

Productivity trends of the rapeseed-mustard in Eastern Plateau and Hill Region

RK Yogi^{1*}, AK Sharma¹, AK Singh³, Sanjay Kumar⁴, AB Tiwari⁴, Neha Rajan³
Anjani Kumar² and PK Rai¹

¹ICAR- Directorate of Rapeseed-Mustard Research, Bharatpur, 321 303 (Rajasthan), India

²ICAR-Agricultural Technology Application Research Institute, Patna, 800014 (Bihar), India

³Divyayan Krishi Vigyan Kendra, Ramakrishna Mission Ashrama, Morabadi, Ranchi, 834 008 (Jharkhand) India

⁴Krishi Vigyan Kendra, Vikas Bharti Bishunpur, Gumla, 835 231 (Jharkhand) India

*Corresponding Author: raj.yogi@icar.gov.in

(Received: 14 December 2023; Revised: 26 December 2023; Accepted: 30 December 2023)

Abstract

The present study is part of an evaluation report of the development action plan for scheduled tribes (DAPST) implemented in the Jharkhand area. Adoption of the mainstream way of life is very slow in these areas. Major features of the tribal communities as well as the identified area discussed in the context of the recent technological interventions. Primary and secondary data were collected across the various agro-climatic zones. Based on the trends, the districts have been categorized into four groups for strategic planning. Productivity improvement of rapeseed-mustard varied from 1.18% in the Deoghar district to 75.57% in the Koderma district of Central and North Eastern Plateau Sub Zone IV during the period of 20010-11 to 2019-20. Quinquennial comparison of decline in the productivity levels ranged from 4.96% in the Godda district to 42.03% in the Bokaro district of Central and North Eastern Plateau Sub Zone IV. Based on the magnitude of the yield variability over time and across the districts, an appropriate strategic plan was developed for the impactful implementation of the schemes in underprivileged areas. The outreach of the most modern technological and policy interventions may be facilitated up to the last frame for minimizing the productivity gaps.

Keywords: Compound annual growth rates, rapeseed-mustard, socio-economic features, yield variability

Introduction

Tribals have been living in forests for ages and identified as "heritage groups" with advocacy for special care and treatment (Bhuria Report, MoTA, GOI, 2004). The strategy for integrated development led to the launching of the tribal sub plan (TSP) concept in the Fifth Plan period. Three basic parameters include variations in the socio-economic and cultural milieu, demographic distribution, and primitive tribal communities living in scheduled regions. In predominant tribal regions, an area approach with a focus on the development of tribal communities has been favored, while for primitive groups community-oriented programs have been preferred. With various development projects launched in Jharkhand, some 30 lakh people were displaced to Sundarbans in West Bengal and Andaman and Nicobar Islands during 1951-95, with 90 % of them being tribals (Ekka, 2000; Xaxa, 2003; Maharatna and Chikte, 2004). The government needs to proactively address the situation and make more long-term farmers-centric policies coupled with viable technological interventions (Chand, 2016).

World Bank (2007) identified Jharkhand as one of the most poverty-stricken states in the country with a sharp

contrast between rural and urban poverty. Singh *et al.* (2012 and 2015) opined that despite years of concerted efforts rural poverty is rampant in Jharkhand. In 2009-10 about 36% of farming households and 47% of agriculture laborer households were living with a minimum annual per capita income of ₹ 7867. Jha *et al.* (2012) reveal that farming in eastern India is facing constraints like drought and submergence, heavy pest infestation, and poor soil fertility. Infrastructure including irrigation, power supply, and transport facilities are the most important aspect of any geographical unit to progress. The State of Jharkhand consists of 24 districts, 33 subdivisions, 211 blocks, 3759 panchayats, and 32620 villages (Government of Jharkhand, 2015). The numbers of electrified villages are 14667 (45.0 % of the total villages). However, only 8484 villages (26.0 %) are connected by roads. The net irrigated area is about 0.16 million ha, constituting about 14% of the cultivated area. Being largely rainfed, the state has a cropping intensity of 126%. Yogi *et al.* (2017) and other researchers reported that this huge gap is indicating a great potential to enhance the productivity of the farm sector.

Jharkhand has immense potential for rapeseed-mustard

cultivation. The present study is part of an evaluation report of the development action plan for scheduled tribes (DAPST) implemented in the Jharkhand area. Under this developmental action plan for scheduled tribe, the scientific production technology of rapeseed-mustard and agriculture management is being showcased through frontline demonstrations, critical inputs including quality seed and fertilizers provided timely, and awareness through capacity building programs and ICT application. Hence, it is necessary to look into the productivity variations.

Materials and Methods

Both primary and secondary data are used for macro and micro-level analysis of the socio-economic features and yield variance. A review of the tribal community-oriented policy initiatives has also been conducted. The study is designed with sampling and focused group discussions (FGDs) based on primary data as well as secondary data. Characterization of the agroecosystem in the study area is depicted in Fig. 1.

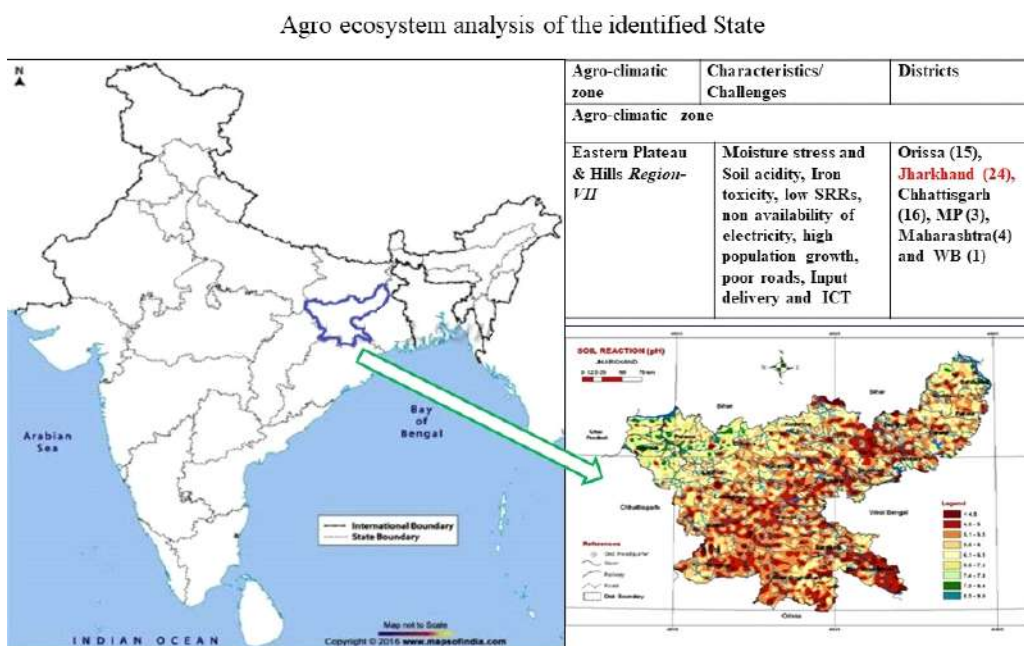


Fig. 1: Characterization of the agroecosystem in the study area

District-level time-series data of Jharkhand state for 10 years from 2010-11 to 2019-20 was used. Time series analysis revealed the variation in productivity levels in different levels of geo-coordinates. The compound annual growth rate (CAGR) was worked out by fitting the exponential function given below:

$$Y = ab^t$$

Where; Y = the dependent variable (export); a = constant term; b = regression coefficient; t = time variable in years. The equation can be rewritten in the logarithmic form as follows:

$$\log Y_t = \log a + t \log b$$

where; Y_t = productivity of rapeseed-mustard in t^{th} year

We can, thus, calculate the compound growth rates (r) as under:

$$r = \text{Antilog}(\log b - 1) \times 100$$

where; r = compound growth rate per annum (%); b = regression coefficient

Results and Discussion

Profile and demographic features

It has been evident for some time that the lion's share of the various benefits and concessions earmarked for the SC and ST is appropriated by the numerically larger and politically well-organized communities (Lakur Committee Report 1965, Department of Social Security, GOI). The Planning Commission Report (2006) on development issues to deal with the causes of discontent, unrest, and extremism highlighted the significant differences in the accessibility to agricultural land and capital assets ranging from ₹0.49 lakh for Scheduled Castes (SC), ₹0.52 lakh for Scheduled Tribes (ST),

₹1.34 lakh for Other Castes (OC) and overall asset value was estimated ₹1.07 lakh. Mungekar Standing Committee Report (2009) of the planning commission on inter-sectoral issues relating to tribal development on standards of administration and governance in the scheduled areas aimed to target only nine states of India including the most recent Jharkhand, Chhattisgarh, and Madhya Pradesh in 2003. Corbridge *et al.* (2003) are careful to point out that the reservations 'has not brought a tribal middle class into existence; rather it has been captured by a pre-existing tribal elite', which is predominantly male and many of whom originate in urban areas. According to Census 2011, a total of 3.3 crore population of the state comprises 76% of the rural population. About 26% populations belong to the tribal community and about 80 lakhs (91%) of the tribal inhabit rural areas. In the state, more than 75% population residing in rural areas is the target group, and out of this about 31% are tribal. An empirical exploration of socioeconomic determinants in the state by Singh *et al.* (2012) and the World Bank Report (2007) revealed the magnitude of gaps.

National Advisory Committee (NAC) reported that about 15% of the landmass in various ecological and geo-climatic conditions ranging from plains to forests, hills, and inaccessible areas provide livelihood support to tribal households. There is a significant variation of decadal growth rates in the population of rural and urban areas as well over time ranging from 21% (from 2001 to 2011) in rural areas to 147% (1971-1981) in urban areas. The sex ratio among the rural tribal population has not witnessed significant changes. According to Census 2011 only 45% of tribal households availing banking services in comparison to the national average of 59% of households.

Jharkhand state ranks sixth in tribal population after Madhya Pradesh (14.7%), Maharashtra (10.1%), Odisha (9.2%), Rajasthan (8.9%), and Gujarat (8.6%) while it ranks third with 14% population of the Particularly Vulnerable Tribal Groups (PVTGs) after undivided Madhya Pradesh (28%) and Maharashtra (15%). Adoption of the mainstream way of life is very slow in these areas. More emphasis had given to the strategies of the XII five-year plan (2012-2017) for livelihood support, apart from the land and forest-based activities under MGNREGA imparting skills and creating employment opportunities near their habitations. Under this project, more than 6000 tribal families of the seven districts of the Jharkhand state were covered under the capacity building and skill development programs with forward and backward linkages during 2021-22. Ramani *et al.* (2015) assumed that some bottlenecks are hampering the growth of the agri-sector. Yogi *et al.* (2017) reported that scattered land holdings, lack of irrigation, and financial support with proper guidance were identified as the major hurdles for the farm sector in Jharkhand. As the Jharkhand state was identified for the study as it has about 0.87% share in total oilseed production and a 2.54% share in total rapeseed-mustard production in India.

Agro-Climatic Zone (ACZ) namely Eastern Plateau and Hills Region-VII is characterized by rainfed agriculture, moisture stress, drought and Soil acidity, Iron toxicity, low SRRs, non-availability of electricity, high population growth, poor road, poor input delivery, and communication infrastructure. The identified state of Jharkhand comprised three Agro-climatic sub-zones briefed in Table 1 as given below:

Table 1: Agro-climatic subzones of the Eastern Plateau and Hills Region-VII

Agro-climatic Subzones	Characteristics	Name of the districts (Numbers)
Central and North Eastern Plateau Sub Zone IV	Erratic and uneven distribution of rainfall Coarse textured soils, crust formation on the soil surface Low water retention capacity of the soil Lack of safe disposal of runoff and drying of tanks.	Bokaro, Deoghar, Dhanbad, Dumka, Giridih, Godda, Jamtara, Khunti, Koderma, Hazaribagh, Pakur, Ramgarh Ranchi and Sahebganj (14).
Western Plateau Sub Zone V	Erratic/ uneven distribution of rainfall Low water retentive capacity of the soil.	Chatra, Garhwa, Gumla, Latehar, Lohardaga, Palamau and Simdega (7).
South Eastern Plateau Sub Zone VI	Uneven distribution of rainfall Low water holding capacity, eroded soils Shallow soil depth Poor soil fertility	East Singhbhum, Saraikela and West Singhbhum (3).

Traditional agriculture provides seasonal employment but not provides sufficient opportunities in these areas and creates the problem of migration. Thus, providing the alternate mean of livelihood as well as employing the rural youths at the local level with an existing resource base would be a good strategy as mentioned by Kumar *et al.* (2020). As per the all India coordinated research project on rapeseed–mustard, agro-climatic condition of Zone V is targeted to address the major challenges in the region. This crop is the best option for targeting rice fallow area (TRFA). In this context, rice fallow area cultivation becomes an important means of livelihood

security among the tribal communities. The TRFA program under national food security mission (NFSM) is also being implemented in 11 states of the country including the Jharkhand state to promote the cultivation of oilseeds and pulses in rice fallow areas of the states (GoI, 2016). It is evident from Table 2 that magnitude of the variation in the productivity of rapeseed-mustard across the different sub-agro-climatic zones ranged from an acceleration of 422 kg ha⁻¹ in South Eastern Plateau Sub Zone VI to a deceleration of 483 kg ha⁻¹ in Central and North Eastern Plateau Sub Zone IV.

Table 2: Agro-climatic zone and district-wise trends of rapeseed-mustard productivity (Yield kg ha⁻¹)

Name of the district /Area	Average yield (kg ha ⁻¹)			Yield improvement kg ha ⁻¹ 2010-15 and 2016-20	CAGR (in %) 2010-11 to 2019-20
	2010-11 to 2019-20	2010-11 to 2014-15	2015-16 to 2019-20		
I. Central and North Eastern Plateau Sub Zone IV					
Koderma	686	498	874	376 (75.57)	9.26
Jamtara	623	477	769	292 (61.12)	9.13
Hazaribagh	690	561	819	257 (45.83)	7.92
Ranchi	758	708	808	100 (14.11)	4.17
Sahebganj	809	829	788	-41 (-4.97)	2.99
Dhanbad	101	1067	954	-113 (-10.58)	2.17
Dumka	858	786	929	142 (18.10)	1.10
Ramgarh	1082	1128	1037	-91 (-8.07)	-0.18
Godda	794	814	774	-40 (-4.96)	-1.37
Deoghar	952	946	958	11 (1.18)	-1.55
Pakur	1256	1339	1173	-165 (12.34)	-2.79
Khunti	901	1018	783	-235 (-23.11)	-3.85
Giridih	754	886	622	-265 (-29.88)	-4.04
Bokaro	908	1150	667	-483 (-42.03)	-4.46
Zone IV	863	872	854	-18 (-2.09)	0.14
II. Western Plateau Sub Zone V					
Gumla	922	852	992	140 (16.46)	2.63
Lohardaga	960	914	1006	92 (10.06)	1.09
Chatra	862	957	767	-190 (-19.88)	-2.21
Garhwa	699	690	708	17 (2.52)	-4.61
Palamu	861	1011	710	-301 (-29.78)	-4.68
Latehar	995	1177	812	-365 (-30.99)	-4.99
Simdega	1024	1134	914	-220 (-19.46)	5.48
Zone V	903	962	844	-118 (-12.28)	-2.69
III. South Eastern Plateau Sub Zone VI					
Saraikela	848	637	1059	422 (66.29)	8.99
Kharsawan					
East Singhbhum	679	684	674	-10 (-1.48)	-0.97
West Singhbhum	798	956	640	-317 (-33.11)	-7.85
Zone VI	775	759	791	32 (4.20)	-0.02
Jharkhand	699	672	726	54 (8.01)	1.29
India	1258	1167	1348	181 (15.47)	2.49

Source: Kumar *et al.* (2019). ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur (Raj); Indiastat.com; FAOSTAT 2022. *Figures in parentheses are the % change in the yield on a Quinquennial basis. (2010-2015 & 2016-2020).

The highest productivity level 1256 kg ha⁻¹ was observed in the Pakur district as well as the lowest productivity level 623 kg ha⁻¹ in the Jamtara district of Central and North Eastern Plateau Sub Zone IV. Chauhan *et al.* (2011) opined that moisture stress during the growing season in rapeseed-mustard could reduce production by 17 to 94%. Rathore *et al.* (2019) reported that water applied 30-40 days after sowing fails to meet the water requirement of the crop at later critical crop growth stages). Kumari and Singh (2023) as well as Singh *et al.* (2019) also advocated the variations in agro-climatic factors and management practices are responsible for variations in the technology gap and index percentage in pulses which can be reduced by farmer's participation in adopting new technologies.

However, other biotic and abiotic factors including seed, nutrient availability in the soil, pest infestation, and sowing time also contribute to the yield variation across the districts as well as sub-agro-climatic zones. Poor access to working capital to procure modern seeds, fertilizers, and water resources for timely adequate irrigation are the major constraints for realizing higher productivity.

Productivity of rapeseed-mustard improved in Koderma

(75.57%), Jamtara (61.12%), Hazaribag (45.83%), Ranchi (14.11%) and Dumka (18.10%) districts of the Central and North Eastern Plateau Sub Zone IV. Saraikela Kharsawan (66.29%) district from the South Eastern Plateau Sub Zone VI; Gumla (16.46%) and Lohardaga (10.06%) district from the Western Plateau Sub Zone V showed a significant improvement over the average yield of the state of Jharkhand (8.01%) during the period of 20010-11 to 2019-20. The higher productivity of various districts may be due to the use of modern seeds and fertilizers and ownership of water resources. Compound annual growth rates of rapeseed-mustard productivity ranged from 9.26% in the Koderma district of the Central and North Eastern Plateau Sub Zone IV to -7.85% in West Singhbhum district from the South Eastern Plateau Sub Zone VI. Western Plateau Sub Zone V showed the highest decline (-12.28%) followed by the Central and North Eastern Plateau Sub Zone IV (-2.09%) in the yield of rapeseed-mustard. The South Eastern Plateau Sub Zone VI showed productivity improvement over the period of 20010-11 to 2019-20 (Fig. 2). The detailed discussion on challenges and strategies of different productivity growth scenarios are depicted in the Table 3.

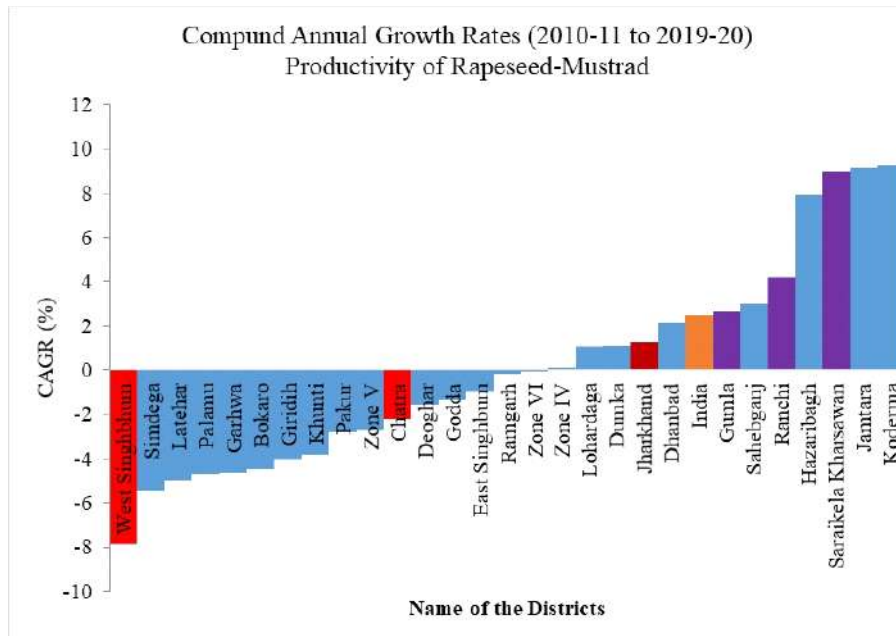


Fig. 2: Spatial variability in the yield of rapeseed-mustard in study area

Positive yield with positive CAGR (PYPC) scenario

It indicates the natural farmer's preference for the crop. A total of nine districts were categorized under this scenario. Out of these, three districts from each agro-climatic sub-zone were identified under the DAPST

program namely Ranchi, Gumla, and Saraikela Kharsawan. Due to the awareness and adoption of the scientific production of rapeseed-mustard and other supports, the temporal productivity growth is estimated as positive. Focused dissemination of the latest

technological advances should be promoted to sustain the current scenario. However, area expansion under oilseed crops may be another strategic aspect to enhance oilseed production in the state.

Positive yield with negative CAGR (PYNC) scenario

Only three Non-DAPST districts namely Deoghar, Pakur, and Garhwa from two agro-climatic sub-zones fall under this category. In the Deoghar district two cropping systems namely upland paddy-toria-fallow and black gram-toria-fallow prevailed. Training for both biotic and abiotic stress management is required to overcome low productivity levels in the future. Soils of hills in the Garhwa district are acidic and very poor in fertility status. Even though the introduction of HYVs Pusa Mahak, Pusa Mustard 26, Pusa Mustard 30, and Shivani with an application of sulfur @ 20 kg/ha+

spraying of boron @ 0.2 % as boric acid powder could improve the productivity levels but due to poor backstopping resulted with the negative CAGR. Keeping honey boxes in mustard fields to improve pollination.

Negative yield with positive CAGR (NYPC) scenario

Only two Non-DAPST districts namely Sahibganj and Dhanbad districts from the Central and North Eastern Plateau Sub Zone IV categorized under this scenario. Low productivity of rapeseed-mustard is the major issue in Sahibganj district. Stray Cattle grazing in the rabi season severely limits the introduction of rabi crops including, rapeseed-mustard during winter, hence mono-cropping. The dissemination of recommended practices and the provision of support for farmers is required for productivity improvement.

Table 3: Categorization of the study area based on the temporal and spatial yield attributes along with the strategic plan

Particulars	Positive CAGR (PC)	Negative CAGR (NC)
Positive yield (PY)	Zone IV: Koderma, Jamtara, Hazaribag, Ranchi and Dumka Zone V: Gumla and Lohardaga Zone VI: Saraikela Kharsawan	Zone IV: Deoghar and Pakur Zone V: Garhwa
Strategic plan	Challenge: Sustainable production of rapeseed-mustard Strategy: Training on the latest technology advances for the production of rapeseed-mustard with ensured quality and timely supply of seed and other inputs.Zone IV: Sahibganj and Dhanbad	Challenge: Poor awareness about the scientific production of rapeseed-mustard Strategy: Organizing the field demonstration and capacity-building programs with proper backstopping. Trapping low productivity area. Integrated Pest Management. Zone IV: Ramgarh, Godda, Khunti, Giridih and Bokaro Zone V: Chatra, Palamu, Latehar and Simdega Zone VI: East Singhbhum and West Singhbhum
Negative yield (NY)		Challenge: Poor awareness/adoption of the scientific production of rapeseed-mustard and inappropriate implementation. Strategy: Strong institutional mechanism for technology transfer targeting the extension personnel under capacity building programs. Massive exposure visits and field days in the best-performing districts. Remunerative price incentives and promoting the value addition by establishing the oil expellers.
Strategic plan	Challenge: Poor awareness/adoption of scientific production of rapeseed-mustard. Strategy: Replacement of the old/obsolete variety would be given priority. Awareness programs for rapeseed–mustard production should be encouraged.	

Note: District-wise secondary data on the area and production of rapeseed-mustard in Jharkhand will be more effective to use the strategic plan accordingly.

Negative yield with negative CAGR (NYNC) scenario: Zone IV

Seven Non-DAPST districts namely Ramgarh, Godda, Khunti, Giridih, Bokaro, Palamu, Simdega and four DAPST districts including Chatra, Latehar, East Singhbhum and West Singhbhum from each agro-climatic

sub-zone falls under this scenario. There is a need to identify the gaps and an awareness campaign including farmers' fairs, field days, exposure visits, farmer-to-farmer interaction meetings, etc. needs to be conducted. Capacity-building programs for the extension functionaries and officials of the line departments. Climate-resilient varieties need to be introduced in a

participatory mode. Also, need a good understanding of the existing cropping patterns/systems and a way of building knowledge in the light of experience. The development and up-scaling of traditional and improved practices also require an enabling environment, such as support for product value chains (small oil extraction units), and coordination among the various sectors involved.

Conclusion and policy implications

Based on the magnitude of the yield variability over time and across the districts, an appropriate strategic plan is developed for impactful planning, monitoring and implementation of the schemes particularly in tribal dominated areas. These results are associated with the prevalence of part-time tribal farmers cultivating marginal and uneconomic land holdings. The outreach of the most modern technological and policy interventions may be facilitated up to the last frame for minimizing the productivity gaps. The productivity of small landholders can be increased by improving their access to the quality seed and other critical inputs through the proactive agricultural extension networks.

References

Chand R. 2016. Why doubling farmers' income by 2022 is possible. *The Indian Express*. Retrieved from <http://indianexpress.com/article/opinion/columns/why-doubling-farmers-income-by-2022-is-possible-2754028/>

Chauhan JS, Singh KH, Singh VV and Kumar S. 2011. Hundred years of rapeseed-mustard breeding in India: accomplishments and future strategies. *Indian J of Agric Sci* **81**: 1093-1109.

Corbridge S. 1988. The ideology of tribal economy and society: Politics of Jharkhand, c.1950-1980. *Mod Asian Stud* **22**: 1-41. Reprinted in Munda RD and Mullick SB 2003. *The Jharkhand movement: Indigenous peoples' struggle for autonomy in India*, Chaibasa: Bindrai Institute for Research Study and Action (in association with Transaction Publishers and International Work Group for Indigenous Affairs). 1988: 131-170.

Ekka, P. 2000. Jharkhand tribals, are they really a minority? *Econ Polit Wkly* **35** (52 & 53): 4610-4612.

Government of India. 1965 Lakur Committee Report: The revision of the list of Scheduled areas and Scheduled Tribes, Department of Social Security, GOI, 1-62

Government of India. 2004. Bhuria Report (2002-04) on the Scheduled Areas and Scheduled Tribes Commission, MoTA, Vol(1), 1-1426

Government of India. 2009. Mungekar Standing Committee Report of the Planning Commission

Report on development issues to deal with the causes of discontent, unrest, and extremism, 1-141

Government of India, 2012. Twelfth Five Year Plan (2012–2017) Social Sectors Volume III Planning Commission, Government of India, 1-22

Government of India. 2013. Census of India 2011, Ministry of Home Affairs, New Delhi, 1-50

Government of India. 2014. Land use statistics at a Glance-State wise, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India.

Government of India. 2015. Census of India population enumeration data. Retrieved from www.censusindia.gov.in/2011census/population_enumeration.html.

Government of India. 2016. Operational guidelines for targeting rice fallow area (TRFA) program, Department of Agriculture and Cooperation, Government of India. https://rkvy.nic.in/static/download/pdf/Rice_Fellow_Guideline.pdf retrieved dated 26th June 2023.

Government of India. 2021. Agricultural Statistics 2020: at a glance. Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India.

Government of Jharkhand. 2016. Vision document sericulture for the state of Jharkhand XII plan. Retrieved from http://www.cyber-swift.com/jharcraft_org_in/img/vision-document.pdf.

Jha A, Singh K, Meena MS and Singh RKP. 2012. Constraints of rainfed rice production in Eastern India: an overview. *SSRN Electronic Journal*. DOI: 10.2139/ssrn.2061953.

Kumar Nirmal, Yogi RK and Yadav SKS. 2020. Knowledge and adoption level of scientific lac cultivation at farmer's field: A case from eastern India. *Indian J Extn Edu* **56**: 88-92.

Kumar V, Sharma AK, Rai PK and Meena PD. 2019. Rapeseed–mustard information and databook. ICAR-Directorate of Rapeseed–Mustard Research, Sewar, Bharatpur (Raj.), *CPeCR Publications (ISBN:978-81-942081-0-5):1-364*.

Kumari Suman and Singh Harinder. 2023. Participatory evaluation of chickpea production technology under Central Punjab conditions. *Ind Res J Extn Edu* **59**: 113-117.

Maharatna A and Chikte R. 2004. Demography of tribal population in Jharkhand. 1951-1991. *Econ Polit Wkly* **39**: 5053-5062.

Ramani R, Kumar SB, Bhatt P, Variar M and Arunachalam A. 2015. Jharkhand Agri-Development Vision. ICAR-IINRG, Ranchi, 80.

- Rathore SS, Shekhawat K, Sass A, Premi OP, Rathore BS and Singh VK. 2019. Deficit irrigation scheduling and superabsorbent polymer hydrogel enhance seed yield, water productivity, and economics of Indian mustard under semi-arid ecologies, *Irrig Drain* **68**: 531-541.
- Sharma AK, Kumar V and Rai PK. 2022. Best management practices for enhancing rapeseed-mustard production in Rajasthan. ICAR-Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur (Raj.) 321 303, 36.
- Singh KM, Singh RKP, Meena MS, Kumar A, Jha AK and Kumar A. 2012. Rural poverty in Jharkhand: an empirical exploration of socio-economic determinants. 2012; Online at <http://mpra.ub.uni-muenchen.de/44811/> MPRA, Paper No. 44811.
- Singh M, Dwivedi AP and Yadav KS. 2019. Gaps in pulses production in Vindhya pleatue agro-climatic zone of Madhya Pradesh: an assessment through frontier technology. *Ind J Extn Edu* **55**: 39-42.
- Singh RKP, Singh KM and Kumar A. 2015. Socio-economic characterization of rural households: A village-level analysis in Bihar, India. Online at <https://mpra.ub.uni-muenchen.de/id/eprint/59681>, MPRA Paper No. 44811.
- World Bank. 2007. Jharkhand: addressing the challenges of inclusive development. Report No. 36437-In Poverty Reduction and Economic Management. India Country Management Unit, South.
- World Bank. 2007. Jharkhand: Addressing the challenges of inclusive development. Report No. 36437-In Poverty Reduction and Economic Management. India Country Management Unit, South Asia. Retrieved from <http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1181699502708/fullreport.pdf>
- World Food and Agriculture-Statistical Year book. 2022. <https://www.fao.org/3/cc2211en/cc2211en.pdf> accessed on 23rd Dec 2022.
- www.indiastat.com/ retrieved on 15th August 2022
- www.tribal.nic.in/ retrieved on 15th November 2022
- Xaxa V. 2003. Tribes in India. In: Veena Das (ed) The Oxford India Companion to Sociology and Social Anthropology. Oxford University Press, New Delhi.
- Yogi RK, Jaiswal AK and Sharma KK. 2017 Enabling rural households of Chotanagpur Plateau Region of Jharkhand for doubling farm income. *Jharkhand J Dev Manag Stud* **15**: 7179-7195.