Indian Journal of Ecology (2024) 51(3): 647-652
DOI: https://doi.org/10.55362/IJE/2024/4288

Manuscript Number: 4288
NAAS Rating: 5.38

Common Pool Resources Key to Sustainable Paddy Cultivation: Study from Drought-Prone Areas of West Bengal, India

Uttam Haldar and Santanu Bisai[1*]

Department of Economics, Serampore Girls' College, Serampore-712 201, India
[1]Department of Economics, Sido-Kanho-Birsha University, Purulia-723 104, India
**E-mail: santanubisai4@gmail.com*

Abstract: In the context of agrarian distress, the present paper aims to study the role of common pool resources in sustaining paddy cultivation in drought-prone areas of West Bengal, India. The study uses primary data collected from 456 households across two districts, Bankura and Purulia, during 2022. Most of the landholdings were marginal and small. Return over total cost (C2) was negative, implying paddy cultivation on these landholdings was not economically viable. Return over paid-out cost (A1) was substantial, indicating common pool resources have a great role in sustaining paddy cultivation and making farming a viable livelihood option for large masses of rural poor people in drought-prone areas by increasing productivity and saving costs through supplementing inputs. Paddy productivity was higher in households whose principal activity was cultivation, had a large family, had larger plots, including more 'Bahal' or 'Kanali' types, had irrigation potential from common pool water resources, had bullocks, used high-yielding-variety seeds, and had savings. This important form of natural resource is gradually degrading. Proper maintenance of common pool water resources, grazing land, and village forests with people's participation will be necessary for the sustainability of paddy cultivation in drought-prone areas.

Keywords: Common pool resources, Cost of cultivation scheme, Paddy cultivation, Sustainability, Sustainable livelihood approach

Agriculture and allied sectors are the backbone of the Indian economy. The majority of Indian people depended on it for their food and livelihoods. During the last two decades, Indian agriculture has faced severe crises and stagnation. The average annual growth of the agriculture and allied sectors during the 12th Five Year Plan (2012-17) at 1.6 percent fell short of the target of 4 percent, which was lower than the average annual growth of 3.6 percent, 2.4 percent, and 2.5 percent achieved during the 11th, 10th, and 9th five-year plans, respectively (Govt. of India 2018). The average size of landholdings is gradually decreasing. It has decreased from 0.725 ha in 2003 to 0.592 ha in 2013 and further to 0.512 ha in 2019 (NSSO 2021). Most of these landholdings are fragmented. Farmers got a lower price for their produce compared to non-farm products. The contribution of income from cultivation to the total household income of farmers has declined from 48% in 2014 to 37% in 2019. Side by side, agricultural productivity in India is much lower compared to other countries. Again, the increasing cost of cultivation added a major threat to the sustainability of agriculture and the livelihoods of the people dependent on it. As a result, land-based rural livelihoods and the food security of small and marginal farmers are becoming increasingly unsustainable. According to a survey by 'Pratham,' an NGO, the average age of farmers is now nearly 50 years old, and they are going to retire (Mahapatra 2020). The next generation is unwilling to continue agriculture. Behind the highlights of the green revolution, there are some regions and some poor farmers who are still using traditional methods of cultivation using bullock labour on their small and marginal plots of land. The sustainability of agriculture is of the utmost necessity for the survival of these large masses of the Indian population, whose lives are based on biomass. Rice is the main staple food of the Indian people. West Bengal is the top producer of paddy in India. Major paddy-producing areas of West Bengal are still dependent on the monsoon. Now there arises a question: is paddy cultivation sustainable in the drought-prone areas of West Bengal? Past literature did not give us a comprehensive picture of how the poor people of Bankura and Purulia districts of West Bengal cope with a variety of risks and shocks in meeting their food and livelihood security while sustaining paddy cultivation. As the green revolution badly affects the environment and soil characteristics (Mishra 2013), the Government of India launched the Bharatiya Prakritik Krishi Paddhati Programme (BPKP) to promote eco-friendly, less water-consuming "Natural Farming," which is based on farm biomass recycling, the use of manure, and the use of bio-pesticides to restore soil organic matter, soil fertility, and the elimination of chemical fertiliser and pesticides. Common Pool Resources (CPRs) are subsets of renewable natural resources commonly used by an identifiable community, either by de

facto or by de jure sense. Modern agricultural practice investigates the conservation of soil and water, raising the productivity of cropland, and reducing agricultural waste. This requires a systematic compilation of natural resources, land use patterns, cropping systems, and production levels to understand their relationship between constraints and potentials under existing agro-climatic conditions (Patel et al 2020). In this context, the objective of the present study is to analyse the role of common pool resources (CPRs) in sustaining paddy cultivation across drought-prone areas of Bankura and Purulia district of West Bengal.

MATERIAL AND METHODS

The study uses primary data collected from 456 households across 16 villages over 8 development blocks in Bankura and Purulia district of West Bengal in India in 2022. These two districts are drought prone in nature(Bhunia et al, 2020). Blocks and villages were selected using the stratified sampling method. The basis of stratification was the concentration of the scheduled caste (SC) and scheduled tribe (ST) populations and the prevalence of CPRs. The distribution of sample households is given in Table 1. The structured questionnaire was used for data collection during the survey. Side by side, interviews with some elderly and knowledgeable people were conducted about the various issues of paddy cultivation and CPRs.

Profile of location: Two drought-prone districts, Bankura and Purulia, are located in an undulating red and laterite zone in the western part of West Bengal (Gorai and Modak 2020, District of Bankura 2020 and District of Purulia 2021). The lands in these two districts are covered with interspersed hillocks, laterite ridges, and sparse forest growth. The formation of soil occurs by weathering bad rocks, contains little organic matter, and is porous in nature. Therefore, the water-holding capacity of the soil is low. The fertility of the soils in these two districts is very poor. Mono-cropping "Aman" paddy is predominantly cultivated. The southwest monsoon regulates the rain, which is erratic and leads to crop failure regularly. Paddy fields are classified as 'Bahal' (low-level land), 'Kanali' (medium-level land), and "Baid' (high-level land) (Roy and Jana 2019). 'Bahal' is always wet from the percolation of the pond. It is composed of rich alluvial soil and is highly fertile (Mahato 2015). "Kanali' is a large stretch of terraced land that lies between Bahal and Baid. It is of medium quality in terms of fertility and moisture content. "Baid" is situated on the upper level. It contains mostly laterite and sand, and thereby its moisture-holding capacity as well as fertility level is also very low. There is negligible scope for employment other than in agriculture and allied sectors in Bankura and Purulia districts.

Methodology: The study uses the Sustainable Livelihoods Approach (SLA) of DFID (1999) to assess the effectiveness of CPRs towards the sustainable agriculture practices and livelihoods of the people depending on them (DFID 1999, Natarajan et al 2022). Variation in production, productivity, price, and cost per unit of paddy production between households depends upon the composition and strength of the asset pentagon of households. These five assets are *human* capital, physical capital, financial capital, natural capital, and social capital (Dutta and Guchhait 2018). The present study identifies some specific components of each asset (Fig. 1).

In order to investigate the cost-benefit analysis intensively, the study classified the sample households into two stages: 1) according to their principal source of earnings. 2) according to their operational holdings. As per the National Sample Survey (NSSO 2014), the principal sources of earnings are:

1) Self-employed in agriculture (C)
2) Non-Agricultural Labour (NAL) who engaged in casual

Table 1. Distribution of sample households

Blocks	Village	No. of households	% of SC, ST	Blocks	Village	No. of households	% of SC, ST
Bankura				Purulia			
Chhatna	Jamthol	28	75	Arsha	Siridi	26	47
Chhatna	Kalipur	27	61	Arsha	Gundligora	28	76
Saltora	Jhanka	31	79	Para	Beryadi	21	79
Saltora	Bamnishala	29	69	Para	Kelahi	28	35
Hirbandh	Talgaria	30	77	Hura	Pakhuria	26	65
Hirbandh	Uganpathar	32	71	Hura	Matipur	30	69
Rani Bandh	Nachna	33	78	Bandwan	Burijhor	25	91
Rani Bandh	Bauripal	30	37	Bandwan	Dhadka	32	42
	Total	240				216	

Source: Computed by authors from primary data

non-agriculture work

3) Self-employed in non-agricultural work (SNA) who engaged in small business and trading
4) Agricultural Labour (AL), who engaged in casual agriculture work and
5) Regular salaried jobs (RS) in the formal sector (private and government)

Secondly, households were classified according to their possession of operational land holdings (own land +leased-in land + leased-out land). These are: 0.01-0.40 ha, 0.41-1.00 ha, 1.01-2.00 ha, and 2.00-4.00 ha (NSSO 2014).

Variation in the cost of cultivation of paddy is analysed following the guidelines of the scheme of cost of cultivation, Government of India (Govt. of India 2023). These are

Cost A1 = all actual expenses in cash and kind incurred = operational cost = paid-out cost

Cost A2 = Cost A1+ Rent paid for leased-in land

Cost B1 = cost A1+ interest on the value of owned capital assets

Cost B2 = cost B1+ imputed rental value of owned land and rent paid for leased-in land

Cost C1 = cost B1+ imputed wage of family labour engaged in cultivation

Cost C2 = cost B2+ imputed wage of family labour engaged in cultivation

Determinants of productivity are identified by a dummy variable multiple regression model as follows: $Y = \alpha + \beta X_i + \gamma D_i + \mu_i$

Where dependent variable Y = productivity of paddy (kg/ha), Xi are explanatory variables, Di are dummy explanatory variables, and error term

Common pool resources: The present study focuses on those components of common pool resources (CPRs) that supplement the inputs of paddy cultivation. These components of CPRs are grazing land for feeding bullocks and collecting cow dung, common pool water resources (such as ponds, rivers, and rivulets) for irrigation, and village forests and woodlots for timber.

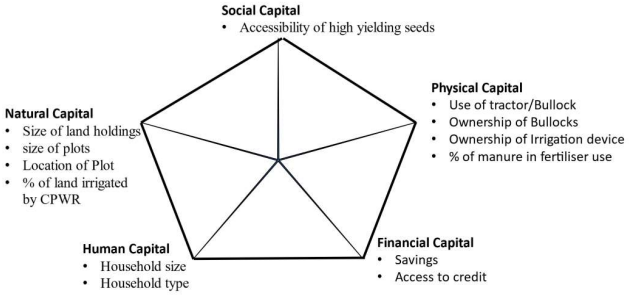

Fig. 1. Asset pentagon

RESULTS AND DISCUSSION

Land holdings: The average land holding size among sample households was 0.6097 ha (Table 2) and considerable proportion of households (22.15%) were landless. Most households (34.87%) possessed cultivable land in the range of 0.41-1.00 ha. The second major land holding category was 0.01-0.40 ha, consisting of 25 percent of households. These two classes (58%) together constitute marginal land holdings. Small holdings constitute 16.67 percent of households. Hence, 75 percent of households possessed either marginal or small land holdings. Only 3 percent of households possessed medium land holdings within the range of 2.01-4.00. Landless households were higher in the Purulia district compared to the district. In both districts, the land holdings of the majority of households were marginal.

Cost-benefit analysis: economic viability of marginal and small holdings: In the analysis, NAL and SNA were clubbed to a group of non-agricultural workers (NAL). The number of samples in regular salaried jobs was too small, so we dropped this category from analysis. Only medium farmers got positive returns over total cost (C2). All other categories of households recorded negative returns, which means losses in terms of C2. The net farm income (which is the value of output over total cost) was negative. Therefore, marginal, and small land holdings in drought-prone areas of

Table 2. Average land holding size across households classified by size of operational holdings

Operational holdings (ha)	Bankura			Purulia			Combined		
	No. of households	Percent of households	Size of land (ha)	No. of households	Percent of households	Size of land (ha)	No. of households	Percentof households	Size of land (ha)
<0.01 (Land less)	46	19.17	0	55	25.46	0	101	22.15	0
0.01-0.40	58	24.17	0.1875	48	22.22	0.1984	106	23.25	0.1924
0.41-1.00	77	32.08	0.692	82	37.96	0.6885	159	34.87	0.6902
1.01-2.00	49	20.42	1.5729	27	12.5	1.4626	76	16.67	1.5337
2.01-4.00	10	4.17	2.174	4	1.85	2.396	14	3.07	2.2374
Total	240	100	0.679	216	100	0.5327	456	100	0.6097

Source: Computed by authors from primary data

Bankura and Purulia districts are not economically viable. Return over cost B2 was positive for each household, which indicates the great role of family labour in sustaining agricultural activity. This return varies from 30 percent to 70 percent over cost B2. Cost A1 is the operational cost of production, which includes all actual expenses in cash and kind. Gross farm income was positive and substantial. The percentage of gross income over paid-out cost, i.e., return over cost A1, ranged from 114 to 197 percent. If we exclude the imputed rental value of land and the imputed wage of family labour engaged in paddy production from the total cost, then the households get an attractive return over cost. This implies that paddy cultivation gives rural people an opportunity to use their land and labour in productive activities to earn income from agriculture.

Factors affecting the productivity of paddy- dummy variable multiple regression model: The estimated productivity of paddy ranged from 2143 to 4436 kg/ha for different categories of households (Table 3). The estimated P value and R square of the model indicate that the estimated overall regression model is highly significant (Table 4). Among the three household types, self-employed in agriculture (C) was taken as the base group. The yield rate was negative for AL and significantly negative for NAL. Therefore, the yield rate of paddy was higher for households whose principal activity was cultivation. Household size had a positive and significant relationship with productivity. The positive coefficient of operational holdings and size of plot shows that the productivity of paddy in drought-prone Bankura and Purulia districts increases with an increase in the size of operational holdings and size of plot. The location of the plot shows that the 'Bahal' type of plot was highly productive, followed by 'Kanali' and 'Baid'. With increasing accessibility of common pool water resources (CPWRs), there was a higher chance of raising the productivity of paddy in drought-prone Bankura and Purulia districts. Similar results in another study of Purulia by Gorai and Modak (2020). The coefficient of technology was statistically significant, but the coefficient of irrigation devices and manure was insignificant. It indicates that there are higher chances of increasing yield when land is tilled with mechanised farming using a tractor compared to traditional farming using bullock labour. Among those households that use bullock labour for tilling, the probability of yield is higher for households that cultivate land with their own bullock compared to cultivating land by hiring bullock labour. In Himachal Pradesh, conventional tillage significantly increased grain yield (Seth and Manuja 2022). The estimated coefficient of improved seeds was positive and highly significant. It implies that the availability of high-yielding varieties (HYV) of seeds, either from neighbours or from panchayats, will produce more paddy per ha of land.

Inherent mechanism of sustainable paddy cultivation: Most of the lands possessed by households who were self-employed in agriculture (C) and possessing 0.01-0.40 ha of land were 'Baid, which have poorer fertility. They tilled their own land with their own bullock labour. To reduce costs and raise productivity, they used manure and exchanged HYV seeds with neighbours. They irrigated their land with common pool water resources (doba, pond, paddy field well, natural spring, etc.) with a small pump. The estimated average productivity was 3177 kg/ha, and the net return over total cost (C2) was negative (-23.3%) (Table 3). The main cost of cultivation is labour. Limited opportunities in the labour market in Bankura and Purulia districts induce family labour to engage in farming. Even children and elderly members

Table 3. Revenue, cost, and return on paddy cultivation across households

Type of households	Operational holdings (ha)	No. of HH	Yield kg /ha	Price of paddy (Rs/kg)	Revenue Rs/ha	Cost Rs /ha			Percentage of return over			Contribution of	
						Cost C2	Cost B2	Cost A1	Cost C2	Cost B2	Cost A1	Rs/ha	% of cost A1
C	0.01-0.40	11	3177	19.00	63484	82796	39404	23829	-23.3	61.1	166.4	18167	76.2
	0.41-1.00	84	3645	19.00	72517	88976	43123	24433	-18.5	68.2	196.8	15709	64.3
	1.01-2.00	40	3738	20.40	79682	86049	49292	30602	-7.4	61.7	160.4	11195	36.6
	2.01-4.00	14	4436	20.40	94072	68924	55467	36777	36.5	69.6	155.8	10884	29.6
NAL & SNA	0.01-0.40	49	2617	19.00	52830	84939	40239	24664	-37.8	31.3	114.2	2187	8.9
	0.41-1.00	51	2947	19.00	59104	82962	37707	22132	-28.8	56.7	167.1	1533	6.9
AL	0.01-0.40	46	2143	19.00	43211	73269	33148	17573	-41.0	30.4	145.9	0	0.0
	0.41-1.00	24	2585	19.00	52239	80259	37272	21697	-34.9	40.2	140.8	13413	61.8
	1.01-2.00	9	3140	19.00	62773	85977	38224	19534	-27.0	64.2	221.4	12881	65.9
		345											

Source: Computed by authors from primary data, note: HH= households

were also engaged in farming. If the imputed value of family labour engaged in cultivation is excluded, the cost of cultivation will go down, and the gross return will be 61.1 percent over cost B2. As they had their own land, they did not have to pay rent. As a result, the return over the cost of A1 was 166.4 percent. Therefore, marginal farmers made their cultivation sustainable. They rented their excess human labour and bullock labour force for tilling land or drawing carts and earned cash income. To rear bullocks, these households mostly depended on grazing land. The possession of bullocks along with other cattle produces manure, which is used to increase the fertility of the soil and reduce the cost of fertilizer. They made their own implements of cultivation, such as ploughs, carts, etc., using raw materials from the village woodlots. The cost of cultivation was saved due to the supplementary contribution of different components of CPRs, which was estimated at 76.2 percent of the material cost of cultivation (A1).

In this way, different types of households (according to principal activity) with varied amounts of cultivable land (including different location and size of plot) try to make their farming sustainable to sustain their livelihoods. The availability and accessibility of supplementary inputs from CPRs, coupled with other assets (components of asset pentagon), helped to increase productivity, stabilise production, and save the cost of cultivation considerably(Table 3).

Market price and minimum support price (MSP): In order to provide a favourable price for paddy, the government announces the minimum support price (MSP) every year. In 2022–23, MSP was Rs 20.40 per kg of paddy. But the local market price of paddy at that time was Rs. 19.00 per kg. Only 15 percent of the sample households were able to sell their paddy to the government at MSP and got Rs 20.40 per kg (Table 3). Bargadars, sharecroppers, marginal, and small farmers did not get the benefits of MSP in terms of price and timing.

Contribution of Common Pool Resources (CPRs) to Sustainable Paddy Cultivation

Saving cost and raising income: Those sample households possessed operational holdings; 89.85 percent of them got resource support from CPRs as supplementary inputs in paddy cultivation. The average contribution of CPRs in paddy cultivation was 35 percent of the material cost (Cost A1) (Table 3). The saving cost in turn reduces dependency on money lenders and exploitation by money lenders. Common pool water resources play a great role in combating drought-like situations by supplying surface water for irrigation, stabilising

Table 4. Factors of productivity: Result of dummy variable multiple regression model

Asset pentagon	Explanatory variables	Code	Coef.	Std. Err.	t	P>|t|
Human capital	Household size	hh_size	1.835	0.59	3.11	0.069
	Household type Agriculture labour yes=1, otherwise=0	Al	-0.84	1.679	-0.5	0.760
	Non-agriculture labour yes=1, otherwise=0	Nal	-2.364	1.209	-1.96	0.079
Natural capital	Size of operational holdings	Land	3.9	0.314	12.42	0.000
	The average size of plots	Plot_size	6.752	2.154	3.13	0.002
	Location of plot, Baid=1, Kanali=2, Bahal=3	Plot location	4.6023	2.026	2.27	0.029
	% of land irrigated by CPWRs	Irrigated	0.538	0.12	4.48	0.004
Physical capital	Bullock=0, tractor=1	Technology	11.181	2.436	4.58	0.000
	Bullock own=1, hired=0	Own bull	3.025	1.446	2.17	0.029
	own irrigation device yes=1, no=0	Pump	0.017	0.372	0.05	0.874
	% of Manure in fertiliser	Manure	0.143	0.531	0.27	0.457
Financial capital	Savings yes=1, no=0	Saving	0.052	0.01	5.2	0.000
	accessibility of credit y=1, no=0	Credit	0.725	2.094	0.35	0.795
Social capital`	Availability of high yielding variety seeds y=1, no=0	Improved seed	0.289	0.1039	2.78	0.002
	_Cons		-9.524	3.184	-2.99	0.002
	Prob > F= 0.000			R-squared= 0.694		
	Number of observations = 345			Adj R-squared = 0.612		

Source: Computed by authors from primary data

agricultural production, and raising productivity and farm income. CPRs provide the opportunity to use idle land and the labour force to mobilise productive activity and raise household income. Thus, paddy cultivation will be remunerative.

CPRs and PPRs linkage: Households have more private property resources (PPRs), like more family members, ownership of bullocks, pump sets, and cultivable land. They extract more benefits (tilling soil, harvesting crops, using manure, and irrigation) from CPRs by utilising different components of CPRs. Hence, there is a strong positive relationship and complementary role between CPRs and PPRs in paddy cultivation, mainly in the biomass-based subsistence economy, and without PPRs, CPRs become insignificant. A similar result was found in the study of Das and Kumar (2022). Respondents and elders in the sample villages mentioned that the availability, productivity, and accessibility of grazing land and water resources are gradually degrading. It demands proper maintenance to restore and recharge CPRs and enhance productivity. It needs the active participation of all users (villagers).

CONCLUSION

The study estimated that 22.15 percent of sample households in SC and ST-dominated drought-prone areas of the Bankura and Purulia districts are landless. 75% of households' land holdings were marginal and small, with an average size of 0.6097 ha. Net farm income was negative, which indicates that tiny plots of land were not economically viable. Farming was done mainly with family labour. Excluding the imputed value of family labour, they got positive returns ranging from 30 to 70 percent. The return varies by type of household and size of holdings. The estimated productivity of paddy was higher in households whose principal activity was cultivation, more family members, larger plots of land with more 'Bahal' or 'Kanali' types, irrigation potential from common pool water resources, , used HYV seeds. Only 15 percent of households were able to sell their crops to the government at MSP. Common pool resources (grazing land, water resources, and forests) act as supplements to the household's physical assets (land, bullocks, irrigation devices, and family labour) for sustaining paddy cultivation by reducing cost, improving soil health and productivity, and combating the drought-like situation. It saves 7 to 76 percent of operational costs. The supplementary role of CPRs provides the opportunity to use idle land and labour to mobilise productive activity and raise household income. In the era of distressed farming CPRs act as shock absorbers. This important form of natural resource is gradually degrading. Proper maintenance of CPRs with people's participation is of the utmost necessity to recharge and sustain CPRs for the sustainability of paddy cultivation in the Bankura and Purulia districts of West Bengal.

Received 24 December, 2023; Accepted 19 April, 2024

REFERENCES

Bhunia P, Das P and Maiti R 2020. Meteorological drought study through SPI in three drought prone districts of West Bengal, India. *Earth Systems and Environment* **4**(1): 43-55.

Das A and Kumar NR 2022. Common pool resources dependency of fisheries-based households: Evidence from North-east India. *Indian Journal of Fish* **69**(3): 144-149.

DFID 1999. *Sustainable Livelihood Guidance Sheet*. Department For International Development. https://www.livelihoodscentre.org/-/sustainable-livelihoods-guidance-sheets.

Dutta S and Guchhait SK 2018. Measurement of livelihood assets in sustainable forest governance: A study in Burdwan Forest Division, West Bengal. *TransInstIndian Geographers* **40**(2): 203-216.

Gorai P and Modak BK 2020. Indigenous Knowledge and Practices on Water Conservation and Management in Purulia District, West Bengal. *Journal of Environment and Sociobiology* **17**(1): 89-98.

District of Bankura. 2020. Bankura District Profile. Bankura DM office. https://bankura.gov.in/location/.

Govt. of India. 2018. Economic Survey 2017-18. Ministry of Finance.

Govt. of India. 2023. Cost concept. Directorate of economics and statistics. http://eands.dacnet.nic.in/Cost_of_Cultivation.htm.

District of Purulia 2021. Purulia District Profile. DM office of Purulia. https://purulia.gov.in/.

Mahapatra R 2020. India's agrarian distress: Is farming a dying occupation. *Down Earth*. https://www.downtoearth.org.in/news/agriculture/india-s-agrarian-distress-is-farming-a-dying-occupation-73527.

Mahato N 2015. Adivasi (Indigenous people) perception of landscape: The case of Manbhum. *Journal of Adivasi and Indigenous Studies* **2**(1): 51-66.

Mishra M 2013. Role of eco-friendly agricultural practices in Indian Agriculture Development. *International Journal of Agriculture and Food Science Technology* **4**(2): 11-15.

Natarajan N, Newsham A, Rigg J and Suhardiman D 2022. A sustainable livelihoods framework for the 21st century. *World Dev* **155**: 105898.

NSSO 2014. *India-Employment and Unemployment*, July 2011-June 2012, NSS 68th Round. Ministry of Statistics & Programme Implementation. Govt. of India.

NSSO 2021. *Land and Livestock Holding of Households and Situation Assessment of Agricultural Households*. Ministry of Statistics & Programme Implementation. Govt. of India.

Patel SK, Sharma A and Singh GS 2020. Traditional agricultural practices in India: An approach for environmental sustainability and food security. *Energy, Ecology and Environment* **5**(4): 253-271.

Roy SS and Jana NC 2019. Agricultural Productivity and efficiency in Purulia District, West Bengal. *International Journal of Reviews and Research in Social Sciences* **7**(2): 283-292.

Seth M and Manuja S 2022. Productivity, Profitability and energy efficiency analysis of rice-wheat cropping system in Mid Hills of Himachal Pradesh. *Indian Journal of Ecology* **49**(6): 2130-2134.