F.No.O-15012/61/18-G&R
Government of India
NITI Aayog
(Governance & Research Vertical)

Sansad Marg, New Delhi-110001
Dated the 19th February, 2019

Public Notice # 3

Sub: EoIs on Research/Study on each of the subjects as mentioned in Annexure-I and II (ToRs).

NITI Aayog invites Expressions of Interest (EoIs) for conducting research/study on the topic as mentioned in Annexure-I from institutions/organisations of repute (including universities/deemed universities). A brief scope/ToRs of the study proposed is also enclosed at Annexure-I. The detailed Research Scheme of NITI Aayog, 2018 (RSNA-2018) guidelines may be seen in the NITI Aayog website at http://www.niti.gov.in/guidelines

2. Here, the aim is to arrive at the policy prescriptions on the issue and to have more focused feedback for future policy-making. The Research/Study Proposals, for which EoIs are being invited, will be funded under the Research Scheme of NITI Aayog, 2018 (RSNA-2018) and its amendments, if any. All the institutions/organisations are requested to go through the Guidelines of the Research Scheme of NITI Aayog, 2018 (RSNA-2018) before responding to this public notice, especially to satisfy themselves that they fulfill all the eligibility criteria for availing of grant under the said scheme and also that they can conduct the research study project as per the guidelines.

3. The hard copy of EoI as per Annexure-II must be submitted by hand/by Registered post to Deputy Adviser (Governance & Research), Room#435, NITI Aayog, Sansad Marg, New Delhi-110001. The EoI must be sent in envelopes superscribed with the words "EoIs on (name of the topic, as mentioned in Annexure-I)' and the same must reach the NITI Aayog within 30 days of the notified date of Public Notice # 3. For any query in this regard, the Deputy Adviser (Research) (+91-11-23096725) may please be contacted over phone.

19 Feb 2019

(Dr. B.Bishoi)
Deputy Adviser (Research)

Annexures: As above

Annexure-I

S.No.	Thrust areas/topics
1.	A Research Study on Mass Production of Manure/Fertilizer from Agricultural Bio-Mass"

Terms of Reference (ToR)

I. Background :

The commitment to attend sustainable development goals is today's global agenda. Agricultural sustainability is not only linked to farming in isolation but it includes the entire farm based operations. To this context, serious attention has been drawn to the policy makers and scientists globally to device suitable technologies for effective utilization of agricultural biomass as an important national resource since creating a wreaking havoc. This has become an imperative need in the backdrop of global quest for cleaner environment and greener world.

2. Globally, 140 billion metric tons of biomass is generated every year from agriculture. This volume of biomass can be converted into source of energy and raw materials. Inadequate management of waste agricultural biomass is contributing towards climate change, water and soil contamination and local air pollution. As raw materials, biomass wastes have attractive potentials for large-scale industries and community-level enterprises. Biomass aggregation includes residual stalks, straw, leaves, roots, husk, nut or seed shells, waste wood, animal husbandry, dairy, fisheries and aquaculture wastes. There is an emerging trend on the utilization of biomass conversion technologies from combustion of rice husk and sugarcane bagasse.

II. Aims & Objectives :

To develop a technology to convert crop bio waste (particularly of paddy) into farm compost in less than six months period with economically efficient methods.

To convert bio waste into wealth and offer economically viable alternative to prevent burning of crop residues, stubble etc.

Create possibility of giving an added value to the agricultural activity through the availability of an additional source of income for managing the treatment and selling resultant compost.

Availability of a new material to improve the soil fertility with the application of compost (in substitution of chemical fertilizers).

III. Opportunities & Challenges :

Burning of crop residues/ rice straw is common in north-western parts of India causing nutrient losses, and serious air quality problems affecting human health and safety. It causes severe pollution of land and water on local as well as regional and global scales. It is estimated that burning of paddy straw results in annual nutrient losses of 3.85 million ton of organic carbon, 59,000 ton of nitrogen, 20,000 ton of phosphorus and 34,000 ton of potassium at the aggregate – which can be effective resource for the farming sector. However, the other estimate indicates the loss of nutrients is in comparatively lower scale and the details of which is detailed below.

Loss of nutrients (million ton/ year) due to burning of crop residues

Sl	Crop residues	N Loss	P Loss	K Loss	Total
1.	Rice	0.236	0.009	0.200	0.45
2.	Wheat	0.079	0.004	0.061	0.14
3.	Sugarcane	0.079	0.001	0.033	0.84
Total		**0.394**	**0.014**	**0.295**	**1.43**

The challenge, therefore, is to convert agricultural biomass as a resource for energy and other productive uses and to explore capturing of best technologies available worldwide, especially those existing in developing countries, have the ease of access to information on these technologies. However, given that some technologies have incomplete data fields and there is a need to intensify and deepen research on the growing number of technologies. Data deficiencies may also be a serious challenge in a country like India, where more emphasis has been laid for solid waste management in contrary, rational management of agricultural biomass received comparatively less attention, which is required to be addressed.

According to the estimates of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), this leads to nutrient loss from the soil which is equivalent to US $18 million worth of urea.

IV. Relevance and Need of the Study :

In India, according to the MNRE, over 500 million ton of agricultural residues are produced every year. With increased production of rice and wheat, residue generation has also increased substantially. Cereal crops (rice, wheat, maize, millets) contribute 70% of the total crop residues *i.e.* 362 million ton comprising 34% by rice and 22% by wheat crops. The rice-wheat system accounts for nearly one-fourth of the total crop residues produced in India.

Crop-wise residue generated (million ton/ year) in various States of India :

Sl.	States/ UTs	Cereal Crops	Fibre Crops	Oil-seeds Crops	Sugarcane
1.	Andhra Pr.	33.07	16.07	2.50	5.80
2.	Aru. Pr.	0.56	0.00	0.06	0.01
3.	Assam	8.15	2.01	0.29	0.41
4.	Bihar	19.87	3.27	0.20	1.87
5.	Chhattisgarh	8.87	0.01	0.11	0.01
6.	Goa	0.24	0.00	0.01	0.02
7.	Gujarat	8.18	28.62	5.06	5.85
8.	Haryana	24.73	7.58	2.15	1.93
9.	Himachal Pr.	1.95	0.00	0.01	0.02
10.	J&K	2.76	0.00	0.11	0.00
11.	Jharkhand	7.34	3.55	0.09	0.13
12.	Karnataka	11.73	0.01	0.81	8.80
13.	Kerala	1.14	3.51	0.00	0.10
14.	Madhya Pr.	16.05	19.51	2.13	1.12
15.	Maharashtra	8.75	0.00	0.57	22.87
16.	Manipur	0.78	0.13	0.00	0.01
17.	Meghalaya	0.44	0.00	0.01	0.00
18.	Mizoram	0.10	0.01	0.00	0.01
19.	Nagaland	0.89	0.56	0.06	0.07
20.	Odisha	13.38	9.32	0.16	0.24
21.	Punjab	45.58	2.96	0.08	1.76
22.	Rajasthan	22.19	0.00	9.26	0.15
23.	Sikkim	0.14	0.78	0.01	0.00
24.	Tamil Nadu	11.69	0.02	1.56	12.37
25.	Tripura	1.22	0.04	0.00	0.02
26.	Uttar Pr.	72.02	0.00	2.49	41.13
27.	Uttarakhand	2.40	24.43	0.03	2.11
28.	West Bengal	37.26	0.00	0.95	0.62
29.	A&N Islands	0.04	0.00	0.00	0.00
30.	Dadra & Nagar Haveli	0.05	0.00	0.00	0.00
31.	Delhi	0.17	0.00	0.00	0.00
32.	Daman & Diu	0.01	0.00	0.00	0.00
33.	Puducherry	0.10	0.00	0.00	0.06
All India (Total)		**361.85**	**122.39**	**28.71**	**107.49**

Note : Contribution of different crops categories in residue generation – cereals 58%, sugarcane 17%, oil-seeds 5% and fibres 20%; contribution of different cereal crops in residue generation – rice 53%, wheat 13%, maize 7% and millets 7%

Crop-wise production, residue generated :

Sl	Crop	Annual Prodn. (million ton/ year, 2014)	Dry residue generated (million ton/ year, 2014)
1.	Rice/ Paddy	153.35	192.82
2.	Wheat	80.68	120.70
3.	Maize	19.73	26.75
4.	Jute	18.32	31.51
5.	Cotton	37.86	90.86
6.	Groundnut	7.17	11.44
7.	Sugarcane	285.03	107.50
8.	Rapeseed Mustard	7.20	17.28
9.	Millets	18.62	21.57
Total		**627.96**	**620.43**

The surplus crop residues in some regions are typically burnt on-farm. The amount of surplus crop residues available is estimated between 84 and 141 million ton/ year (44.5 million ton rice straws and 24.5 million ton wheat straws), where cereals crops contribute 58%.

Crop residues burnt in various States of India (2008-09, in million ton/ year)

Sl.	States/ UTs	Residue burnt (IPCC)	Residue burnt (Country data)
1.	Andhra Pr.	12.60	5.29
2.	Aru. Pr.	0.16	0.05
3.	Assam	2.65	0.96
4.	Bihar	5.21	3.35
5.	Chhattisgarh	2.39	0.73
6.	Goa	0.17	0.03
7.	Gujarat	9.63	4.51
8.	Haryana	6.85	9.18
9.	Himachal Pr.	0.25	0.42
10.	J&K	0.47	0.23
11.	Jharkhand	1.90	1.28
12.	Karnataka	5.52	5.93
13.	Kerala	0.55	0.12
14.	Madhya Pr.	3.86	2.00
15.	Maharashtra	10.96	6.82
16.	Manipur	0.21	0.07
17.	Meghalaya	0.14	0.05
18.	Mizoram	0.03	0.01
19.	Nagaland	0.21	0.09
20.	Odisha	3.84	1.31
21.	Punjab	13.30	21.32
22.	Rajasthan	4.27	2.77
23.	Sikkim	0.02	0.01
24.	Tamil Nadu	5.57	3.37
25.	Tripura	0.63	0.11
26.	Uttar Pr.	22.38	22.25
27.	Uttarakhand	1.07	0.76
28.	West Bengal	14.85	5.43
29.	A&N Islands	0.01	0.00
30.	Dadra & Nagar Haveli	0.01	0.00
31.	Delhi	0.04	0.02
32.	Daman & Diu	0.00	0.00
33.	Puducherry	2.11	0.02
All India (Total)		**131.86**	**98.49**

Residue to crop ratio :

Sl	Crop	Ratio
1.	Rice/ Paddy	1.50
2.	Wheat	1.70
3.	Maize	1.50
4.	Jute	2.15
5.	Cotton	3.00
6.	Groundnut	2.00
7.	Sugarcane	0.40
8.	Rapeseed & Mustard	3.00
9.	Millets	1.50

Hence there is an ardent need to undertake a study, which should address the following issues : (i) How much agricultural biomass is available and recoverable; (ii) What is the potential economic utilization of agricultural biomass wastes; (iii) What are the key uncertainties for agricultural biomass prospects in India; (iv) What will be the supply cost and future price of agricultural biomass; (v) What role government is playing to strengthen agricultural biomass deployment and (vi) What are the implications towards SDGs ?

V. Problem Identification :

Typically, surplus residue is burnt *in-situ* in India during the period of March to May. On farm burning of crop residue becomes a source of five greenhouse gases, aerosols, particulate matters, smoke, volatile organic compound and radioactive gases; there-by they exacerbate global and regional atmosphere. The study should focus on the status of crop residue in India as well as recycling of crop residue for economic and environmental sustainability.

VI. Benefits of the Study :

The goal should be to ensure that the agricultural waste used as potential economic resource and not just discarded. It is also very important to set up institutions that can harness the large potential of agricultural wastes as a resource in farming including on farm energy production.

Hence, the gravity of the situation demands that an appropriate policy should be evolved to promote alternative uses of crop residues to prevent on-farm burning; working on modalities for potential of economic utilization of agricultural biomass waste in India targeting to convert manure to support farming sector to drive the gradual shift from inorganic to organic may be one of the most suitable options.

VII. Alternative Uses of Crop Residues

The crop residues produced during the harvesting of rice and wheat crops can be used for various alternative purposes, if it is not burnt. These include use of crop stubble as fodder for animals, use of crop stubble for the generation of electricity, use as input in the paper/ pulp industry *etc.*

In China 37% of crop residues are directly combusted by farmers, 23% used for forage, 21% discarded or directly burnt in the field, 15% lost during collection, 4% for industry materials and 0.5% for biogas. Thus burning of crop residues in the field is a major problem in China as well.

Micro-level evidence in India reveals, Patiala district of Punjab generates 23 and 19 quintal of paddy and wheat residues per acre annually. Out of this in the case of paddy, more than 85% burnt in open field and less than 10% was incorporated, while rest of 5% is used for other purposes. In case of wheat, 77% of the total amount is used as fodder for animals while 9% was incorporated and around 14% was burnt. The current status of utilization of crop residues/ agricultural biomass in selected states of India is detailed below :

Chhattisgarh

Nearly 64% of the total biomass is consumed as animal fodder; nearly 7.7% is consumed for mulching and thatching; Biomass power plants in the region consume about 18.4% and nearly 5% is imported from Ambikapur & surrounding area at the rate of Rs 1600–2300 per MT.

Maharashtra

About 44% of the total biomass generated is used as animal fodder; about 9% is consumed as domestic fuel; Biomass power plants consume only 8.6%; Oil mills and brick kilns consume about 20% and 1.79%, respectively and about 10% is exported outside the catchment area.

Rajasthan

About 60% is used as animal fodder; about 11% is consumed as domestic fuel; nearly 4.6% is consumed in Biomass power plants; Oil mills and brick kilns consume 6.9% and 3.4%, respectively and about 2% is exported outside the catchment area and 4.6% is left in the fields to decompose or burnt in the fields.

Punjab

About 57% of total biomass generated is consumed as animal fodder; About 5.6% is consumed in Biomass power plants in the region; About 17% is exported outside the catchment area and About 12.5% of total biomass is left on the fields because of low density of fuel and lack of proper mechanical equipment to collect and transport the biomass resulting in low collection efficiency.

VIII. Implications towards SDGs : Contribution to the overall sustainability; improvement of overall waste management targeting country approach; increased recycling levels and reduction of organic waste; obtaining a quality compost to be used as an organic amendment that contributes to improve soil fertility; to stop the desertification process and to capture carbon in soil. These factors will add up to the climate change mitigation targeting the reduction of biogas generations. Hence, the proposed study will also be helpful to review the global warming problem associated with residue burning besides providing an impetus in production of fertiliser/ manure to generate economic value.

IX. Economic Value ;

It is important to understand the economic use of crop residue to alleviate the problem of *in-situ* burning of it. Contrastingly, across India, the majority of crop residue is not being burnt. In southern and northern India the major portion of rice straw is being used for cattle feed and roof thatching, and burnt on-farm, respectively. Conversely, husk is mostly subjected to on-farm burning across the country, especially after the introduction of modern combine harvesters.

Wheat is the second most consumed crop after rice. The large amount of wheat straws (residue) goes into cattle feeding, domestic fuel, paperboard making and oil extraction. However, in areas of Indo-Gangetic plains (IGP) such as Punjab, Haryana, Uttarakhand and Uttar Pradesh - where intense cropping system is adopted - the straw is burnt as it is the easiest and most economical option to get rid of it in the short period available between two crops. Unlike wheat, corn straw and millet stalks are relatively hard, and therefore used less for fodder. However, it is either left in the field as compost or used for cattle feed. Similarly, mustard stalks are widely burnt or used for domestic fuel.

Sugarcane is a relatively long duration crop and its residue is disposed of quickly to catch-up for the sowing of the follow-up crop. Sugarcane residue includes trash, tops and bagasse. Trash is used as fuel for jaggery extraction, cattle feed or burnt on-site. Likewise, peanut stems and shells are used for domestic and industrial fuel, respectively. On a global basis, burning of crop residue represents nearly 2020 Mt (approx. 25% of total biomass produced). The four states *viz.* Uttar Pradesh, Maharashtra, Madhya Pradesh and Punjab constitute 47% of total burnt crop residue as per IPCC.

This huge amount of burnt crop residue is virtually a loss of opportunity to its potential use for different purposes such as composite making and bio-energy generation. In developing nations, clean and affordable energy production can be enhanced from the

deployment of advanced biomass cooking stoves. It is projected that growth in use of biofuel for transportation will rise from 2% at present to 27% in 2050.

X. Progress made so far :

In terms of efforts being made to reduce crop residue burning, the following approaches have been used by various States and Central Administrations and regulatory bodies so far :

Banning of Crop Residue Burning : Crop residue burning was notified as an offence under the Air Act of 1981, the Code of Criminal Procedure, 1973 and various appropriate Acts. In addition, a penalty is being imposed on any offending farmer.

Detection and prevention : A combination of remote sensing technology, use of satellite imagery and a team comprising local officials–Sub-Divisional Magistrates, Tehsildars, Block Development Officers, *Patwaris* and village-level workers are being deployed to detect occurrences of crop residue burning on real time basis.

Establishment of a marketplace for crop residue burning : Efforts are being made to increase the avenues for the alternate usage of paddy straw and other crop residue. Paddy straws can be utilised for the preparation of bio-fuels, organic fertilisers, paper and cardboard making industries. The strategy should assign a real economic and commercial value to the agricultural residue.

Outreach and Public Awareness Campaigns : Efforts are made through *kisan* camps, trainings and workshops, apart from campaigns through various print media, television shows and radio transmissions, in informing farmers about the alternative usage of crop residue.

Subsidy on agri-implements : The State Governments, in collaboration with the Centre, has rolled out schemes for providing subsidy on mechanical implements that help tillage of soil, so that the crop residue can be retained in the soil, adding to its fertility, or alternately, collection of crop residue for putting it to commercial usage.

Crop Diversification : There are various ongoing, long-term efforts at diversification of cropping techniques, such that crop residue burning can be effectively prevented. This is being attempted through cultivation of alternate crops (apart from rice and wheat duopoly) that produce less crop residue and have greater gap periods between cropping cycles.

XI. Time-line/ Project Period : 2019-20 to 2021-22 (3 years); year-wise details of physical and financial break-ups are to be worked out.

XII. Methodology and Execution of the Study : *How to proceed (indicative pathways)*

Agricultural Biomass Assessment (available and recoverable) : Crop Biomass – Rice &Wheat (Hull/ Husk, Straw and Stalks); Coconut (Fronds, Husk and Shell); Coffee (Hull, Husk and Ground); Corn (Cob, Stover, Stalks and Leaves); Cotton (Stalks); Nuts (Hulls); Peanuts (Shells); Sugarcane (Bagasse); Agricultural Crops (Mixed agricultural crops, not limited to crop waste) and Mixed Type (Agricultural crops, animal, dairy and fisheries wastes). For every 4 ton of rice grain, 6 ton of straw is produced. In India, 97.19 million ton of rice straw is produced every year and around 23% of it is left unutilized.

The potentials of four main types of biomass are, (i) energy crops, including food crops; (ii) forest products (fuel wood, residues and processing, and post-consumer waste); (iii) agricultural residues (harvesting residue, processing residue and food waste); and (iv) animal manure.

Inventories of Existing Technologies :

Agricultural Biomass Conversion Routes :

Agricultural Biomass Convertible Materials :

Conversion of Agricultural Biomass into Fertiliser :

Detailed Product and Technical Descriptions of Technology :

Crop Residue Process Equipment :

Indicative Examples :

Crop : Rice Straws, Weeds, Sugarcane, Bagasse, Corn Stalks, Stover, Leguminous Materials
Azolla, Sesbania, Mungbean, Cowpea, Soybean Crop Residues, and Animal manure
Residue Process : Composting
Equipment : Incubator with fungus activator and N-fixing bacteria
Main Product : Organic Fertilizer

Crop : Oil Palm Fruit, Wheat
Residue : Oil Palm Fruit Residue
Auxiliary Materials : Wheat Straw Fibres
Process : Recycling
Equipment : Mould
Main Product : Biodegradable Packaging materials

Crop : Agricultural Crops
Residue : Agricultural Waste
Process : Composting
Equipment : Hopper/ Feeder and Crusher, Conveyor System, Shredder, Mixer, Silo, *etc.*
Main Product : Fertilizer

Crop : Rice
Residue : Rice husk
Process : Gasification
Equipment : Gas burner, Dual Fuel Reactors, Char Chamber, Blower, Char Lever, Control Switch, Gas Pipe, Chimney
Product : Carbonized Rice Husk used for composting

Exploring Sustainable Conversion Technologies :
Operations and Maintenance Requirements :
Job Potential and Social Considerations :
Assessment of Economic Feasibility :

Scope and limitations/ assessment risk factors (source and process continuity) :

Level of use and stakeholders participation :

Conclusion and Recommendations :

Way Forward :

Annexure-II

Format of Expression of Interest (EoI)

1. Scope of work and organisation

i. The broad scope of work or service (briefly in about 100 words)

ii. Type of Inputs to be provided by NITI Aayog on the subject

iii. Eligibility of the consultant(s) for the study

Type of organisation	Address of Organisation	Registration no as per NGO portal of NITI Aayog	Samavesh Partner/Chair professor unit/ other	Single or Joint or collaboration (Name of all organisations)	Whether blacklisted by Govt of India/ State Govt/ any other Department*
*If so, details thereof					

1. Required Documents:

i. Copy of Registration Certificate of the Institution/Organisation OR Articles of Association {Copy of the Constitution/MOA (Memorandum of Association) of the Institute/ Any letter issued by UGC if University }

ii. Registration number (Copy) in NGO-Portal "Darpan" of NITI Aayog, if applicable.

iii. Photo copy of PAN card of the organisation.

1. Undertaking: "The [Institute/ Organisation/University (name only)] has not obtained or applied for assistance for the same purpose/activity for …….. [Name of study] from any Ministry/Department of Central Government / State Governments. It is solely depending on the assistance of NITI Aayog". [To be given separately on A4 size paper)
2. Information of PI and Organisation

Details of Bidder		
1	Name of the Principal Investigator (PI)	
2	Address of PI	
3	Status of the Organisation (Public Ltd./ Pvt. Ltd./ NGO/ Society/ Trust/ University/ Autonomous Body/ Deemed University	
4	Status as per Registration certificate/ Act	
5	Name and Designation of the contact person/ PI and Co-PI to whom all communication shall be made	
	Telephone No. (with STD code)	
	Mobile Number	
	Email of the Contact/ key person	
	Fax No. (with STD code)	
	Website:	

Name and Signature of the Principal Investigator (PI)

Name and Signature of the Head of the Institution/ Registrar (if university) /Principal (if college)

Official Seal

Date: