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Research Article

BIOMASS AND ENERGY DYNAMICS IN DADHIBAMANPUR VILLAGE ECOSYSTEM OF CUTTACK DISTRICT OF THE BANK OF RIVER MAHANADI, ODISHA, INDIA

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ABSTRACT: The village of Dadhibamanpur in Baiyalish Mouza of Cuttack district, Odisha which is agriculture based of the bank of river Mahanadi was studied as an ecosystem during 2012 - 2013. In this study, biomass energy productions and consumption patterns of the village ecosystem of Dadhibamanpur were studied in the bank of river Mahanadi, Odisha, India. The Dadhibamanpur village has population of 472 of which 255 are males while 217 are females as per Population Census 2014. Annual crop yield was 934.34t on 275ha of land. Annual energy consumption in terms of food was 278.4GJ and energy expenditure for agricultural, domestic and other daily activities in the village ecosystem. Based on the energy-flow and large dependence on agriculture land (mainly agriculture biomass for sale along with minor products), the village Dadhibamanpur was accomplished to be an open agriculture land dependent based village ecosystem. The energy flow was also developed for the Dadhibamanpur village ecosystem.
Key words: Village Ecosystem, Biomass, Energy Flow, Dadhibamanpur, Agriculture.

INTRODUCTION

About 534,654 lakhs people belonging to Cuttack district areas of Odisha. They depend mostly on agriculture land for their survival and still operate with the traditional practice of Rice, Dal and Vegetables agriculture in the agriculture land. The agriculture food products and agricultural biomass yields the basic energy demands of the people [1, 2].

The Mahanadi system supplies water to the existing canals of the Mahanadi Division at Cuttack. To supply water to the canals of this system, three anicuts have been constructed. One of them is at Naraj (1,169 meters) at the head of the Kathajori, which serves as feeder anicut by diverting the water to the Mahanadi. The other two are at Jobra (1,936 meters) on the Mahanadi and at Choudwar over Birupa (604 meters). The anicuts help in making an artificial detention reservoir at the apex of the delta [3, 4].

Dadhibamanpur is a Village of Baiyalish Mouza in Cuttack Tehsil in Cuttack District of Odisha State, India. It is located 5KM towards South from District head quarters Cuttack, 24 KM from State capital Bhubaneswar. Dadhibamanpur Pin code is 754031 and postal head office is Barambagarh. Dadhibamanpur is surrounded by Baranga Tehsil towards South, Tangi Choudwar Tehsil towards North, Balianta Tehsil towards South and Bhubaneswar Tehsil towards South. Cuttack, Bhubaneswar, Dhenkanal, Jagatsinghapur are the nearby Cities to Dadhibamanpur. This Place is in the border of the Cuttack District and Khordha District. Khordha District Balianta is South towards this place.

In India, some work on agriculture and marine based village ecosystems has been con- ducted, whereas studies of village ecosystem of the bank of river Mahanadi, Odisha, India is scanty. The aim of the present study is to evaluate the relationship between the village ecosystem of the bank of river Mahanadi and the agriculture resources in terms of biomass and energy in village ecosystem with reference to land use, productivity, consumption and import-export status of biomass resources.

STUDY SITE AND ENVIRONMENT

Location

The study was carried out in village Dadhibamanpur of Cuttack district, Odisha, India which is situated at Latitude 20.4124503 and longitude 85.9261584 and 6.5km away from Cuttack railway station (Fig. 1).

Figure 1: Map showing the study site (Images courtesy: Various sources at http://www.images.google.com).

Climate

The study site experiences a monsoon climate and the total annual rainfall during 2012-2013 was 1501.3mm. Three seasons, namely, the summer (February-May), the rainy (June- September) and the winter (October-January) are experienced during the year. The average annual solar insolation (6.3 GJ m^{-1}) for Bhubaneswar (at a distance of 29km), the nearest meteorological station, was used due to the lack of local facilities.

Soil

Soil samples collected from different areas of the village at the beginning of the study were analyzed for water holding capacity (brass box method) and pH while moisture content was measured seasonally (gravimetric method). Red, mixed red and black soils are found in this block. The soil reaction (pH) varies from 4.92 – 8.04 and the mean is 6.07. Therefore most of the soils are acidic. The soil organic carbon varies from 0.13 – 1.49(%) and the mean is 0.53%. Therefore the soils are medium in organic carbon content. The available nitrogen varies between the ranges from 110.2 – 208.7 (Kg/h) and the mean is 150.3 Kg/h. So, the soils are low in available nitrogen. The available phosphorus varies from 1.47 – 29.64 (Kg/h) and the mean is 5.58 Kg/h [5, 6].

Population

The total human population was 472 (December, 2013) in 67 families with male: female ratio of (255:217)1: 1.05 (Table-1). The livestock consisted of 198 cows, 12 bullocks, 23 goats, 205 poultry, 50 Duck, 19 pig and 19 buffalo respectively (Table 2).

Table 1: Human population and body weight of the village Dadhibamanpur during the year 2013.

Age (group) years	Male			Female		
	Total population	Average wt (kg)	Total wt (kg)	Total population	Average wt (kg)	Total wt (kg)
0-2	21	5.1 ± 1.7	105	19	6 ± 2.8	114
2-5	34	15.0 ± 1.7	510	27	14 ± 2.5	378
5-10	21	25.0 ± 0.8	525	19	21 ± 1.2	399
10-15	25	39.0 ± 6.3	975	23	27 ± 2.4	621
15-25	45	45.0 ± 1.3	2,025	42	30 ± 1.3	1260
25-40	62	69.0 ± 2.7	4,278	49	45 ± 1.4	2,205
40-55	23	74.0 ± 0.5	1,702	21	62 ± 1.2	1,302
Above 55	24	70	1680	17	67 ± 1.5	1,139
Total	255	-	11,800	217	-	7418

± SEM. Total Population - 472, Total Human Biomass - 6.56t

Table 2: Livestock population and body weight in Dadhibamanpur village ecosystem during the year 2013

Animals	Population	Average wt (Kg head^{-1})	Total wt (kg)
Cow	198	124 ± 2.2	24,552
Bullocks	12	264 ± 5.5	3,168
Goats	23	25.3 ± 6.1	575
Poultry	205	2.1 ± 5.3	410
Duck	50	4.2 ± 2.1	200
Pig	19	30 ± 2.4	570
Buffalo	19	158 ± 5.1	3,002
Total	526	-	32,477

People

The people of Dadhibamanpur belong to the farmer. They maintain their life through cultivation on agriculture and marketing. Literacy rate in the village was about 41% male and 27% female. The village was selected for the study because of its (i) Considerable population and land area in the region, (ii) Location in the bank of Mahanadi River making access easy, and (iii) typical structural and functional characteristics of a village.

Methods

The study was undertaken from July 2012 to June 2013; methodology included survey work through questionnaires and field observations followed by laboratory experiments. In addition to continuous stays for more than 5 days during each season, the village was visited a minimum of once in a week. During each visit questionnaires were filled in and sample weighing was done in the field. The necessary samples were brought to the laboratory for analyses [7-11].

The village area and land classification data were obtained from Revenue and Forest records confirmed through cross-checks in some cases. Al1 the households of the village were considered for the study.

RESULTS AND DISCUSSION

Land use Pattern

The village ecosystem covers 475ha of land consisting of 65.3% cropland, 21.7% wasteland, 10% grassland / grazing land and 3% housing settlement. Rice and Dal agriculture is a common practice and hence the total area under cultivation differs from year to year.

Cropping Pattern

Crop cultivation was restricted to the wet period (rainy and winter) during which soil moisture was available. The crops raised were cereals (Rice), legumes (Dal) and seasonal vegetables (brinjal, tomato and gourds). Most of the cereals and legumes were grown on bank of Mahanadi River whereas vegetables were grown in the valleys. Lack of suitable flatland prevents paddy cultivation in the village ecosystem.

Biomass and Productivity

The plant biomass of the Dadhibamanpur village ecosystem includes agricultural products. Table - 3 shows crop productivity during 2012 - 2013. Total annual agricultural crop production was 934.34t. Productivity ranged from a minimum 0.21 t ha^{-1} for vegetables to a maximum of 4.7 t ha^{-1} for Rice (Table-3). Disaggregation of crop biomass showed the highest proportion for straw (63.51%) and least for grains (29.61%).

Table 3: Plant Biomass Production

Crop	Cultivated area (ha)	Productivity (t ha^{-1} yr^{-1})	Total production (t yr^{-1})	Disaggregation (t)		
				Grain	Straw	Residue
Rice	178.75	4.7	836.6	37.23%	53.12%	10.3%
Mug Dal	45.65	1.9	86.73	29.61%	63.51%	6.88%
Vegetables	52.45	0.21	11.01	-	-	-

Annual net above-ground productivity of grassland/grazing land was 6.4t ha^{-} and total fodder production of these lands was 15.68t. Secondary productivity was contributed by animal dung and meat. Milk production was not considered as it was not extracted. Total annual dung production by cows, bullocks and goats was 38.64t (Table - 4). Annual meat available for consumption was 830kg (fresh weight) consisting of the flesh of wild animals, goats and birds.

Table 4: Annual Dung Production

Source	Average* dung production per Head (kg dry wt day^{-1})	Total annual dung Production (t)	Average energy Content (KJ g^{-1} dry wt)
Cow	4.45 ±0.75	10.5	21.23
Bullock	5.23±0.53	23.34	
Goat	0.66 ± 0.01	4.8	

± SEM. *Fresh dung contains average 62.6% moisture.

Biomass Consumption

Rice (19.34t yr^{-1}) forms the staple food of the villagers though it was produced in the village. The average rice consumption was 325g cap^{-1} day^{-1}. Other major food items include millets (11.5t yr^{-1}) which are produced locally.

Domestic animals mostly depend upon grassland, fallow land and forest for green fodder. Bullocks, however, were fed with boiled bran during heavy agricultural operation. Total annual fodder consists of pearl of millets (0.32t), crop residues (26.45t), grasses (24.78t), crop straws (14.46t) and leaves & twigs (36.7t) (Table -5).

Table 5: Biomass consumption and total energy derived from food and fodder items.

Items	Consumption Pattern			
	Biomass		Energy Equivalent	
	(g cap^{-1} day^{-1})	(t yr^{-1})	KJ g^{-1}	Total (GJ)
Rice	325	19.34	14.42	154.3
Pearl millet	11.5	0.32	15.05	4.8
Vegetable	26.2	0.73	14.01	10.2
Meat	26.3	0.83	4.88	3.6
Dry fish	56.18	2.45	13.76	36.78
Edible oil	6.3	0.17	37.67	6.4
Sugar	8.2	0.23	16.67	3.8
Fruits and miscellaneous	15.9	0.44	14.32	6.3
Crop residues	36.45	26.45	14.27	3.3
Green fodder	125.3	53.95	17.08	921.5
Sub Total	-	-	-	1150.98

Energetic

The major part of the annual energy consumption in the village was in the form of food, fodder and fuel. Most energy (1150.98 GJ) was derived from fodder followed by fuel (650.56 GJ), food (278.46 GJ) and so on (Tables - 5, 6). Biomass fuel energy consumption was 96.8% of total domestic fuel use derived from 85.2% of stem wood and 14.6% of branch wood (Table 6).

Table 6: Domestic Fuel Consumption

Sources	Consumptives		Energy content	
	(g or ml cap^{-1}day^{-1})	(t yr^{-1})	Sample (KJ g^{-1})	Total (GJ)
Stem wood	15	0.48	34	14.18
Branch wood	212	5.9	16	88.78
Kerosene (ml)	1234	34.3	17	547.60
Total	**-**	**40.68**	**-**	**650.56**

CONCLUSION

In this paper an attempt has been made to emphasize the need for the conservation of biomass and energy dynamics within the rural areas, considering Dadhibamanpur village of Baiyalish Mouza in Cuttack District, Odisha, India ecosystem studies. An important feature of the village ecosystem allowing some ecological insight is the lack of use of animal dung and crop wastes. Other socioeconomic factors associated with the ecosystem structure are illiteracy, malnutrition and lack of animal husbandry. Any attempt at an improved functioning of the ecosystem must allow these aspects to be handled carefully.

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