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Potential of wastelands for mixed farming system in India

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Abstract
The paper presents estimated potential of wasteland for biomass production from selected categories *i.e.,* under-utilized/degraded forest (scrub dominated), under-utilized/ degraded forest (agriculture), degraded pastures /grazing land and degraded land under plantation crops. A mathematical model was developed to estimate wastelands potential for green fodder production. These categories of wastelands account for 23 % of total area under wastelands (47 million ha) of the country. Study estimated that at national level, selected categories of wastelands have potential to produce 16 million tonnes of green fodder, an additional quantity other than cultivated green fodder and grass from grazing area. The selected categories of wastelands in Madhya Pradesh, Andhra Pradesh, Maharashtra and Rajasthan have potential to produce more than 50% of total fodder production from wastelands. With scarce information on potential of wastelands in terms of fodder production, these estimates can serve an important input into policy making particularly wastelands development programmes in different parts of the country.

Key words: Fodder potential, Fodder yield, Wastelands

Introduction

India is a home of around 16% of the world population, while its land is only 2% of the total geographical area of the world. Obviously, the population pressure on the land is more than its carrying capacity. As a result, the productive lands, particularly the croplands in the country are in the constant process of different types of degradation and converting into wastelands. The spatial extent of wastelands was estimated at 47.22 million hectares, constituting 14.91 % of total geographic area of the country (Wastelands Atlas of India, 2011).

India has one of the largest livestock populations in the world. According to the FAO estimate, in 2007 India had 16.6 % of world's large ruminants (277 million), 9.9 % small ruminants (190 million), 3.0 % poultry (560 million) and 1.5 % pigs (14 million). The livestock and fisheries sector contributed over 4.07 % to total GDP during 2008-09 and about 26.84 % value of output for total agriculture and allied activities and providing gainful employment to nearly around 22.4 million working population in both principal and subsidiary status (Anonymous, 2008-09). It is the main source of income to farmers particularly of arid and semi-arid regions in the country where crop failure is the recurrent phenomenon.

One of important characteristics of mixed farming system is that livestock receives its entire feed in the form of crop residues and byproducts; grasses and green fodder collected from cultivated, uncultivated lands and through grazing on common lands. Out of total fodder consumed by livestock, about 33% is sourced from pastures, public lands, wastelands, fallows and forests (Dikshit and Birthal, 2010). Trends in area under cultivated green fodder indicated that land allocation to cultivation of green fodder crops is limited and has hardly ever exceeded 5 % of the gross cropped area (Anonymous, 2009), and there is a gap between demand and supply of livestock feed (Anonymous, 1976; Singh and Mujumdar, 1992; Ramachandra et al., 2007). As per report of the working group on Animal Husbandry & Dairying 12th five year plan (2012-17), despite the increase in availability of dry fodder, concentrates and green fodder over the last two decades (1985-86 to 2005-06), the gap between availability and requirement of dry fodder, concentrates and green fodder currently is 10, 33 and 35 % respectively. Major concern is the stagnation in the availability of green fodder and its increasing deficit over the years.

Lack of quality feed and fodder leads to under exploitation of livestock production potential (Birthal and Jha,

2005). Moreover, strategic utilization of available feed resource and enrichment in terms of nutritive value of poor quality roughages and exploitation of newer non-conventional feed resource would be the key issues for making the livestock system more remunerative (Ramchandra *et al.,* 2007*).* Furthermore, diversion of acreage from traditional to cash crops due to higher returns from per unit of land, is a matter of concern. Studies indicate that if the present scenario continues, there would be a scarcity of feed and fodder availability in the years to come. Cultivated green fodder occupies merely 5 % of country's gross cropped area and there is very little scope to deploy additional land for this purpose. Moreover, shrinking common property resources like permanent pastures and grazing lands *etc.* are the other major concern. The roles of these common property resources are more important in the states where there is preponderance of landless and marginal holdings.

The significance of all kind of alternative sources of green fodder namely wastelands, degraded lands *etc.* has continued to be strong to meet out surging feed demand for livestock. Apart from biomass production, wastelands can also generate assets and employment opportunities. Study conducted in Karnataka (Singh, 1999) reveals that wastelands (ravines and sodic lands) development can provide employment opportunities to 4.92 lakh man years in agriculture and afforestation annually and availability of work in local would check the labour migration. An effort in this direction will not only harness the full potential of available land resource particularly livestock production but also prevent from its further degradation.

In this paper, we have provided state wise and all India estimates of potential of green roughages production from selected categories of wastelands. This study makes an important contribution towards understanding utilization of wastelands for animal feed, the information on which is scarce. The inferences drawn from present study would help in planning to formulate livestock and wastelands development programmes in the country.

Materials and Methods

Wastelands atlas of India (2011) and wasteland maps (2005-06), provides statistics on the area under wastelands during 2003, 2005-06 and 2008-09. Wastelands of our country are divided into 23 classes based on pilot studies carried out by National Remote Sensing Agency (NRSA) and Central Arid Zone Research Institute, Jodhpur.

Out of 23 classes, 4 classes namely under-utilized/ degraded forest (scrub dominant), under - utilized/ degraded forest (Agriculture), degraded pastures/grazing land and degraded land under plantation crops have been considered as potential for fodder production under the present study. Hence, an attempt has been made to explore the potential of these wastelands as a source of green forage for livestock. Area under selected categories of wastelands has been used to calculate green fodder production.

Now, the critical question is: what is the productivity of green fodder of the selected categories of wastelands? Way back in 1970s the Committee on feed and fodder (Anonymous, 1976) had assumed 1.0 tonnes/ hectare of green forage available from area under permanent pasture and grazing lands. In the year 2003 Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India (Anonymous, 2008-09) assumed a productivity rate of 0.75 ton / hectare from permanent pasture and grazing lands. This reduced productivity assumption in comparison to 1970s appears reasonable in view of the likely degradation of pastures due to increased livestock pressure. However, The National Institute of Animal Nutrition and Physiology (NIANP) in their 'Feed Base' have assumed 1.5 tonnes/hectare for forest and 5.0 tonnes/hectare for permanent pasture and other grazing lands (Anonymous, 2001-02).

Present study uses yield of green forage, 1.5 tonnes/ hectare for under-utilized/degraded forest (scrub dominant) and under- utilized/degraded forest (agriculture) while, 0.75 tonnes/hectare for degraded pastures/grazing land and degraded land under plantation crops.

Green forage production from a selected category of wasteland was estimated as the product of area under that category of wasteland and its yield of green forage. Following procedure was adopted to estimate the green forage production from selected categories of wastelands:

$$TGF_{wl} = (a_{wl1} * y_1) + (a_{wl2} * y_1) + (a_{wl3} * y_2) + (a_{wl4} * y_2)$$

Where;

TGF_{wl} = Total green forage production from all selected categories of wastelands

a_{wl1} to a_{wl4} are acreage under different categories of wastelands.

y_1 and y_2 are, respectively green forage yield of selected categories of wastelands.

Summing up the production from selected categories of wastelands will give total green forage production.

Results and Discussion

Trends in area under wastelands

According to wastelands atlas of India 2011, country has 46.70 million hectares of wastelands which accounts for 14.75 % to total geographical area in the year 2008-09. Trends in area under wastelands at country level indicated that the share of wastelands to total geographical area has declined from 17.6% to 14.7% between 2003 and 2008-09. State wise area under wastelands, its share to total geographical area and livestock density per hectare of wastelands are given in Table 1.

In the year 2008-09, J&K reported 74% its geographical area under wastelands followed by Sikkim (46%), Himachal Pradesh (40%), Nagaland (32%) however Manipur, Rajasthan, Uttarakhand and Mizoram have more or less 25% of its area under wastelands. The high presence of wastelands in J&K and Himachal Pradesh is due to snow cover and degraded forest whereas; Nagaland, Manipur, Mizoram and Sikkim are due to shifting cultivation and degraded forests. The reason of high share of wastelands in Rajasthan (25%) is sandy area. The states namely Uttar Pradesh, Karnataka, Tamil Nadu, Kerala and West Bengal have less than 10% of area under wastelands.

Table 1. Trends in wastelands **Area: '000 Ha**

States	Total Geographical Area (TGA)	2003		2005-06		2008-09		CAGR (%) 2008-09 over 2003	Livestock Density*
		Waste-land Area	% to TGA	Waste-land Area	% to TGA	Waste-land Area	% to TGA		
Andhra Pradesh	27507	4527	16.5	3879	14.1	3730	13.6	-3.2	16
Arunachal Pradesh	8374	1818	21.7	574	6.9	1490	17.8	-3.3	1
Assam	7844	1403	17.9	878	11.2	845	10.8	-8.1	20
Bihar	9417	544	5.8	684	7.3	960	10.2	9.9	32
Chhattisgarh	13519	1130	8.4	1182	8.7	1148	8.5	0.3	13
Delhi	148	7	4.6	8	5.6	9	6.1	4.3	46
Goa	370	53	14.4	50	13.4	49	13.2	-1.3	4
Gujarat	19602	2038	10.4	2135	10.9	2011	10.3	-0.2	12
Haryana	4421	327	7.4	235	5.3	215	4.9	-6.8	41
Himachal Pradesh	5567	2834	50.9	2247	40.4	2235	40.1	-3.9	2
Jammu and Kashmir	10139	7020	69.2	7375	72.8	7544	74.4	1.2	1
Jharkhand	7971	1117	14.0	1167	14.6	1102	13.8	-0.2	16
Karnataka	19179	1354	7.1	1444	7.5	1303	6.8	-0.6	24
Kerala	3886	179	4.6	246	6.3	245	6.3	5.3	15
Madhya Pradesh	30825	5713	18.5	4004	13.0	4011	13.0	-5.7	10
Maharashtra	30769	4928	16.0	3826	12.4	3783	12.3	-4.3	10
Manipur	2233	1317	59.0	703	31.5	565	25.3	-13.2	1
Meghalaya	2243	341	15.2	387	17.2	413	18.4	3.2	4
Mizoram	2108	447	21.2	602	28.6	496	23.5	1.7	1
Nagaland	1658	371	22.4	482	29.0	527	31.8	6.0	3
Odhisha	15571	1895	12.2	1665	10.7	1643	10.5	-2.4	14
Punjab	5036	117	2.3	102	2.0	94	1.9	-3.6	79
Rajasthan	34224	10145	29.6	9369	27.4	8493	24.8	-2.9	7
Sikkim	710	381	53.7	328	46.2	327	46.1	-2.5	1
Tamil Nadu	13006	1730	13.3	913	7.0	872	6.7	-10.8	35
Tripura	1049	132	12.6	132	12.5	96	9.2	-5.1	19
Union Territories	949	25	2.6	34	3.6	32	3.3	3.9	17
Uttar Pradesh	24093	1698	7.1	1099	4.6	988	4.1	-8.6	61
Uttarakhand	5348	1610	30.1	1279	23.9	1286	24.0	-3.7	4
West Bengal	8875	440	5.0	199	2.3	193	2.2	-12.8	194
All states	316641	55641	17.6	47226	14.9	46702	14.7	-2.9	11

*Livestock density/ hectare of wastelands (2008-09); **Source:** Area under wastelands from Wasteland atlas of India, 2011 and Wasteland maps, 2005-06, Livestock population from Anonymous, 2007 (18th Livestock census, 2007).

Area under wastelands in western region namely Rajasthan, Gujarat, Madhya Pradesh and Maharashtra varies from 10 to 25 % of their geographical area. Punjab has less than 2 % its area under wastelands.

To study change in area under wastelands, compound annual growth rate between 2003 and 2008-09 have been worked out. Negative sign shows decline in wasteland while positive values indicate increase in area under wastelands between the two points of time. States namely Manipur, West Bengal, Tamil Nadu, Uttar Pradesh, Haryana and Madhya Pradesh have shown negative growth which indicates wastelands becoming non-wastelands in these states. However, Bihar, Nagaland, Kerala and J & K have shown positive growth between the years 2003 and 2008-09. This indicated that non-wastelands becoming wastelands in these states. Annual growth at country level has been worked out to be (-) 3% during the same period.

At the country level, density of livestock was about 11 animals per hectare of wastelands (table 1). It was found lower in Western Himalaya regions and North eastern states. This may be due to high availability of wastelands and low livestock population in these states. Density of livestock varies from 7 to 12 animals per hectare of wastelands in the states namely Rajasthan (7), Madhya Pradesh (10), Maharashtra (10) and Gujarat (12). The highest density was noticed in West Bengal *i.e.* 194 animals followed by Punjab (79), Uttar Pradesh (61), Bihar (32), Haryana (41), Tamil Nadu (35) and Bihar (32).

Table 2. Production of green roughages in wastelands (2008-09) ('000 Metric tonnes)

States	Under-utilized/ degraded forest (Scrub dominated)	Under-utilized/ degraded forest (Agriculture)	Degraded pasture /grazing Lands	Degraded land under plantation crop	Total
Madhya Pradesh	1862.6	462.7	1.5	0.0	2326.8
Andhra Pradesh	1926.6	261.6	9.9	2.6	2200.7
Rajasthan	1644.4	24.0	257.9	0.1	1926.3
Maharashtra	1493.5	180.9	11.2	0.0	1685.6
Odhisha	768.4	251.6	0.1	0.0	1020.1
Chhattisgarh	443.2	539.5	0.0	0.0	982.7
Karnataka	770.1	114.7	0.5	0.6	885.9
J & K	774.8	33.3	9.2	3.7	821.0
Jharkhand	683.3	93.1	0.0	0.0	776.5
Tamil Nadu	378.0	11.4	70.1	2.4	461.8
Assam	139.4	309.5	0.2	0.0	449.1
Gujarat	269.5	36.7	1.1	3.6	310.9
Uttar Pradesh	276.5	9.6	0.7	0.9	287.8
Himachal Pradesh	190.8	0.0	12.3	0.0	203.2
Arunachal Pradesh	179.7	0.6	16.5	0.0	196.8
Bihar	163.6	7.0	2.6	0.1	173.3
Uttarakhand	118.4	8.2	38.4	0.0	165.0
Kerala	84.0	0.0	15.6	0.0	99.6
Haryana	20.3	1.5	64.5	3.9	90.2
Mizoram	83.7	0.1	0.0	0.0	83.8
West Bengal	76.4	0.7	0.0	0.2	77.2
Manipur	74.3	0.4	0.0	0.0	74.7
Tripura	57.7	2.5	0.0	0.4	60.6
Union Territories	37.8	0.0	0.0	0.0	37.8
Meghalaya	10.3	0.1	0.0	0.0	10.4
Goa	8.5	0.5	0.0	0.8	9.8
Sikkim	9.2	0.0	0.0	0.0	9.2
Punjab	9.1	0.0	0.0	0.0	9.2
Nagaland	0.0	2.0	0.0	0.0	2.0
Delhi	1.0	0.0	0.0	0.0	1.0
All India	12555.0	2352.0	512.4	20.9	15440.3

The high pressure of livestock in these major dairy states is major concern particularly for landless and marginal dairy farmers who depend upon these lands for fodder.

Trends in wastelands area indicated that area under wastelands is continuously declining in majority of the states. This may possibly due to increase in pressure on land, shifting cultivation to permanent cultivation particularly in North-Eastern states, reduction/elimination of Rann of Kutch in Gujarat and implementation of watershed programme.

Potential of wastelands in terms of forage production

Present study is confined to biomass production from selected categories of wastelands *i.e.* under-utilized / degraded forest (scrub dominated), under-utilized/ degraded forest (agriculture), degraded pastures/grazing land and degraded land under plantation crops.

These categories of wastelands accounts for 23% of total wastelands of the country in the year 2008-09. Estimated potential of wastelands in terms of production of green fodder from selected categories of wastelands is given in Table 2.

Quantum of fodder that can be produced from selected categories of wastelands about 15.4 million tonnes. Out of which 81 % fodder would come from under-utilized/ degraded forest (scrub dominated) followed by under-utilized/degraded forest (agriculture) 15 %, degraded pastures/grazing land (3.3 %) and degraded land under plantation crops (< 1 %). Wastelands of Madhya Pradesh, Andhra Pradesh, Rajasthan and Maharashtra together have potential to produce about 8.1 million tonnes of green fodder which is around 53 % of total green production from wastelands. Wastelands in Odisha, Chattisgarh, Karnataka, Jharkhand and J&K may have potential to produce fodder varies from 0.78 to 1.02 million tonnes.

Wastelands in other important milk producing states namely Uttar Pradesh, Gujarat, Bihar, Tamil Nadu, Haryana, Kerala, West Bengal and Punjab have the potential to produce less than 1.5 million tonnes of fodder this may be due to less availability of selected categories of wastelands in these states.

It is clear from the above analysis that 81 % of the total fodder would come from under-utilized/degraded forest (scrub dominated) and under-utilized/degraded forest (agriculture) due to their lion share (79 %) to total area under selected categories of wastelands and relatively high productivity rate. It is pertinent to mention here that majority of the states have no area under rest of the categories under consideration.

Conclusion and Implications

In this paper we have estimated potential of selected categories of wastelands in terms of fodder production. At all India level wastelands may supply 15 million tonnes of fodder, an additional quantity other than cultivated fodder and gleaning of grass from grazing area which includes cultivable waste, current fallows, miscellaneous trees, other fallows and permanent pastures and grazing lands. Note that, there is hardly any information on potential of wastelands in terms of fodder production, and these estimates can serve an important input into policy making particularly wastelands development programmes in different parts of the country.

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