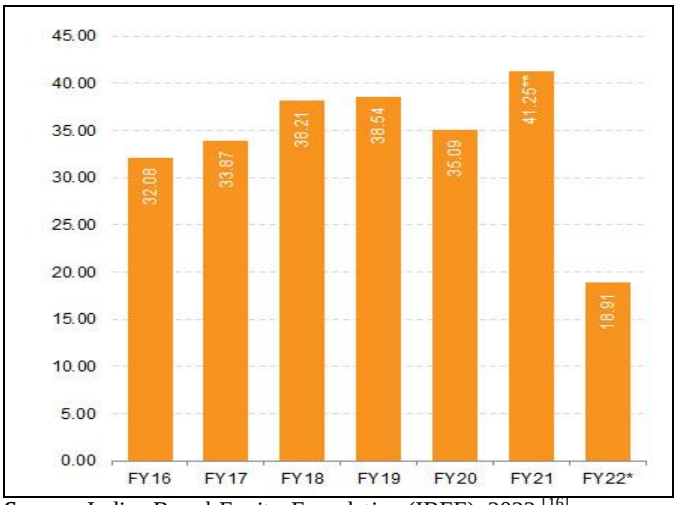
Introduction
Agriculture is the nation's most significant economic sector. It employs more than a billion people and produces food worth more than $1.3 trillion per year. Croplands and pastures cover roughly half of the world's land area, providing a home and a source of food for many animal and plant species, including humans (World Wildlife Fund, 2022) [7].

Agriculture production has more than tripled in the last 50 years due to advances in agronomy (the study of soil and crop) and technological contributions that influence productivity to meet the accelerated growth of population (Climate-Smart Agriculture, 2022) [14]. The agriculture industry produces 23.7 million tonnes of food per day on average around the world (Convention on Biological Diversity, 2018) [15].

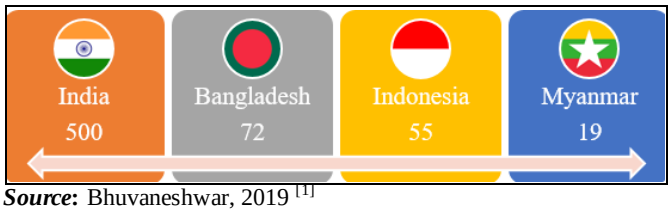
India is a major agricultural producer around the world. It is a leading producer of milk, legumes, and spices in the world. It also has the world's largest cattle herd (buffalo) and the most significant acreage of wheat, rice, and cotton production (World Bank, 2012) [8]. India was the world's second-largest agro-based economy in 2012, and it currently ranks fifth (2022), with year-round agricultural cultivation in which grains such as rice, wheat, cotton, sugarcane, fruits, and vegetables are produced annually to support the country as well as for exports (Table 1) (World Bank, 2012) [8].

The country has approximately 195 million hectares of arable land, of which nearly 63% (about 125 million hectares) is rain fed and about 37% (70 million hectares) is irrigated (World Bank, 2012) [8]. Each year, a significant amount of agricultural waste, including crop residue, is produced as a by product of agricultural production. The country generates over 500 million tonnes of agricultural waste per year (figure 1), posing a number of difficult management challenges. It is significantly higher than in other developing countries such as Bangladesh, Indonesia, and Myanmar, posing a serious threat. The fact that the country is responsible for feeding approximately 17.6% of the world's population highlights the fact that our natural resources are under severe strain. (Bhuvaneshwar, 2019; Chauhan, 2015) [1, 2].

Table 1: Agricultural Exports from India (US$ billion)



***Source*:** Indian Brand Equity Foundation (IBEF), 2022 [16]



***Source*:** Bhuvaneshwar, 2019 [1]

Fig 1: Agricultural waste generation (million tons/year) in India compared to its neighbouring countries

The agriculture sector in India is expected to reach $24 billion by 2025 (Indian Brand Equity Foundation (IBEF), 2022) [16]. According to a third preliminary estimate, India's food grain production in the fiscal year 2021-22 is expected to be 314.51 MT. Rapid population growth in India is a major driving force behind the industry. Rising income levels in rural and urban areas also contribute to increased demand for agricultural products nationwide. Moreover, the market is changing as a result of the proliferation of cutting-edge technologies such as block chain, artificial intelligence (AI), Geographic Information Systems (GIS), drones, remote sensing technology, and the emergence of various e-agriculture applications (IBEF, 2022) [16]. A thriving agricultural sector is thus critical to the global economy's expansion. However, there is scant discourse of agricultural waste management, which requires attention.

The historical, geographical, and cultural characteristics of the country have a significant impact on the types of activities carried out and the amount of agricultural waste generated. (Bhuvaneshwar, 2019) [1]. Punjab, Haryana, Rajasthan, and Western Uttar Pradesh (UP) are the Northern states of the nation that are well-known for their extensive agricultural practises of crops, primarily paddy fields and wheat, leading to large amounts of stubble waste generation. These states are situated in the country's north and north-western regions (Porichha, *et al*., 2021; Divesh Singh *et al*., 2022) [11, 17].

The generation of stubble waste is gradually increasing, in order to reduce pollution and increase economic benefits, which can be achieved by managing stubble waste in an effective and efficient manner. Burning stubble waste is one of the most common practises of managing stubble that contributes to increased pollution in neighbouring states because farmers believe it is the easiest and least time consuming process, which leads to a variety of problems such as lung problems, increased risk of heart disease, exacerbate asthma etc (Department of New and Renewable Energy, 2021).

Aside from burning 85% of the stubble waste on the fields, 5% is used to feed cattle, 9% is used for manure, and only 1% is used to make something out of stubble, such as cardboard, Diya (a small oil lamp, usually made from clay), and so on. On the other hand, the government of India has implemented numerous schemes and policies to assist farmers in managing stubble waste, as good management of field residue can increase irrigation efficiency and erosion control (Devedee *et al*., 2019) [5]. Stubble waste, when properly managed, can provide enormous economic benefits to farmers while also protecting the environment from a variety of pollutants (Prakash & Kuriniji, 2021) [4].

Material and Method

The review paper study is an attempt to identify the various programmes and policies started by the government in India to manage stubble waste. The primary information was gathered from discussions with farmers and government, the secondary information was gathered from newspaper and government official websites in order to comprehend the policies and programmes put into practise for effective management of stubble waste in the country.

Programmes & Policies in India

The government of India has initiated various programmes and policies for managing stubble waste at the state and central level benefiting the farmers and other stakeholders. The policies and programmes can be classified under the following titles, which are further discussed.

Table 2: Shows the Available in which states

	Name of the policy/ programme	Year of initiation	By which organisation	Available in which states	Success rate
1	Krishi Udaan Yojana and Krishi UDAAN 2.0	Oct 2021	Airports Authority of India (AAI)	Hilly areas, North-Eastern States and tribal areas such as Bagdogra & Guwahati airports, and at Leh, Srinagar, Nagpur, Nashik, Ranchi, and Raipur	Covers 58 airports presently
2	Paramparagat Krishi Vikas Yojan(PKVY)	2015	Government of India launched it as an extended component of Soil Health Management (SHM) under the Centrally Sponsored Scheme (CSS)	North Eastern Region such as states of Punjab, Sikkim ,Tamil Nadu, Chhattisgarh, Karnataka, Kerala and Maharashtra	As in Nov 2017, 6211 clusters were formed.
3	Sub Mision on Agricultural Mechanism (SWAM)	2014-2015	Ministry of Agriculture and Farmers Welfare	Madhya Pradesh, Andhra Pradesh, Tamilnadu, Kerala, Arunachal Pradesh, Manipur, Nagaland, Tripura, Uttar Pradesh, Uttarakhand & West Bengal	Presently in Madhya Pradesh

4	Rythu Bandhu Scheme	February 2018	Telangana State government Dhamarajupalle-Indiranagar village in Karimnagar	Telangana	Actively running in the state of Telangana
5	Farmers Corporation & Welfare (Union Budget 22-23)	2022-23		Pan India	Currently not applied in any state
6	National Agricultural Infrastructure (AIF)	July 2020	Government of India	Pan India	Presently applicable in various states of the country
7	Krishivigyan Kendras	1974	Indian Council of Agricultural Research (ICAR)	Various parts of the country such as Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Bihar and Chhattisgarh.	A network of 729 Krishvigyan Kendras has been established at the district level across the country
8	Agricultural Mission for sustainable agricultural	2014-2015	Government of India		
9	Sustainable Alternative towards affordable Transportation	2018	Ministry of Petroleum And Natural Gas.	Pan India	Presently applicable in various states of the country
10	Industrial organic waste-to- Energy	2021-2022	Ministry of New and Renewable Energy in association with UNIDO & Indian Renewable Energy Development Agency	Urban and industrial sector	Currently applicable in various states of the country
11	New National Biogas & Organic Manure programme (NNBOMP)	2017-2020	Ministry of New and Renewable Energy	Pan India	Presently in Punjab and Tamil Nadu
12	PUSA BIO-DECOMPOSER	2020	Indian Council of Agricultural Research	PAN India	Presently in Uttar Pradesh, Punjab, Delhi, West Bengal, and Telangana
13	National policy for management of crop residue (NPMCR)	2014	Ministry of Agriculture	Pan India	Currently in Haryana, Punjab, Uttar Pradesh & West Bengal
14	Custom Hiring centres(CHC)	2018	Department of Agriculture, Corporation & Farmers Welfare	Pan India	Currently in Jharkhand and Bihar, Haryana, Punjab , Uttar Pradesh & Rajasthan
15	Kisan Drones	2022	Government of India	Pan India	Currently in Uttar Pradesh, Punjab & Goa
16	Digital farm Mission	2021- 2025	Government of India		In initiation stages

- **Krishi UDAN Yojana and Krishi UDAN 2.0:** Launched by the Airport Authority of India (AAI), the main aim of the schemes is to facilitate marketing of farm and agricultural products of the north-Eastern states outside the region. Krishi Udan Scheme 2.0 aims to increase share of air carriage in the modal mix for transportation of Agricultural-produce, which includes fishery, livestock, horticulture and various processed products. The scheme is aimed at assisting farmers in transporting agriculture products to improves their value realization. The programme aims to guarantee smooth, affordable, timely air transportation for all agricultural produce, especially that coming from the Northeast, hilly regions, and tribal areas of the nation. Eight Ministries/Departments—the Ministry of Civil Aviation, the Department of Agriculture & Farmers' Welfare, the Department of Animal Husbandry and Dairy, the Department of Fisheries, the Ministry of Food Processing Industries, the Department of Commerce, the Ministry of Tribal Affairs, and the Ministry of Development of the North-Eastern Region - pool their resources and existing programmes to improve the logistics for transporting agricultural products (Ministry of Civil Aviation, 2022) [9].
- **Paramparagat Krishi Vikas Yojan (PKVY):** Launched in 2015, the Paramparagat Krishi Vikas Yojana (PKVY) is a part of the National Mission on Sustainable Agriculture's Centrally Sponsored Scheme for Soil Health Management (SHM) (NMSA). The program's goal is to encourage and support organic farming, which enhances soil health. Utilizing cutting-edge methods for organic farming, enlisting the help of professionals from India's public agricultural research system, and planning at least one cluster demonstration in a village (Ministry of Agriculture & Farmers Welfare, 2021).
- **Sub Mission on Agricultural Mechanism (SWAM):** The Indian Ministry of Agriculture and Farmers' Welfare launched the Sub-Mission on Agricultural Mechanization (SMAM) in 2014–15. It main aim is to enhance the reach of farm mechanization to marginal as well as small farmers and also to areas where there is low power availability. Under the scheme, he Government has released funds for a variety of farm mechanisation activities, such as the establishment of custom hiring centres, a farm machinery bank, high-tech hubs, and the distribution of various agricultural machinery to various states, in order to empower farmers through the Sub-Mission on Agricultural Mechanization (SMAM) scheme. Agricultural mechanisation is essential for maximising the productivity of the available cultivable area and making agriculture a more lucrative and appealing career for young people in rural areas. The Department of Agriculture, Cooperation & Farmers Welfare (DAC&FW) released Rs. 288.24 crores to Madhya Pradesh under the SMAM scheme between 2014–15 and 2020–21, and released Rs. 16.20 crore as the first instalment under SMAM between 2021–22 for the distribution of 2000 pieces of agricultural machinery and equipment and the establishment of 90 Custom Hiring centres. Growing mechanisation in agriculture will require the best agricultural machinery, supported by the most advanced technology (Ministry of Agriculture &

Farmers Welfare, 2021).

- **Rythu Bandhu Scheme:** Also known as the Farmer's Investment Support Scheme (FISS) is administered by the Telangana government to assist farmers to invest in two crops per year. Implemented in February 2018, the scheme provides farmers with INR 5,000 per acre twice a year, during the rabi (Yasangi) and Kharif (Rainy) seasons. In order to encourage agricultural investment, the government distributes approximately INR 58.33 lakh (5.8 million) to various stakeholders per year. This is India's first direct investment support programme for farmers, with cash delivered immediately (Pisharody, 2021).
- **National Agricultural Infrastructure (AIF):** It is a medium – long term debt financing facility provided for farmers for investment in projects for management of post-harvest infrastructure and to support community farming assets through credit and interest subvention. Approved by the union cabinet in July of 2020, the scheme provides interest subsidy and financial support to farmers by allowing them to sell directly to a larger sector of consumers due of improved marketing infrastructure. The growth of Primary Agricultural Cooperative Societies (PACS), the foundation of the village-level credit system, has been significantly aided by AIF. PACS has been given 76 percent of the projects, with a sanctioned cost of Rs. 2,934 in 2021. (Ministry of Agriculture & Farmers Welfare, 2020).
- **Krishivigyan Kendras (KVKs):** The first Krishvigyan Kendra was established in Puducherry in 1974. A network of 729 Krishvigyan Kendras has been established at the district level across the country to ensure that new technologies such as improved crop seeds, new livestock and fish breeds/strains, and improved production and conservation techniques reach farmers (Indian Brand Equity Foundation (IBEF), 2022) [16]. They play a vital role in conducting on-farm testing for farmers to demonstrate location-specific technology modules in agriculture and allied enterprises, through technology assessment, refinement and demonstrations.
- **National Mission for sustainable agricultural:** It is one of the eight missions designed under the National Action Plan on Climate Change (NAPCC) which seeks to address the issues related to sustainable agriculture in context of climate change related hazard and devising appropriate strategies for adaptation and mitigation towards food security, access to food resources, improving livelihood and at the same time contributing towards economic stability. It was established in 2014–15 and the scheme's objectives are to boost production, encourage farmers to grow a variety of crops, and using modern farming techniques. Farmers would receive financial assistance during the programme equal to half the cost of the programmes (Tractorgyan, n.d).
- **Sustainable Alternative towards affordable Transportation (SATAT):** The Ministry of Petroleum and Natural Gas (MoPNG) launched this initiative in October 2018 to extract economic value from bio-mass/waste, such as rice straw, in order to produce compressed bio-gas (CBG) as a substitute for petroleum-based fuels. The programme aims to build 5000 CBG (Compressed Biogas) plants by FY 2023–2024. SATAT has developed over the past two years into one of MoPNG's flagship initiatives. A variety of advantages, including a decrease in natural gas imports, a decrease in greenhouse gas emissions, a decrease in the burning of agricultural waste, a remunerative income for farmers, the creation of jobs, efficient waste management, and more, will result from SATAT's creation of an ecosystem in the nation for the production of compressed biogas from various waste and biomass sources. The project's objectives were in line with Aatma Nirbhar Bharat's, the Swachh Bharat Mission's, and the expansion of the MSME (Ministry of Micro, Small and Medium Enterprises) industry (Ministry of Agriculture & Farmers Welfare, 2022).
- **Industrial Organic Waste-to- Energy (IOWTE):** The Ministry of New and Renewable Energy (MNRE) has introduced a financial support programme in order to encourage modern industrial organic waste-to-energy Bio-methanation technologies and business models in India. This programme is a partnership between UNIDO (United Nation Industrial Development Organization) and IREDA (Indian Renewable Energy Development Agency). The programme, was launched in 2021–2022, offers Central Financial Assistance (CFA) to project developers and service fees to implementing/inspection organisations for the successful commissioning of Waste to Energy plants for the production of Biogas, Bio-CNG, enriched Biogas, Compressed Biogas, Power, or Syngas. Under the GEF-MNRE-UNIDO PROJECT, a geographic information system (GIS)-based waste mapping tool has also been developed to aid in the spatial mapping of the various types of waste availability and its potential for energy generation throughout India (Ministry of new and renewable energy (MNRE), 2021).
- **New National Biogas & Organic Programme (NNBOMP):** The New National Biogas and Organic Manure Programme (NNBOMP) encourages the use of biogas generated from cattle manure and other organic wastes found in rural areas. The programme has aided in the establishment of several small-scale biogas plants with installed capacities ranging from 1 to 25 m3 per day. Rural families use the plants for cooking fuel and organic fertiliser. The NNBOMP also provides funding for community-scale biogas plants with installed capacities of up to 2500 m3 per day. MNRE contributes 30 to 35 percent of project costs in the form of back-end subsidies for the establishment of biogas plants. India has installed over 5 million small-scale biogas plants to date. The projects have increased biogas-based power generation capacity by 7.2 MW. The National Policy on Biofuels of the MNRE (Ministry of New and Renewable Energy) aims to reduce crude oil imports into India by 10% by 2022 by increasing the use of ethanol, biodiesel, and CBG (Compressed Bio Gas). The Sustainable Alternative towards Affordable Transportation Program funds the construction of 5,000 CBG plants by 2023, with a total annual production capacity of 15 million tonnes. These two initiatives work together to promote CBG as a vehicle fuel (Ministry of Agriculture & Farmers Welfare, 2022).
- **PUSA BIO-DECOMPOSER:** The Indian Council of Agricultural Research (ICAR) developed the Pusa Decomposer bio-decomposer in 2020, and it has been used by the states of Punjab, Haryana, Uttar Pradesh, and the National Capital Territory of Delhi to manage approximately 2.4 million tonnes of straw this year on a total of 978,713 acres (3,91,485 ha). In 2020, the governments of Uttar Pradesh (3700 ha), Punjab (200

ha), Delhi (800 ha), West Bengal (510 ha), and Telangana (100 ha), as well as the Confederation of Indian Industry (100 ha), NGO and farmers (320 ha), received Pusa Decomposer for a total area of 5730 ha. IARI's Pusa Samachar You Tube channel frequently broadcasted a programme titled "Pusa Decomposer Technology" for the benefit of farmers. Furthermore, IARI, New Delhi, has developed 20,000 packets of Pusa decomposer for farmers to use at its own facilities (Ministry of agriculture & farmers welfare, 2021).

- **National Policy for Management of Crop Residue (NPMCR):** The National Policy for Crop Residue Management (NPMCR) was implemented in 2014. Recent formulations of the Central Government's National policy for crop residue management (NPMCR) have outlined policies and regulations to be implemented by local agencies in order to prevent crop burning and promote sustainable management methods. As a result, the National Remote Sensing Agency (NRSA) and the Central Pollution Control Board (CPCB) now monitor agricultural burning via aerial surveillance and penalise farmers who burn crops (Krishi, n.d.).
- **Custom Hiring centres (CHC) Farm machinery:** Launched by Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, the scheme has taken several steps to maintain the ongoing delivery of farm supplies during the Covid lockout in order to minimize the effects of farm labour migration. A multilingual mobile application was created as well (Krishi, n.d.). The program's objectives include building more than 39,000 custom employment centres and installing 1,950,000 crop residue management machines at CHCs for distribution to different farmers. Four states-Haryana, Punjab, Uttar Pradesh, and Rajasthan-received grants totalling Rs 2,440,070 million between the years 2018–19 and 2021–22 to carry out the plan (Krishi, n.d).
- **Kisan Drones:** Introduced by the government of India, Kisan Drones is an attempt to improve crop assessment and better digitalization of land records. In order to boost the country's agricultural sector, 100 Kisan Drones were launched in 100 villages across 16 Indian states, including Uttar Pradesh, Punjab, and Goa, to provide high-capacity drones for transporting vegetables, fruits, and fish directly from farms to markets. The union budget for 2022-2023 included a focus on kisan drones. In addition, the budget proposed a public-private partnership for high-tech farm service. The government has also allocated a contingency budget of 6,000 rupees per hectare to implementing agencies that do not intend to purchase drones but rather rent them for demonstration purposes (Indian Brand Equity Foundation (IBEF, 2022) [16].
- **Digital farm Mission:** The Indian government has announced the launch of the Digital Farm Mission for 2021-25, which will fund agriculture initiatives based on new technologies such as artificial intelligence, block chain, remote sensing and GIS technology, drones, robotics, and others (Indian Brand Equity Foundation (IBEF), 2022) [16].

Conclusion

India is a country which relies largely on its agricultural produce to support its population and exports. Over the years, with rising population, the demand for food production has led to increase in stubble waste generation. To combat the problem the government of India has launched various programmes and policies for the betterment of the farmers and to manage stubble waste in the most productive way possible in various parts of the country. But the reach of the initiatives of government is still limited and mostly are in their initial phases. There is need to do more and increase the extend of these policies to benefit not only the farmers but also the citizens of the country. The government needs to prioritize implementation the these programmes and policies in real life.

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