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Availability of Raw Materials for Building Industry in India

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ABSTRACT - In 2009, India stands on third position in the world after China (with 21.5 billion tonnes) and the USA (with 6.1 billion tonnes) in terms of material consumption. In that year, India accounted for 7.1% of global material consumption while hosting 17% of global population (Dittrich,2012).India's Construction material consumption in the previous few many years exhibits a sample of nations making a transition from an agrarian society to an industrial society.

Due to some unsustainable aspects of the highly polluting and the exhaustive nature of building materials it's a challenge for construction industry to find the alternative materials. There is a need for energy efficient and economical methods of construction for which the opportunities have to be created for innovative and unconventional resources to emerge due to the widening gap in demand and supply of building materials. This paper presents an analysis of various conventional materials being utilized in present scenario to the availability of agro waste in which could be used as construction material as per need of construction industry. This paper includes the study of harvesting season of rice and wheat in various states of India to analyze the time period of availability of agro waste when it could be utilized for strawbale units production.

Key Words: Construction materials, agro-waste

I. INTRODUCTION

India's needs nearly 15 billion tonnes of construction materials by 2030 and little above 25 billion tonnes by 2050 (Dittrich, 2012), with the biggest shares in fossil fuels and non-metallic minerals, as depicted in Figure 1.2.

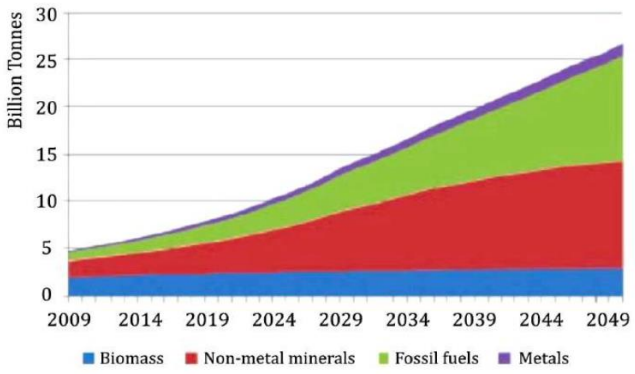

Figure 1.2: Future material consumption in India by category in scenario continuing current dynamic

The share of the real estate segment accounts for about half of the construction sector, while the other half is contributed by infrastructure. In the last few decades, India has increased its housing stock to a remarkable degree.AS per census 2011,330 million units have been constructed. Out of which two –third were in rural areas and one –third in urban areas which was a significant increase compared to 250 million units in 2001 (Government of India, 2012). In the last decade the Indian construction sector has been growing at an average annual growth rate of 10%. In India's economy as per the Planning Commission, 2011 we stand on second position in terms of employment, after agriculture, providing employment to about 35 million people.

II. PRESENT SCENARIO OF RAW MATERIALS AVAILABLE FOR CONSTRUCTION

Sand (concrete and mortar), soil (bricks), stone (aggregates), limestone (cement) and iron and steel (bars and rods) are the most intensively used materials for building and construction purposes. Some of these materials are already facing scarcity issues. The extraction and use of these materials also has associated environmental and social impacts. Therefore, it is important to understand the flow of these materials in the market in

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order to identify competing users of these materials and points where interventions can be made

2.1 IRON AND STEEL (BARS AND RODS)

Notably, the share of metals increased around 400% between 1997 and 2007, reflecting the more intensive use of structural metal elements in construction.

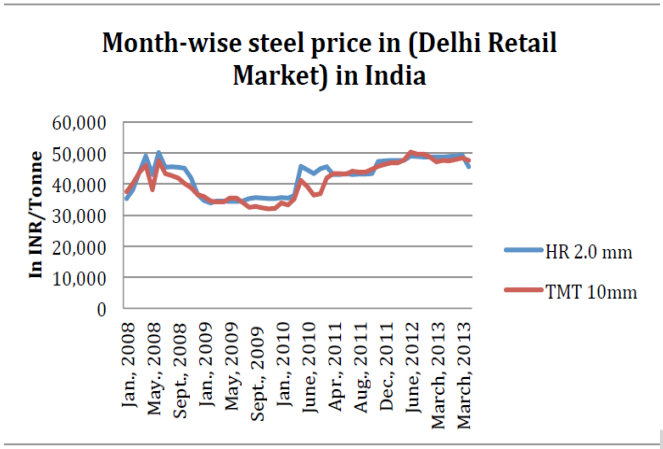

Figure 3.9: Month-wise steel price in (Delhi retail market) in India

(Source: Indiastat.com)

India is self-sufficient in production of iron and steel. Iron ore availability is also sufficient to meet domestic demand. However, international price fluctuations and supply gaps due to legal issues with iron ore mines, as well as perceived quality concerns about domestic steel encourages steel manufactures to import finished steel. Iron and steel have high recyclability potential even after demolition of buildings and other infrastructure. Salvaged steel is seen as a valuable resource and fetches a high price in the secondary market. Local foundries reuse recovered iron and steel rods in finished steel production.

2.2 CEMENT

India is currently the second largest producer of cement in the world, producing 210 million tonnes in 2010, which was 6.3% of global production. India nearly quadrupled cement production between 1996 and 2010 (WBCSD & IEA, 2013). While India has considerable limestone reserves, they may run out by 2030 under the assumptions of the above scenarios (IGEP, 2013). The cement industry is one of the largest emitters of CO2; in India it accounts for approximately 7% of the country's total CO2 emissions (WBCSD & IEA, 2013).

2.3 BRICKS

Fertile top soil is exploited by brick kilns to produce fired clay bricks, threatening food security of the nation (as a direct consequence of reduced fertility of the land). There is also a large amount of "embedded energy" in clay bricks from the mining and firing processes.

Soil demand for brick making: Every year about 350 million m3 of soil is required to produce bricks (GIZ, 2015b). Taking standard density of soil as 2.4 g/cc, the amount of soil required is about 840 million tonnes/annum. Considering 5% loss17 of soil in brick making, gross demand of soil is estimated to be 884 million tonnes/annum. Fertile topsoil is one of the most exploited natural resources in India. Similar to sand, soil is also formed by constant weathering of rocks, a geological process that takes millions of years. About 56% of the total land area in India is classified as agricultural land which relies on soil fertility .Alluvial, red and black soils cover majority of land area in India and, in addition to agriculture, are used for road construction as base material, and for manufacture of clay bricks. Covering about 150 million hectares or about 45.6% of the total land area of the country, alluvial soils constitute the largest share among all soil types found in India (Negi, 2015) and are most popular for brick making. Red and black soils cover about 27% and 17% of the total land area respectively (Bhattacharyya, 2013). Increased urbanisation has led to excessive exploitation of topsoil for brick production. Soil extraction for brick production decreases agricultural productivity, which translates to increased food security concerns. Production of bricks also has serious environmental impacts such as air pollution, and social impacts such as labour exploitation.

2.4 SAND

Though sand miners are required to obtain a permit from the state government and pay a royalty on the sand sold to the market, this procedure is seldom followed as mining is carried out in a decentralised and unorganised manner, frequently skirting the law. Illegal sand mining is a practice followed in almost every state. While the number of illegal mines is still unaccounted for, there are 12 illegal hotspots of sand mining that have been identified in the country (Figure 3.39). In the southern states where sand is scarce, there has been a greater challenge of illegal mining. The gap between demand and supply will increase in the future as the demand for infrastructure and housing continues to rise. Conventional building materials like sand used for concrete and mortar, soil used for bricks, stone used for aggregates, limestone used for cement and iron and steel bars are used now a days for building and construction purposes.. The extraction and use of these materials has environmental and social impacts and few of these materials are facing the issue of scarcity. Flow of these materials in the market is needed to be studied in order to identify competing users of these materials and points where interventions can be made.

Stone

The stone quarrying industry is poorly regulated and the production of aggregates is environmentally destructive. The stone substitutes are getting popular that affected its use in the construction industry.

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Table 2.1: Criticality framework for materials in the construction sector

Parameters → Resource ↓	Scarcity	Cost	Environmental Impact	Embodied Energy	Supply Risk	Lack of Recycl-ability	Opportunity Cost / Conflict of Use
Soil	**	*	***	***	**	***	***
Iron	*	**	***	***	*	*	*
Limestone	*	*	***	***	*	***	**
Sand	***	***	***	***	***	***	***
Stone (Aggregate)	**	*	***	**	**	***	***
Marble / Granite	*	*	***	**	*	***	**
Copper	*	**	***	***	*	*	*
Bauxite (Aluminium)	*	**	***	***	*	*	*
Petroleum (PVC)	*	*	***	**	*	*	*
Silica (Glass)	*	**	***	**	*	*	*
Wood	**	**	***	**	**	**	*

The reason behind shortlisting sand, soil, stone and limestone is their scarcity against the projected demand. As compared to other metals a distinguishing factor was the lack of reuse/recyclability .Iron is also shortlisted even than it is recyclable. This is because of its social, economic and environmental problems associated with extraction and supply and its growing importance in construction.

III. AVAILABILITY OF AGRO-WASTE IN INDIA

Presently in India, about 960 million tonnes of waste is being generated every year as by-products throughout industrial, mining, municipal, agricultural and exclusive processes. Of this 350 million tonnes are organic wastes from agricultural sources; 290 million tonnes are inorganic waste of industrial and mining sectors and 4.5 million tonnes are hazardous in nature. For the sake of conservation of re-sources and saving of energy , efficient recycling of all these agro wastes is now a global concern requiring extensive R&D work towards exploring newer applications and maximizing use of existing technologies for a sustainable and environmentally sound management.

Crop Estimate of Production (Mt)

- Rice 105
- Wheat 94
- Sugarcane 361
- Oil seeds 30
- Cotton 35
- Jute 11
- Pulses 17

Source: Directorate of Economics and Statistics, in 2012–2013

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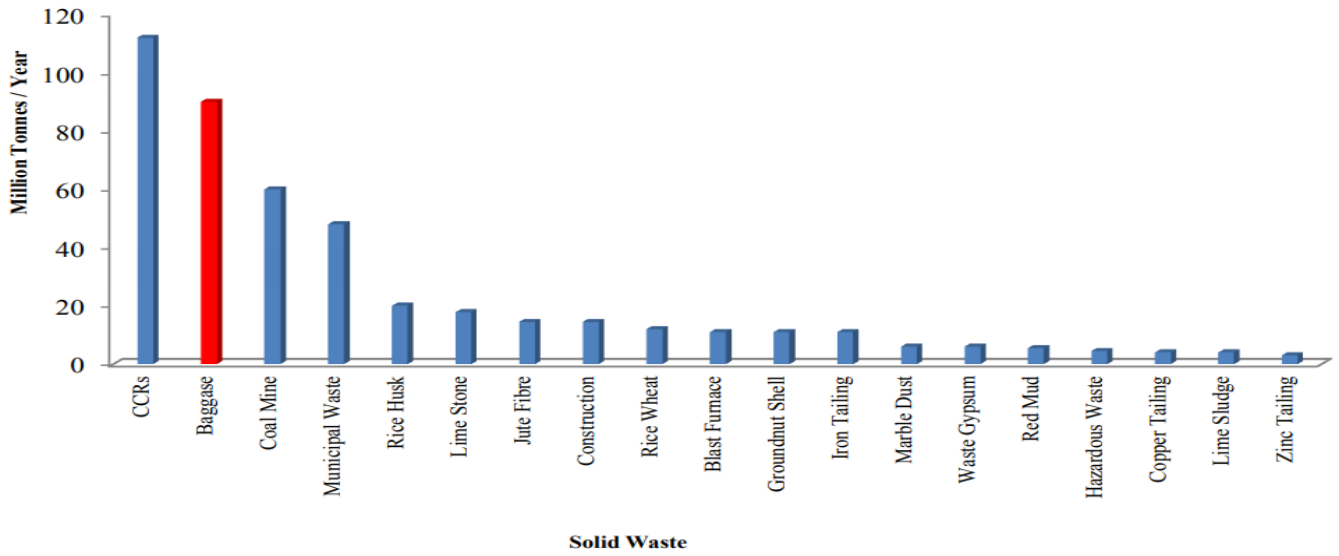


Figure 1: Annual solid waste production in India

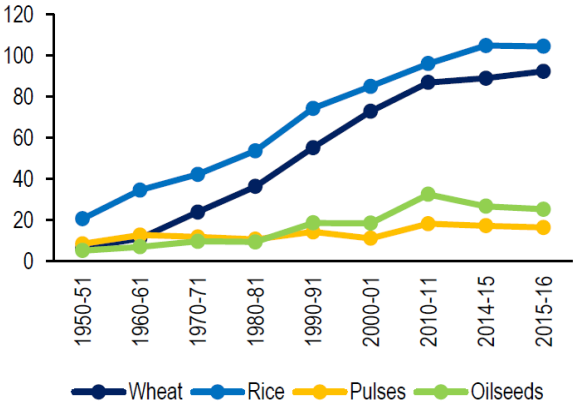
3.1 Rice straw

Rice straw is a by-product of rice cultivation produced throughout the world .It can be disposed by composting and feeding on-farm and also by burning. For a sustainable agricultural system straw development should not be seen in terms of economic development only where rice straw could potentially create a valuable added-value commodity in industry chain. A by –product of rice husk produced after burning it is Rice Husk Ash (RHA) that can be used as an admixture for concrete.. RHA blended concrete has been found to be very manageable and long lasting based definitely on a number of tests. RHA-concrete can show to be boon for the cement and the concrete organization in endless components because of large manufacturing of paddy in India.

3.2 Wheat straw

A study was conducted to determine the straw grain ratios (S/G ratio) and straw quality of wheat cultivars to develop wheat straw availability estimates at national and state levels. The sampling locations were the farmer's field spread over 8 major wheat producing Indian states viz., Bihar, Haryana, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand and West Bengal. These states together contribute more than 85 percent of total wheat production in India. A significant variation ($P<0.001$) in straw to grain ratios was observed among wheat cultivars grown in different states. Variability ($P<0.001$) within the cultivar was also observed when it was grown under different agro climatic regions and agronomical practices. At present (year 2010-11) 112 million tonnes of wheat straw is expected to be available in the country and in next 10 years (year 2020) this quantity will increase up to 120 million tonnes, registering a growth of 6 percent. As per the projections, the share of UP in total wheat straw pool will be the highest (33%), followed by Punjab (19%), Haryana (15%), Rajasthan (11%), MP (10%) and Bihar (6%). It was concluded that straw grain ratios are variable and therefore the projection based on area specific ratios will be more realistic for assessing the straw availability in the country. Chemical composition and digestibility of straw varied among the wheat cultivars. Results suggested that the variability in nutritional parameters among varieties need to be exploited by plant breeders, particularly in areas where straw is an important component of ruminant feed.

Figure 5: Agricultural production (million tonnes)



Sources: Ministry of Agriculture; PRS.

Other agro based products are Bamboo corrugated sheet, jute fibre and sugarcane baggase particle board

IV. TYPES OF CROPS

Agriculture has consistently been the spine of our country's economy. And ever for the purpose that the Green Revolution, we have started out cultivating unique types of crops. Crops are normally grown so they can be commercially traded. i.e any plant that is grown and harvested extensivelyfor earnings purposes. There are two quintessential kinds of vegetation that are grown in India.

The Indian cropping season is categorized into two fundamental seasons-(i) Kharif and (ii) Rabi based totally on the monsoon. The kharif cropping season is from July – October at some factor of the south-west monsoon and the

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Rabi cropping season is from October-March (winter). The vegetation grown between March and June are summer time crops. The kharif vegetation consist of maize, sorghum, pearl millet/bajra, finger millet/ragi (cereals), arhar (pulses), soyabean, groundnut (oilseeds), cotton etc. The rabi vegetation consist of wheat, barley, oats (cereals), chickpea/gram (pulses), linseed, mustard (oilseeds) etc.

Table 8: Top producing states for major crops in 2014-15

State	Production (million tonnes)	% of all India	Yield (kg/ha)
		Rice	
West Bengal	14.7	14.0	2,731
Uttar Pradesh	12.2	11.7	2,082
Andhra Pradesh	11.6	11.0	3,036
India	**104.8**		**2,390**
		Wheat	
Uttar Pradesh	25.2	28.4	2,561
Punjab	15.8	17.7	4,491
Madhya Pradesh	14.2	16.0	2,551
India	**88.9**		**2,872**

4.1 Kharif Crops

The phrase "Kharif" is Arabic for autumn on account that the season coincides with the moving forward of autumn or winter. Kharif vegetation alsoare regarded as monsoon crops. These are the crops that are cultivated in the monsoon season. The Kharif season differs in every state of the United States Of America then again is in many instances from June to September. These flowers are frequently sown at the setting up of the monsoon season round June and harvested via the use of September or October. Rice, maize, bajra, ragi, soybean, groundnut, cotton are all Kharif sorts crops.

4.2 Rabi Crops

The Arabic translation of the phrase "Rabi" is spring. These crops' harvesting takes place in the springtime consequently the name. The Rabi season normally begins in November and lasts up to March or April. Rabi vegetation are through and massive cultivated the use of irrigation on account that monsoons are already over through November. In fact, unseasonal showers in November or December can smash the crops. The seeds are sown at the opening of autumn, which effects in a spring harvest. Wheat, barley, mustard and inexperienced peas are some of the foremost rabi types of plant life that grow in India.

4.3 Zaid Crops

There is a brief season between Kharif and Rabi season in the months of March to July. The vegetation that enhance in this season are Zaid crops. These flowers are grown on irrigated lands and do no longer have to wait for monsoons.

Table showing the harvesting periods and the availability of basic construction materials Crop Calendar of Major Crops

States/Uts	Period	Kharif	Rabi	Summer	Rabi	AVAILABILITY OF SAND	AVAILABILITY OF SOIL FOR MAKING BRICKS	AVAILABILITY OF STEEL
		Paddy	Paddy	Paddy	Wheat			
Andhra Pradesh	Harvesting	Nov-Dec	May-June	July-Aug.		NO	NA	AVAILABLE
Assam	Harvesting	June-July	Nov-Dec	May-June	Mar(B)-Apr(E)	AVAILABLE	AVAILABLE	NA
Bihar	Harvesting		April-May	July-Aug.	Mar(M)-Apr(E)	NO	NA	NA
Gujarat	Harvesting	Oct-Nov			Feb(B)-Mar(E)	NO	NA	NA
Haryana	Harvesting	Sept-Oct.			Apr(M)-Apr(E)	NO	AVAILABLE	NA
Himachal Pradesh	Harvesting	October			Apr(M)-Jun(E)	NO	NA	NA
Jammu & Kashmir	Harvesting	Sept-Oct.			May(B)-May(E)	AVAILABLE	NA	NA
Karnataka	Harvesting	Sept-Oct.	Jan.-Feb	May-June	Jan(B)-Feb(E)	NO	NA	AVAILABLE
Kerala	Harvesting	Sept-Oct.	Dec-Jan.	March-April		NO	NA	NA
Madhya Pradesh	Harvesting	Oct-Nov			Feb(M)Apr(E)	NO	NA	AVAILABLE
Maharashtra	Harvesting	Oct-Nov			Feb(B)-Mar(E)	NO	NA	AVAILABLE
Orissa	Harvesting	Sept-Oct.	Nov-Dec	April-May	Mar-Apr	NO	NA	AVAILABLE
Punjab	Harvesti				Apr(B)-	AVAILABLE	AVAILABLE	NA

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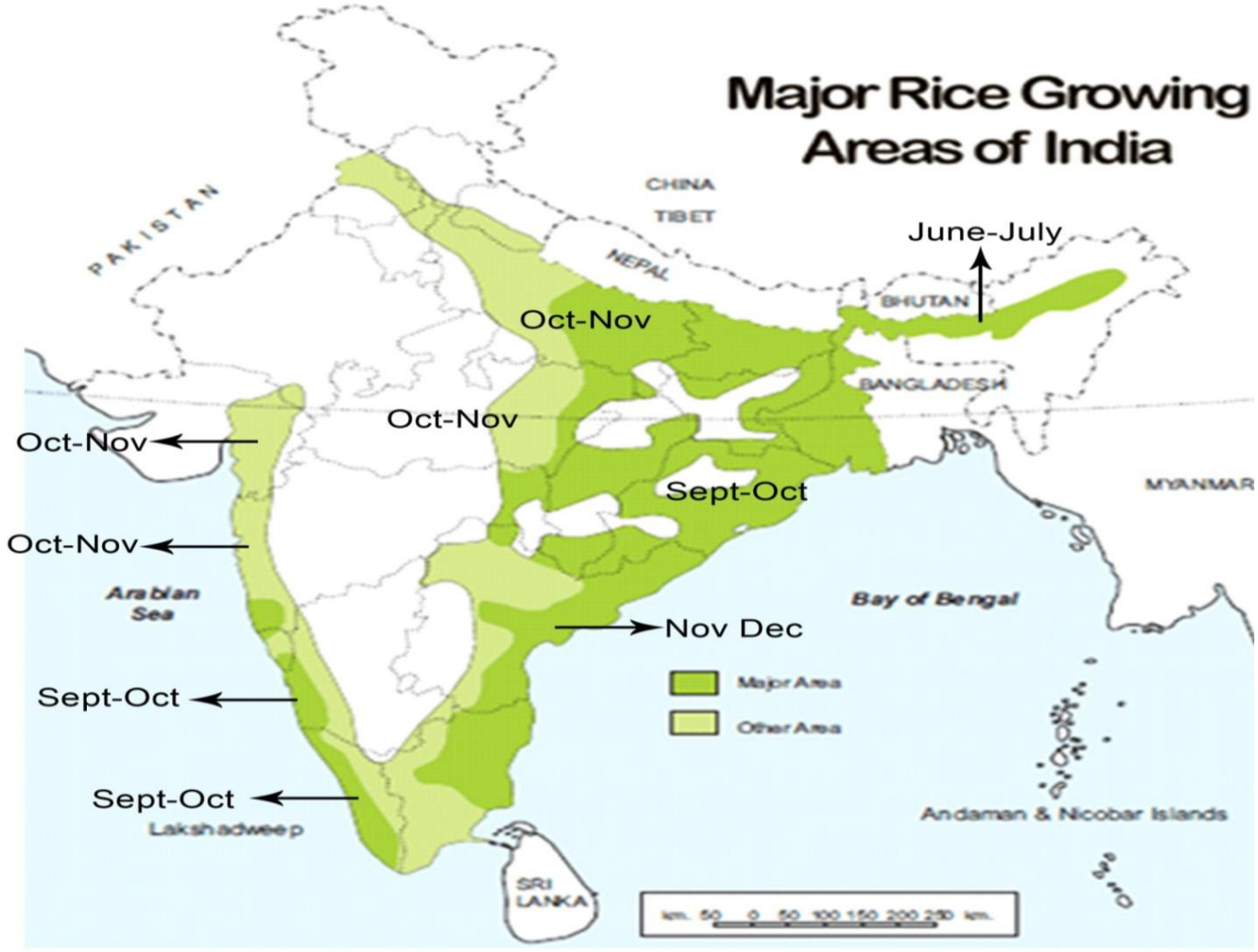
	ng				May(E)			
Uttar Pradesh	Harvesting	Oct-Nov	April-May		Apr(B)-Apr(M)	AVAILABLE	AVAILABLE	NA
West Bengal	Harvesting				Mar(B)-Apr(E)	NO	AVAILABLE	AVAILABLE

(Source: Aggregate Business International, 2013)
Source : Indian Council of Agricultural Research (Crop Science Division)



Map showing the harvesting months of Rice in various states of India.

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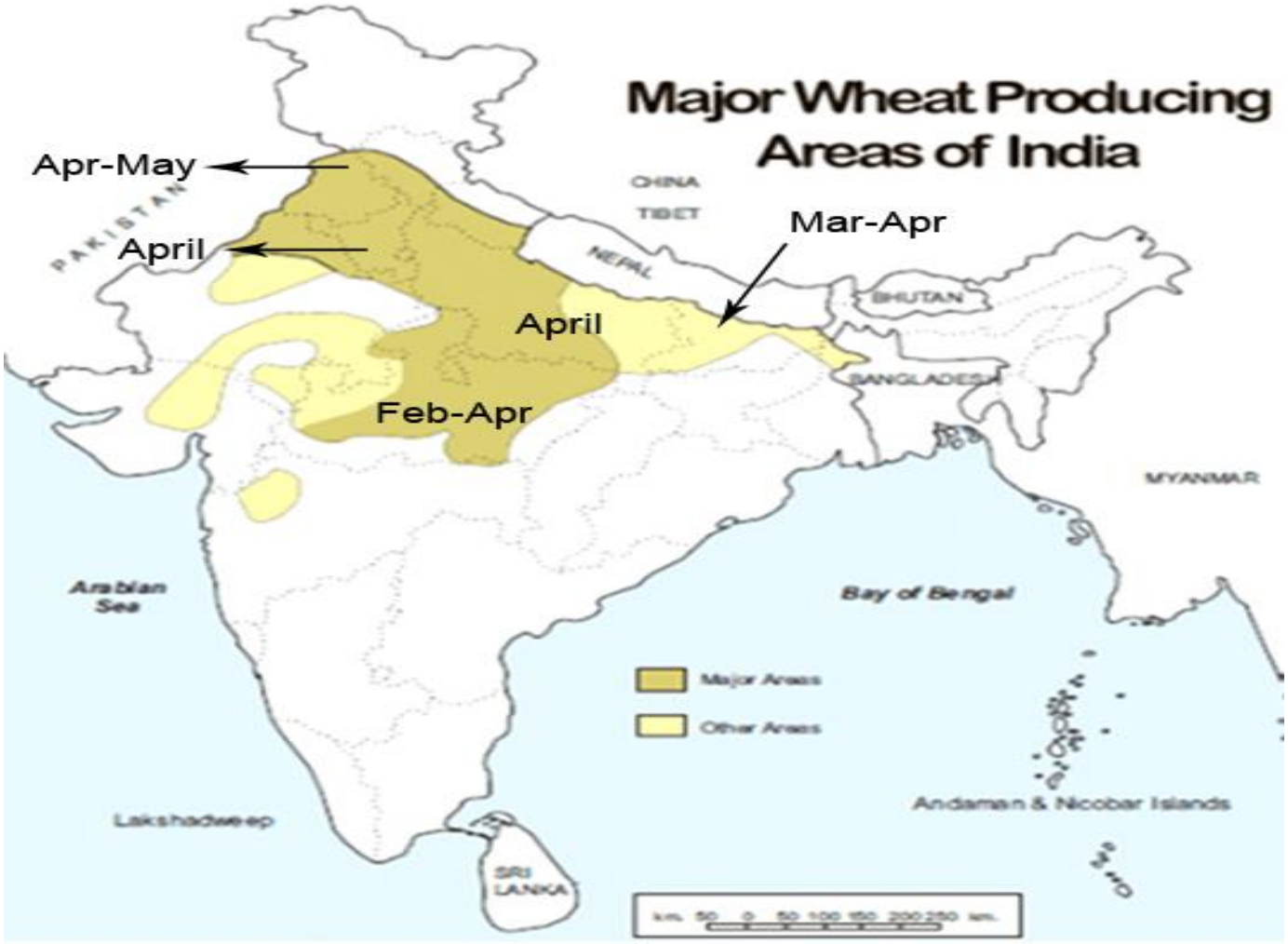

Map showing the harvesting months of wheat in various states of India.

State	Supply of agro waste	Scarcity of Conventional materials	Remark	Viability of Strawbale Construction
Andhra Pradesh	YES	YES	Agro waste available all the year round. Only steel is available.	YES
Assam	YES	NO	Agro waste available all the year round. Only steel is not available.	NO
Bihar	YES	YES	Agro waste available from April-Aug. Conventional materials not available.	YES
Gujarat	YES	YES	Agro Waste available only for four months in a year. Conventional materials not available.	YES
Haryana	YES	YES	Agro Waste available only for one month in a year. Only bricks are available.	YES
Karnataka	YES	YES	Agro waste available all the year round. Only steel is available.	YES
Kerala	YES	YES	Agro Waste available only for four months in a year. Conventional materials not available.March-April	YES
Madhya Pradesh	YES	YES	Agro Waste available only for five months in a year. Only steel is available.	YES
Maharashtra	YES	YES	Agro Waste available only for four months in a year Only steel is available.	YES
Orissa	YES	YES	Agro waste available all the year round. Only steel is available.	YES
Punjab	YES	NO	Agro Waste available only for four months in a year. Only steel is not available.	YES
Uttar Pradesh	YES	NO	Agro Waste available only for four months in a year. Only steel is not available.	YES
West Bengal	YES	NO	Agro Waste available only for two months in a year. Only sand is not available.	YES

After analyzing the supply and scarcity of building materials we came to the conclusion that raw material for strawbale construction is available in all the major sates of India except Rajasthan.

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V. CONCLUSION

As per these maps straw is wheat straw is harvested in U.P.,M.P. and Punjab during the months of April and May. And rice straw in W.B.,A.P. and U.P. during the months of September to October. Farmers are the stakeholder, must have an integrated approach and must not be passive to reform. They should be make aware of the profits of the new project by the government. Farmers find straw burning the easiest and traditional option for straw disposal and are not aware about the serious effects on soil fertility and environment.

Developing favourable policies for products made from secondary materials Codes and standards that ensure products meet quality standards will go a long way in building user confidence in the product. BIS codes should be supported by preferential procurement of products made from secondary materials. This can be done through amendments in tenders issued by public enterprises in the construction sector.

Emphasis has to be given on encouragement from the institutions, continuous advice from extension officers on theory and practice and efficient demonstration in the field so the farmers become more skilled and knowledgeable to find the new ways of crop residue management.

Farmers must be given the incentives for increasing their participation in terms of field operating costs and for increasing straw potential and market expansion for the straw-uses.

Straw industries in India could be successful only with the support of farmers by implementing good crop management practices, by providing an adequate logistics; R&D at the local level including diversification potential opportunities for straw in both wet and dry condition. For a more competitive and progressive outcome an integrated support from agricultural agencies and government is required.

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