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ORIGINAL ARTICLE

AGRO-RESIDUES GENERATION IN ANDHRA PRADESH AND ODISHA-CONSTRAINTS AND ISSUES OF UTILISATION FOR ENERGY AND ENVIRONMENTAL MANAGEMENT

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Abstract:

The agro-residues utilisation for energy generation is energy, agriculture and environment nexus. Andhra Pradesh and Odisha states generate large quantities of primary agro-residues, whose potential is more than 8200 MW. These residues are presently burnt openly, resulting in worse pollution. The issue of agro-residues power generation overlaps in the utilisation pattern required for Agricultural activity. A part of the agro-residues is also required for soil water Conservation and maintaining soil nutrient levels for sustainable production. A balance should be maintained for retention of these residues and diversion for alternate uses like energy generation. The resolution of the issues, constraints and guidelines for evolving suitable strategies based on the requirement for agriculture and energy generation are discussed in this paper for sustainable biomass power generation.

KEYWORDS:

Agro-residues, energy generation, power generation, biomass, energy feed stocks crop residues.

INTRODUCTION

Concerns for sustainable energy sources and environmental pollution is necessitating the search for renewable energy sources. Biomass is highly flexible renewable energy source and the least cost alternative, which promotes the development of healthy and sustainable local economies. Biomass residues as energy feed stocks are more environment friendly than fossil fuels.Utilistation of biomass energy recycles the carbon and does not add carbon dioxide to the environment friendly than fossil fuels. The agro–resides which are primary biomass otherwise cause environmental pollution due to disposal problems has main environmental Benefit of displacement of emissions associated with conventional power generation. These are considered as carbon neutral when used in a sustainable way since the CO_2 released during Combustion of these fuels was originally sequestered from the atmosphere. Andhra Pradesh and Odisha produce large quantities of primary agricultural -residues every year, which can be converted into energy. The constraints pertaining to the infrastructure and technicalities pose a Challenge for the utilisation of these resources, in addition to some critical environmental issues.

Under optimal growing conditions, terrestrial ecosystems (natural and agricultural) Produce about 3 tonnes ha^{-1} yr^{-1} (dry) making the total biomass about $60.8X10^9$ tonnes or $175X10^{15}$ Kcal yr^{-1}.This corresponds to about five times the total world's energy need. Agricultural Yields are aimed high due to increased demands of the population explosion and Self-sufficiency in food production. Subsequently, their residues like straws, stalk, haulms and Leaves are also generated in huge quantities. The worldwide energy generation capacity from agricultural residues (straw, animal slurries, green agricultural wastes) is estimated to be about 8800 MW. More than 1500 million tonnes of crop residues are produced annually in India, among which, straws of various pulses and cereals alone account for more than 1025 million tonnes^6.

Globally, in 2001, India was in second and third position in agro-residue generation with 42.79 %and 25.16% of the world's share of paddy and wheat straws respectively. It generated total paddy and wheat straw of 880.5 million tonnes occupying the second largest Producer (35.33%) status of these useful resources in the world7.Estimates indicate that even with the present utilisation pattern of these residues and by using the surplus biomass material More than 25000 MW of grid-quality power can be generated for decentrailsed applications.According to preliminary estimates, India has a biomass power potential of about 32,800 MW.

A consider proportion of the residues are wasted or handled inappropriately, Causing undesirable effects from an environmental, ecological and food production viewpoint. Andreae8 estimated that over 12 billion tonnes of agricultural residues are burned annually world Wide, while Smil9 estimated the total as between 5.0 and 6.4 billion tonnes, producing 6.1 to 7.7 billion tones/yr of CO_2.

Hence it is felt necessary to utilize these residues in India where agriculture is the prime occupation.

Energy generation with agricultural residues is cost-effective and economically Viable on sustainable basis. The results of typical numerical calculations indicate that Medium and large-capacity systems could be financially attractive for higher values of the Capacity utilisation factor. They involve lower capital costs as compared to conventional coal-based plants. A 1-MW biomass-gasifier-based power generation system (two units of 500 KW each),would cost about Rs 11 million as compared to Rs 45-50 million per MW for Coal-based power generation system in India10. The cost of electricity in a direct combustion Plant from rice husk was found to be 0.0243-0.0414 $/kWh for 1MW to 29 MW power Plant, where as it was 0.0610-0.1100$KWh for a coal/diesel fired power plant11 .

AGRICULTURAL RESIDUES GENERATION IN ANDHRA PRADESH AND ODISHA

The average annual production of major crop residues of A.P and Odisha from 1990-91 to 2000-2001 has been estimated by employing Residue to Product Ratio (RPR) and the data of total annual crop production. Fig.1 represents the year wise agro-residues generated in A.P. and Odisha states.

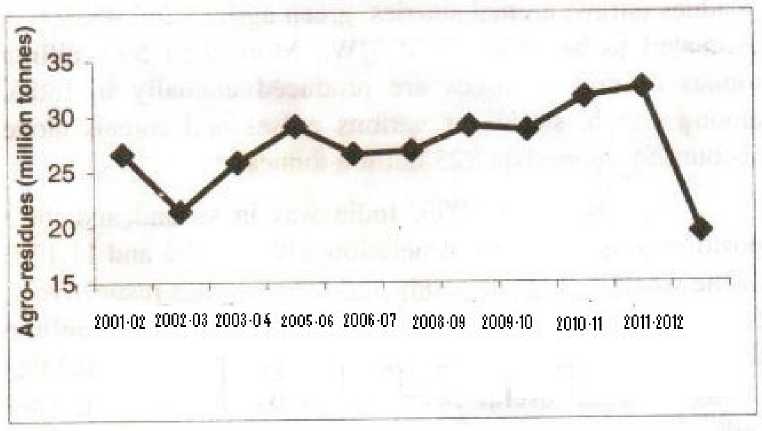

Figure 1.Agro-residue generation in A.P. Odisha (2001-02 to 2011-12)

It indicates that, more than 25 million tonnes of agro-residues are generated which can be beneficially utilized for energy generation (year 2000-01 is an exception, due to severe drought in the states).

Table 1 presents the details of the annual total crop residues generated in A.P and Odisha, which is about 27.094 million Tonnes12.Wheat has the greatest average potential of 10.8287 million tonnes of straw annually with a 37.25% share of the total crop residues. Soybean and gram occupy 2nd and 3rd positions with 4.1981(14.47%) and 2.2148 million Tonnes (8.16%) per year respectively. According to estimates12 ,there is a potential of more than 3100 MW from these major agro-residues of A.P. and Odisha. These huge quantities of agro-residues are of concern when they are neglected, under utilized and misused. Various constraints faced at different stages from generation to ultimate utilisation compel the framers to either their neglect or misuse. These are discussed to the Indian circumstances and to A.P. and Odisha in particular.

Biomass based power generation, which utilizes agricultural residues as feed stocks have been picking momentum in India with various installations in progress. Indian Renewable Energy Development Agency (IREDA) has financed 6 MW biomass power plants at Sirgitti Industrial Area,

Table 1: AGRICULTURAL RESIDUES GENERATION IN A.P. & ODISHA (2001-2012 MEAN)

Crop	Residue type	Average annual residue (Million Tonnes)
Paddy	Straw	2.0055
Maize	Straw	1.6876
Sorghum	Straw	1.2743
Bazra	Straw	0.1980
Wheat	Straw	10.8287
Red gram	Stalks	1.0889
Black gram	Straw/Stalks	0.1760
Bengal gram	Straw/Stalks	2.2148
Soybean	Straw/Stalks	4.1981
Groundnut	Haulms	0.5102
Sunflower	Stalks	1.9830
Mustard &Rapeseed	Straw	0.9224
	Total	**27.0875**

RESULTS AND DISCUSSION

The agro-residues for energy generation benefits the energy, agriculture and environment sectors. The following are salient benefits of agro-residues as input fuel source for power generation when they are utilized sustainably.

Agro-residues are renewable energy sources and their use does not contribute to global warming. In fact, they can reduce the atmosphere CO_2 levels.

Unlike coals, which contain about 5% sulphur, agro-residues as fuels have low sulphur content (0.10 to 1.00%),and therefore the biomass power generation emits little so214 .The combustion of agro-residues produces less ash(2-17%) than coal combustion (30-45%), and the ash produced can be used as a soil amendment for increasing agricultural productivity.

The conversion of agricultural residues for energy production is an effective management of waste disposal.

Biomass is a domestic resource, which is not subject to world price fluctuations or the supply uncertainties of imported fuels.

However, there are many issues and constraints in their utilisation for power generation. The constraints in utilisation of agro-residues for bio-energy generation are either related to the handling/infrastructure or technical. The former are basically related to the nature of the residues, which are handled from its generation at the farmers field to the utilisation as input at the power plant. The technical constraints are directly related to the bottlenecks in utilisation at the power plant and its resulting processing consequence.

HANDLING AND INFRASTRUCTURE

CONSTRAINTS

Location of the residues: Agricultural residues are more spatiality dispersed than fossil fuels. The major constraint that can hamper their utilization is remoteness of the centers of production and prohibitive costs of transport to other locations.

Collection: Collection of biomass residues is a labour intensive process that can be costlier .The time of availability of the agro-residues coincides with the season of the harvesting/threshing, which is a peak period of labour scarcity. Hence a proper mechanism should be evolved for collection of these residues.

Transportation: Different Agricultural residues are scattered in various districts of A.P. and Odisha because different cropping patterns followed in different regions based on the soil type, agro-ecological suitability of the crops and socio-economics. The high moisture content and low bulk density inhibit their economic transportation over long distances. The transport cost is a major component in the overall power generation cost. Economically viable catchment area for collection of these residues is a radius of 500-100km around a single plant 15 .Location of power plants at places close to concentrated sources of agro-residues can reduce the costs. The agro-residues can offer a sizeable biomass if infrastructure is developed to economically recover and deliver them to energy facilities.

Facilities and space: Agro- residues have a strong seasonal character and unless they can be stored, put a heavy burden on investment costs. Due to its low density and seasonality, extensive storage facilities are required. Hence the local infrastructure should be carefully looked into.

Other concerns: There are often political and institutional constraints to agro-residues utilisation, such as energy policies, taxes and subsidies that encourage the use of fossil fuels. As evidenced in most of the advanced nations, once the intensive utilisation of the agricultural residues starts, the farming community is ought to seek remuneration/charges proportional to the type, quality and quantity of their product. This factor needs to be considered and the concerned parties need an assurance in the form of agreements with involvement of the state agricultural department.

TECHNICAL CONSTRAINTS:

Seasonality: The different crop residues are available in either kharif or Rabi seasons. This seasonality of the residues necessitates the supplementation by other biomass resources for the power plant on a year-round basis without operational constraints. The processors for biomass utilisation need to be modified suitably for variations in the type of feedstocks.

Densification: The agricultural residues have low bulk density 0.1 to 0.2 g cm^{-3} [16] and occupy large space for storage and transportation. Hence, the size reduction either before or after transportation is a feasible solution to reduce the overall cost of power generation. Briquetting is practiced on a limited scale in A.P. and Odisha, mainly due to its high production cost. The use of electrical energy inputs for size reduction, transportation, agglomeration and moisture removal is estimated to be 20-150 kWh/tonne[13].

Alkali Fouling: Straws and grasses contain potassium and sodium compounds called alkalis and silica. In all the crop residues, alkalis are present, which during combustion, combine with silica and causes slagging and fouling problems at higher temperatures in conventional agro-residue combustion equipment. Volatile alkali also lowers the fusion temperature of ash. In conventional combustion equipment having furnace gas exit temperatures above 788^{0}C (1450 ^{0}F), combustion of agro-residues causes slagging and deposits on heat transfer surfaces, reducing the efficiency of the boilers. Fuels having the ratio $(Na_2O+K_2O)/SiO_2$ above 2.0 require special precautions to avoid fouling problems. If the ratio is below 0.2, precautions must be taken to avoid erosion, which can occur from the

Table 2: Analysis of AGRO-RESIDUES for determination of AlKALI FOULING properties

S.No	Biomass fuel	Composition(%)				$(Na_2O+K_2O)/SiO_2$
		Ash	Na_2O	K_2O	SiO_2	
1	Bagasse	3.5	0.86	3.52	54.00	0.08
2	Cotton stalks	4.6	2.00	30.00	8.40	3.81
		3.16	1.37	21.40	33.00	0.69
3	Maize straw	3.99	0.41	30.25	33.80	0.91
4	Maize cobs	1.20	1.19	2.04	40.30	0.08
5	Mustard straw	9.73	2.79	19.01	11.15	1.96
6	Rice husk	23.4	0.10	1.20	95.60	0.01
		18.15	0.88	1.54	92.10	0.03
7	Rice straw	13.4	1.10	8.00	79.80	0.11
		18.16	0.62	11.32	75.93	0.16
		20.20	0.70	5.70	80.70	0.08
8	Sunflower stalks	11.20	0.26	24.67	4.90	5.09
		3.50	3.10	27.50	3.10	9.74
9	Wheat straw	8.9	0.30	6.60	78.20	0.09
		6.21	0.56	17.07	51.51	0.34
		5.90	0.70	25.30	30.60	0.85

High silica content18 .For a detailed evaluation of such a constraint, the alkali compositions of different agricultural residues ashes are adopted from various references[19,20,21] and the $(Na_2O+K_2O)/SiO_2$) ratios are calculated.

Table 2 gives an account of the major alkalis present in biomass fuels and represents their fouling behaviour.Specially designed boilers with lower furnace exit temperatures could reduce slagging and fouling.

Low-temperature gasification may be another method of using these fuels for efficient energy production. Pacific Northwest laboratory (USA) has developed a catalytic reactor system of the thermochemical gasification of high –moisture biomass feed stocks such as energy crops, agricultural residues, aquatic biomass and food processing wates.The reactor system was operated at low temperature, 350 ^{0}C to 450 ^{0} C and high pressure,2000-5000 psig. The catalyst was a reduced nickel metal on a silica-alumina support which was sometimes used in combination with sodium, carbonate. Results of batch reactor tests showed >95% carbon conversion in producing a product gas consisting essentially of CH_4 and CO_2[22] .

ENVIRONMENTAL ISSUES

Bioenergy technologies are friendlier to the environment than conventional energy technologies, which rely on fossil fuels. Fossil fuels combustion contributes significantly to may of the environmental problems like greenhouse gases, air pollution and soil-water contamination. The agro-residue based energy technologies help us deviate from conventional pattern to converse the quality of our environment. Since crop wastes are the by product of existing agricultural activity and are essentially a biomass, which is carbon-netural, therefore, the use of these wastes does not adversely affect the environment. Replacement of fossil fuels with biofuels provides the other major biological opportunity for CO_2 mitigation. Besides this, as reported by Sampson et al.23, a consensus estimate by a panel of experts estimated that before the end of the next century about 4 to 16 Gt per year of CO_2,20% to 80% of current fossil CO_2 emissions, could be mitigated world-wide through replacement of fossil fuels with biofuels.

Disposal Issues – a case of burning crop residues

The agro-residues utilisation for power generation reduces the problem of waste disposal, particularly in rural and semi-urban areas. The crop wastes might otherwise be landfilled or subject to open burning .Open burning of the crop residues is a loss to the soil system as well as damage to the environment causing worse pollution. Crop residues contain about 1% nitrogen,0.2% phosphorus and 1.2% potassium. When burned, the nitrogen releases in to the atmosphere and some phosphorus and potassium are retained in the ash. As estimated 70-80% of these nutrients are lost when the fine particulate matter is dispersed into the atmosphere during burning process 5 .Air borne particulates also cause severe health hazards.

Eco-friendly Recycling of Carbon

Unlike the carbon in fossil fuels, the carbon in agro-residues is already part of the atmosphere's carbon cycle. Whatever the ultimate fate of this biomass organic matter whether burned or allowed to decay the carbon will be recycled. The carbon in fossil fuels when burned adds to the existing stock of atmospheric carbon. If allowed to decay, all forms of crop-residues also release methane, which is approximately 21 times more damaging than CO_2 over a 100 year time horizon when it comes to global warming. Burning this organic matter in a power plant, therefore, can help reduce the global climate change threat.

UTILIZATION OF AGRO-RESIDUES

Soil and Water Conservation

Biomass fuels have negligible sulphur content and therefore do not contribute to SO_2 emissions, which cause acid rain. The combustion of biomass generally produces less than coal combustion, and the ash produced can be used as a soil additive on farm land to recycle material such as phosphorous and potassium. Consideration for straw removal should first evaluate the soil erosion risk due to water and wind and its associated long-term yield reductions that are difficult to alleviate.

TABLE-3: C ROP RESIDUE NEEDED FOR WATER EROSION CONTROL

Field slope		Cereal residue needed (Kg/ha)
Gentle	: 6-9%	784-1120
Moderate	: 10-15%	1120-1680
Steep	: 16-30%	Continuous grass
Very steep	: >30%	Native vegetation

Bare soils are especially vulnerable to erosion, which generally require more than 30% of the soil surface cover by crop residues, which amounts to about 896-1120 Kg/ha (800-1000 1b/acre)for cereals. Surface crop residues reduce the splash sheet erosion. They also increase the infiltration rate thereby reducing runoff and erosion. Table 3 represents the minimum amount of crop residue needed to prevent water erosion depends on the soil, crop, tillage system and slope characteristics. Removal of straw is discouraged if the risk of wind or water erosion is moderate to server. On deep black soils and highly fertile lands, straw removal once in a 3-4 year rotation is an option. On other soils, straw removal would be less economic or not recommended. Crop residues cover conserves the soil moisture and reduces evaporation. Farmers in drought-prone areas should retain considerable quantities of crop residues.

SOIL ORGANIC MATTER MAINTENANCE

Incorporation of agro-residues build up the soil organic matter to maintain its productivity level, which ultimately essential for food grain production and biomass generation. Hence the diversion of the quantity of the organic matter should take account the total organic carbon level required for the specific purpose of the soil. However the net value of residues remains elusive. Hence, for low organic matter soils, retaining crop residues is very important to maintain sufficient soil organic matter. For soils with high organic matter, the annual addition of straw may not always be critical.

COMPETITION FROM OTHER USES

The agricultural residues like straws and stalks are the by-products of harvesting of seasonal crops. These are presently utilized partially for the uses like bedding for the livestock and poultry, partial substitute as feed to the animal husbandry, particleboard industry, local firewood etc. The utilisation of the agro-residues may face a competition from the above utility areas, which needs a critical consideration since the sustainability of the above existing activities is also a pre-requisite for the sustainability of the agricultural system. Thus the value of straw and stalks differs greatly from area to area. Framers sometimes struggle with the decision to sell straw to improve their short-term economic returns or to retain straw to sustain the soil's long-term productivity. Hence a strategy should be evaluated keeping in view of the product requirement of the farming community, existing utilisation pattern and future utilisation requirements on commercial basis for biomass energy generation.

CONCLUSIONS

The agro-residue based bioenergy technologies could help us break our conventional pattern of energy use to improve the quality of our environment. Use of these wastes does not contribute to pollution, environmental degradation and global warming. Agro-residues are potentially carbon neutral and they can reduce the atmospheric levels of carbon dioxide, as they act as sink and soil carbon can also increase.

Hence a balance should be maintained for retention of these residues and diversion for alternate uses like energy generation. The utilisation of the agro-residues may face a competition from the existing utility areas.

REFERENCES:-

1.Stanton, T.(1995) Biomass energy: It's not just for breakfast anymore. Lansing,MI: Michigan Biomass Energy Program, Michigan.
2.Anderson M.,M. Drisch, M. Oden and L. Pederson (1985) Biomass resources: Generating jobs and energy. Lansing ,MI: Employment Research Associates.
3.Brower M., M. Tennis, E. Denzler and M. Kaplan (1993) Powering the Midwest: Renewable electricity for the economy and environment. Washington, D.C.: The Union of Concerned Scientists.
4.Twidell J.(1998) "Biomass energy" ,Renewable Energy World,1(3):38-39
5.Pimental David (2002) limits of Biomass Utilisation, Encyclopedia of physical Sciences and Technology (III Ed.) Academic Press B., Vol 2, pp2-3.
6.TERI (2001).Survey of Renewable Energy in India .Tata Energy Research Institute (TERI) Project Report No.2000:RT45.
7.Mantains G. (1999). Worldwide availability of agri wastes, MARLIT ltd., Greece.
8.Andreae M.O (1991). Biomass burning: Its history,use and distribution and its impacts on the environmental quality and global change,in: J.S. Levine (ed) Global Biomass Burning.
9.Smil V., (1999). Crop Residues: Agriculture's largest Harvest, Bio-Science, 49(4):299-308.
10. Arun Kumar Tripathi, P.V.R Iyer and Tata Chandra Kandpal (1997) A Financial evaluation of Biomass

gasifier based power generation In India,Bio-Resource Technology ,61:53-59.
11.Bhattacharya S.C,M.Arul Joe,Zahed Kandhekar ,p.Abdul Salam and R.M.Shreshta (1999) Greenhouse-gas emission mitigation from the use of agricultural residues: the case of rice husk,energy,24:43-59.
12.Murali S (2003), Assessment of Biomass Energy Potential of Agricultural Residues – A Case Study,M.Tech.Thesis, Maulana Azad national Institute of Technology ,Bhopal,August,p 47.
13.MNES Annual Report: 2002, Ministry of Non Conventional Energy Sources (MNES), Government of India, New Delhi, India.
14.EERE (2006) Biomass Program: Environmental Benefits Energy Efficiency and Renewable Energy, U.S. Department of Energy, (http://www1.eere.energy.gov/biomass/environmental.html).
15.ETSU (1994) Emissions from Biomass Electricity Generation ,ETSU Report 2919,ETSU,Harwell.Oxford.
16.Grover P.D. and S.K. Mishra (1996) Biomass Briquetting:Technology and Practices, Regional Wood Energy Development Programme in Asia: Field Document No.46,FAO(UN).
17.Rajvanshi Anil K (1985) Potential of briquettes from farm residues as rural energy source, in briquettes from agricultural and forestry wastes. Construction on Rural Technology, New Delhi.pp 113-134.
18. Vamvuka D and D. Zografos (2004) Predicting the behavior of ash from agricultural wastes during combustion, Fuel, 83:2051-2057.
19.ICE (2001) BIOBIB data base: Fuel and Environmental Technology,Institute of Chemical Engineering ,University of Technology ,Vienna Austria .
20.Hall W. Carl and Kitani Osamu (1989) Biomass Handbook,Taylor and Francis Publishers ,New York,US.
21.Gaur Sidhratha and Thomas B. Reed (1995) An atlas of thermal data of Biomass and other Fuels.NREL/TP-433-7965.
22.Elliot D.C..,R.S. Butner and J.Sealock Jr.(1988) Low temperature gasification of high-moisture biomass,proc.Internaional conference on Research in hermochemical biomass conversion :2-6 May : Phoenix Arizona ,USA ,pp1-6.
23.Sampson, N.R., L.L. Wright ,J.K. Winijum, J.D. Kinsman,J.R. Beneman, E. Kursten, and J. M. O Scurlock (1993) Biomass Management and Energy ; Water, Air and soil Pollution,70:129-141.

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