Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 2433-2439

Adarsh Kumar Srivastava
MC Jerai Scientist, Krishi Vigyan Kendra, Dhanbad, Head, KVK Latehar, India

Seed replacement for boosting food grains production in Dhanbad district of Jharkhand

Adarsh Kumar Srivastava

Abstract
The majority of Dhanbad population is dependent on agriculture and Farm saved seed (FSS) is commonly used to raise the next crop in predominantly rain-fed Dhanbad. Though the seed is critical, its cost in farmers' total price of inputs is low as compared to other input factors such as fertilizers, bio-fertilizers, insecticide, fungicides and herbicides including bio- pesticides, land preparation, irrigation and post-harvest management etc. Farmers generally used traditional or stored seed of previous crop to grow new crop is also a main reason for low productivity in the district. Seed is the carrier of technology and the medium for translating scientific achievements to the field. Often, Indian farmers do not distinguish between grain and seed (Chand, 2007). It has been scientifically proved that if farmers use new improved, the yield of the crop may be increased by 20-25 percent depending upon the effective management of the crop it further increased by 35-45 percent.

Keywords: Seed, Seed Replacement Rate, Seed Multiplication Rate (SMR), Varietal Replacement Rate (VRR), Vigor.

Introduction
Crop seed is one of the most crucial elements in the livelihoods of farming communities. The potential benefits to farmers from increasing the use of quality seeds of a diverse range of crop varieties are widely acknowledged. Though the seed is critical, its cost in farmers' total price of inputs is low as compared to other input factors such as fertilizers, bio- fertilizers insecticide, fungicides and herbicides including bio- pesticides, land preparation, irrigation and post-harvest management etc. Supply of quality seeds is not a onetime affair; they need to be produced every new season continuously. The hybrid seeds (those produced by cross pollinating of plants) can be sown only once because the seed from their first generation does not reliably produce the same copies of their parents. Thus, every new crop season requires purchase of new seeds. Producing certified seeds from breeder seeds takes at least three years efforts. Due to huge demand supply gap, India suffers from a dismal seed Replacement Ratio. Currently, only around 15 per cent of India's total cropped area is planted with freshly obtained quality seeds every year. A huge 85 per cent area is sown with farm saved seeds. This ratio varies from crop to crop between 7% in staple crops to maximum 70% in some vegetables and fruits. For wheat and rice, it is between 9 to 18%.We note here that enough seeds are available for fruits, vegetables, flowers and high value / costly seed crops but not enough seeds are supplied in case of low value and high volume crops such as rice, wheat. For crops such as wheat; this ratio must be between 20-30%. For oilseeds and pulses; this ratio must be between 20-100% and for some crops such as Hybrid cotton, it must be 100%.Without achieving the optimal seed replacement ration, any efforts to get expected yields will be futile. It is estimated that the direct contribution of quality seed alone to the total production is about 15-20 percent, depending upon the crop and it can be further raised up to 40-50 percent with effective management using other inputs (Singh, 2013; Natrajan, Jacob, & Mandal, 2009).

Correspondence
Adarsh Kumar Srivastava
MC Jerai Scientist, Krishi Vigyan Kendra, Dhanbad, Head, KVK Latehar, India

Comparative Productivity (kg/ha) Performance in Major Crops Cultivated in Dhanbad and Jharkhand

Year	Rice		Wheat		Maize		Pulse		Oil seeds	
	Dhanbad	Jharkhand	Dhanbad	Jharkhand	Dhanbad	Jharkhand	Dhanbad	Jharkhand	Dhanbad	Jharkhand
2005-06	970	1150	1500	1340	1025	1266	325	427	350	1004
2006-07	2718	1832	1359	1528	850	1504	425	727	375	916
2007-08	2749	2023	1405	1500	844	1621	278	749	210	1115
2008-09	2450	2035	1568	1541	854	1407	646	764	456	1006
2009-10	1273	1546	2560	1550	858	1332	650	733	510	958
2010-11	1073	1541	1298	1500	931	1215	561	656	310	1193
2011-12	3478	3315	1865	1908	1240	1603	1045	817	700	1135
2012-13	2555	2833	1876	1944	1064	1812	1201	1169	610	1169
2013-14	2420	2896	3689	3145	1072	2012	1173	764	640	1168
2014-15	4542	2879	2086	2750	2022	1559	1142	728	915	1075
2015-16	1118	1617	2500	3093	2859	2020	1291	652	878	968

The above table data shows that, the rice productivity of the district is below than state productivity except in the year 2006-07, 2007-08, 2011-12 and 2014-15. The productivity of the wheat is somewhat parallel to the state productivity but in case of maize the district productivity is low except 2014-15 and 2015-16. In case of pulses the productivity is also low except in few years like 2012-13, 2013-14, 2014-15 and 2015-16. The oil seed productivity of the district is lower than state productivity in last eleven years data. Therefore, it clear from the table, that the productivity of the district is lower in all the major cereals pulses and oilseeds crops, this may be due to rain-fed condition and also use of old variety seeds. The average productivity of major food crops in Dhanbad is far below the Jharkhand average, which indicates the backwardness of the agriculture practices in the district.

Seed Replacement Rates (SRRs)

The number of generations up to which the seed could be used from the previous crop is another important aspect, vital for the maintenance of crop productivity. Deterioration in seed quality may occur due to physical admixtures as well as loss of genetic vigour and germination power. Admixture may occur in the field, at the threshing yard or even during storage when seeds of other crops get mixed with the variety. Further, the germination power may go down due to physical damage to seed through insect and fungal infestation, moisture, breakage of grains and death of embryo due to ageing or prolonged exposure of seed to adverse environment. Deteriorated seed quality results in loss of productivity per unit of area. In India more than 70 percent seed usage, particularly for food crops, is through FSS (Farm Saved Seeds) which leads to low SRRs. In spite of the availability of quality seed of superior genotypes from the organized seed industry, the age old tradition continues (Pattanaik, 2013). Seed viability and seed vigor are the two important traits that significantly influence crop performance. The use of quality seed solves this problem because the term 'quality' is maintained in the seed as per seed certification standards and the certified seed is supposed to have all the quality parameters as per norms. SRRs have a strong positive correlation with productivity, hence to meet desired productivity levels skewed SRRs and VRRs should be tackled (Bhaskar *et al*., 2014). The need for achieving optimal seed replacement rates should be one of the focus areas besides putting in place mechanisms for supplying quality and appropriate seed varieties taking into account the native agro-ecosystems and the pest profile of the region (Planning Commission, 2011a).

Rolling seed plan and seed requirement of Dhanbad

The seed requirement of different crops grown in Dhanbad District is estimated through an effective seed roll plan which in turn can be calculated by having knowledge of

(i) Area under the respective crop,

(ii) Seed rate/hectare and

(iii) Seed multiplication rate (SMR). The seed roll plan is always dynamic and keeps on changing depending on the earlier mentioned factors which are variable in nature.

Seed Requirement of Different Categories of Crops Grown in Dhanbad

Sl. No	District Level Seed Requirement to Achieve Standard Rate of SRR in different crops for Dhanbad District										
	Crop	Cropped Area	SRR Area	Seed Rate (Kg/ha)	Standard SRR (%)	Seed yield (q/ha)	Seed (C/S) requirement for SRR (q)	Area required to produce F/S to C/S achieve Standard SRR(seed village Area)	Seed (F/S) requirement for Standard SRR	Area Required to produce Foundation Seed(ha)	Seed (B/S) requirement for Standard SRR (q)
1	Paddy	37835.00	12485.00	40.00	33.00	25.00	4991.00	200.00	80.00	3.00	1.20
2	Maize	2645.00	1325.00	20.00	50.00	20.00	267.00	13.00	3.00	0.15	0.03
3	Arhar	5000.0	1650.0	20.0	33.0	10.0	330.0	33.0	7.0	0.7	0.14
4	Urd bean	3000.0	990.0	30.0	33.0	5.0	900.0	180.0	54.0	11.0	4
5	Moong bean	700.0	231.0	30.0	33.0	5.0	210.0	42.0	13.0	3.0	1
6	Kulthi	500.0	165.0	20.0	33.0	5.0	33.0	7.0	2.0	0.5	0.1
7	Wheat	4000.0	1320.0	100.0	33.0	20.0	1320.0	66.0	66.0	4.0	4
8	Rabi Maize	300.0	150.0	20.0	50.0	20.0	30.0	2.0	0.4	0.5	0.1
9	Chickpea	7000.0	2310.0	80.0	33.0	10.0	1848.0	185.0	148.0	15.0	2
10	Lentil	1500.0	495.0	30.0	33.0	6.0	149.0	25.0	8.0	2.0	0.6
11	Pea	1000.0	330.0	80.0	33.0	10.0	264.0	27.0	22.0	3.0	4
12	Mustard	1000.0	500.0	6.0	50.0	7.0	30.0	5.0	0.3	0.5	0.03
13	Linseed	1000.0	330.0	20.0	30.0	5.0	66.0	13.0	3.0	1.0	0.2
14	Ground Nut	400.0	132.0	75.0	33.0	10.0	99.0	10.0	8.0	1.0	0.75
Total		65880.0	22413.0				10537.00	808.00	414.70	45.35	18.15

From the above table, the total cropped area of the district for different crops like paddy, maize, Arhar, urd, moong, kulthi, wheat, rabi maize, chickpea, lentil, pea, mustard, linseed and ground nut 65880 ha.. The paddy occupies highest area in the district in case of cereals (37835ha). The total seed replacement rate area is 22413.0 ha. The standard seed replacement for paddy, Arhar, urd, moong, chickpea, lentil, pea and ground nut is 33 percent while SRR for maize, Rabi maize, mustard is 50 percent. The seed requirement for SRR from certified seed is about 10537.0 q for above mentioned crops in the table. The area required to produce the certified seed from foundation seed for different crops of the district 808.0 ha. The requirement of the foundation seed for SRR is about 414.70q. And to produce the foundation seed of 414.70q, 45.35 ha. Land is required. The breeder seed requirement for SRR for different crops of the district is 18.15q.Therefore. it is clear from the table that, the requirement of seed of different type like breeder, foundation and certified is different and to achieve the standard SRR, the quality seed must be produced and supplied to farmers well in time so that yield can be increased by replacing through traditional varieties

District Profile of Dhanbad

Geographical Area (in Hac)	Cultivated Land (in Hac.)	Waste Land (in Hac)	Land Cultivated (in Hac)				Irrigated Land (in hac)	No of Blocks	No of Panchayat	No of Village
			Kharif	Rabi	Summer	Total				
1	2	3	4	5	6	7	8	9	10	11
181046.89	64456.06	35392.45	5554.45	21315.86	16	76871.31	4695.55	10	256	1247

Block Level Information of District Dhanbad

Sl. No.	Name of Block	Geographical Area (in Hac)	Cultivated Land (in Hac.)	Waste Land (in Hac.)	Land Cultivated (in Hac)				Irrigated Land (in hac)
					Kharif	Rabi	Summer	Total	
1	2	3	4	5	6	7	8	9	10
1	Dhanbad	4212.52	1132.94	1041.91	869.24	193.00	0.00	1061.24	82.00
2	Tundi East	12754.60	5771.65	1530.89	4605.00	2080.00	0.00	6685.00	376.00
3	Tundi	26489.73	8863.29	2516.26	7006.40	2364.00	0.00	9370.40	645.00
4	Baliapur	18261.17	9852.00	222.00	8809.90	3587.58	0.00	12397.48	2165.00
5	Govindpur	29592.99	11682.52	2831.08	9474.50	4500.00	0.00	13974.50	901.00
6	Nirsa	43280.42	10644.74	1726.24	9473.25	4881.00	16.00	14370.25	399.55
7	Topchanchi	19177.57	8629.94	6125.17	8112.15	3538.28	0.00	11650.43	17.94
8	Baghmara	27277.89	7878.98	19398.90	7190.01	172.00	0.00	7362.01	109.06
	Grass Total	181046.89	64456.06	35392.45	55540.45	21315.86	16.00	76871.31	4695.55

The above shows the, total area of the district is 181046.89 ha which includes 64456.05 ha. Cultivable land and 35392.45 ha. Waste land. The land cultivated in all the season is 76871.31 ha. Which includes kharif (21315.86 ha), Rabi (21315.86) and summer (16 ha).The total irrigated land of the district is 4695.55 ha. The total number of blocks in the district is 10and spread in 256 panchayat and 1247 villages. The Dhanbad district is rain-fed and mono cropping is most common.

Standard Seed Replacement for paddy in Kharif season of Dhanbad district

Name of Block	Paddy (ha)	SRR Area for Paddy (ha)	Seed (C/S) requirement for SRR in Paddy crop (qt.)	Area required to produce F/S to C/S achieve 33 % SRR (seed village Area) (ha)	Seed(F/S) requirement for SRR in Paddy crop (qt.)	Seed (B/S) requirement for SRR in Paddy crop (qt.)
Dhanbad	652.00	215.00	86.00	4.00	1.60	0.80
Tundi East	2455.00	810.00	324.00	13.00	5.20	
Tundi	3615.00	1192.00	476.00	19.00	8.00	
Baliapur	6717.00	2216.00	886.00	36.00	15.00	
Govindpur	6485.00	2140.00	856.00	34.00	14.00	
Nirsa	7519.00	2481.00	992.00	40.00	16.00	
Topchanchi	4167.00	1375.00	550.00	14.00	6.00	
Baghmara	6225.00	2054.00	821.00	33.00	13.00	
Grass Total	37835.00	12483.00	4991.00	193.00	78.80	0.80

The total paddy cultivated area of the district is 37835 ha, in which paddy is cultivated in kharif season and area required for standard SRR is about 12483ha.and area required to produce certified seed from foundation seed 193 ha. The seed requirement of foundation seed for SRR is about 78.80q.

Standard Seed Replacement for Maize in Kharif season of Dhanbad district

Name of Block	Maize (ha)	SRR Area for Maize (ha)	Seed (C/S) requirement for SRR in Maize crop (q)	Area required to produce F/S to C/S achieve 55 % SRR (seed village Area) (ha)	Seed(F/S) requirement for SRR in Maize crop (q)	Seed (B/S) requirement for SRR in Maize crop (q)
Dhanbad	85.00	43.00	9.00	0.50	0.10	0.03
Tundi East	210.00	105.00	21.00	1.00	0.20	
Tundi	235.00	118.00	24.00	1.50	0.30	
Baliapur	490.00	245.00	49.00	3.00	0.60	
Govindpur	410.00	205.00	41.00	2.00	0.40	
Nirsa	435.00	218.00	44.00	2.50	0.50	
Topchanchi	355.00	178.00	36.00	2.00	0.40	
Baghmara	425.00	213.00	43.00	2.00	0.40	
Grass Total	2645.00	1325.00	267.00	14.50	2.90	

The maize is second major crops grown in the district in 2645 ha. and SRR area is 1325 ha. The requirement of the certified seed for maize is 267 qt and area required for 55 percent SRR is 14.50 ha. the requirement of the foundation seed is 2.90qt.Now farmers also using hybrid seeds in case of maize, but majority of the farmers using traditional or previous crop seeds

Standard Seed Replacement for Pulses in Kharif season of Dhanbad district

Name of Block	Pulses (ha)	SRR Area for Pulses (ha)	Seed (C/S) requirement for SRR in Pulse crop	Area required to produce F/S to C/S achieve 33 % SRR (seed village Area)	Seed (F/S) requirement for SRR in Pulses crop	Seed (B/S) requirement for SRR in Pulses crop
Dhanbad	62.00	21.00	6.00	1.50	0.45	1.50
Tundi East	422.00	139.00	42.00	9.00	3.00	
Tundi	315.00	104.00	32.00	7.00	2.00	
Baliapur	474.00	157.00	47.00	10.00	3.00	
Govindpur	450.00	149.00	45.00	9.00	3.00	
Nirsa	607.00	200.00	60.00	12.00	4.00	
Topchanchi	448.00	148.00	45.00	9.00	3.00	
Baghmara	527.00	174.00	52.00	10.00	3.00	
Grass Total	3305.00	1092.00	329.00	67.50	21.45	

The pulses has been grown in all the blocks of the district and the area under pulse production is 3305.0 ha. The standard seed replacement rate area is 1092ha. and certified seed required to SRR is 329.0 q. The area required to produce certified seed from foundation seed is 67.50 ha in all the blocks of the district. The foundation seed required to achieve 33 percent SRR is 21.45q while breeder seed required to produce foundation seed is 1.50q.

Standard Seed Replacement for Oilseeds in Kharif season of Dhanbad district

Name of Block	Oilseeds	SRR Area For Oil Seed	Seed(C/S) Requirement For SRR In Till Seed Crop	Area Required To Produce F/S to C/S Achieve 33 % SRR (Seed Village Area)	Seed(F/S) Requirement For SRR In Oils Crop	Seed (B/S) Requirement For SRR In Til Seed Crop
Dhanbad	8.00	3.00	0.15	0.01	0.30	0.02
Tundi East	11.00	4.00	0.20	0.10	0.30	
Tundi	12.00	4.00	0.20	0.10	0.30	
Baliapur	12.00	4.00	0.20	0.10	0.30	
Govindpur	15.00	5.00	0.25	0.01	0.30	
Nirsa	16.00	6.00	0.30	0.01	0.30	
Topchanchi	12.00	4.00	0.20	0.10	0.30	
Baghmara	12.00	4.00	0.20	0.10	0.30	
Grass Total	98.00	34.00	1.70	2.40	2.40	

The area under kharif oil seed in the district 98 ha. and SRR area is 34 ha. The seed required for SRR for til is 1.70q and the area requirement of 33 percent certified seed from foundation seed is 2.40 ha. The breeder seed required to produce 2.40 q seed is 0.02q.Til (sesame) is major oil crop of the district.

Challenges

There are several reasons for poor seed replacement in field crops in Jharkhand, including high cost of seed, large storage losses, inefficient conversion of breeder seed to certified seed, and lesser participation of the private seed sector. In spite of several constraints the seed replacement rate has increased tremendously in Dhanbad. A poor SRR among crops grown in Jharkhand, particularly in oilseed and pulses, has been observed. The various factors which are responsible for low SRRs in Dhanbad are mentioned below:

1. Recycling of seed: Dhanbad is characteristically a rain-fed district and its distribution of rainfall is erratic both spatially and temporally, with late onset of monsoon, and thus farmers prefer farm saved seed particularly in oilseed and pulses which are grown under marginal conditions. Pixley and Bänzinger (2001) reported that if second-generation

('recycled') seed of both open pollinated varieties (OPVs) and hybrids are used, then OPVs/HYVs are higher yielding than hybrids. So, regarding grain yield the following formula applies: hybrid > OPV > recycled OPV >recycled hybrid. In marginal areas where yield levels are low, if the price of hybrid seed is high compared to the grain price and if fertilizer application is constrained, consequently it is more profitable for resource-poor farmers to use OPVs or recycled OPVs than to purchase new hybrid seeds annually. Recycling of hybrid seed is a non-recommendable economic alternative (Schroeder *et al.*, 2013). In some areas, farmers indicated that they often are forced to recycle hybrid seed because the input supply system is unreliable and replacement seed is unavailable. But even when replacement seed is available, many farmers choose not to purchase first filial generation (F1) seed because they do not expect the investment to be profitable.

2. High seed cost: The cost of good quality seeds, especially hybrid seeds are very high and farmers at times are unable to purchase the seed at high cost. Considering small and marginal farmers who will be affected by the high cost of hybrid seeds, the seed producing companies should set the price of quality seed at a reasonable level.Supply of seed to small and marginal farmers should be at subsidized rates using government support.

3. **High seed rate per unit area and cost of transportation:** The availability of quality seed of improved varieties and hybrids is grossly inadequate and is a major constraint to enhanced production. Cost of transportation for some of the seeds e.g. potato and sugarcane seeds, is high because the seed production centers are located far away from the areas where production takes place. Localized seed production centers may be created to avoid the high cost of transportation.

4. Inefficient seed conversion ratio: Production of certified seed by following an efficient chain of breeder seed - foundation seed -certified seed, is still a major concern throughout India including Jharkhand. The most challenging task is to correct the conversion ratio (the seed multiplication ratio) in different categories of seed. The conversion ratio can be increased by improving seed multiplication rates (SMRs) and ultimately through good agronomic practices (GAPs).

5. Non-availability of quality seed of new varieties: In Eastern India, rain-fed upland rice covers approximately 4 million hectares. Although the upland varieties of rice are clearly marketable, efforts to involve the private sector in India in their seed production have not been successful because of the unprofitable nature of low yielding upland rice compared with irrigated transplanted rice (Witcombe *et al*., 2009). It is evident from the data that a huge gap exists between the number of varieties released and the number of varieties brought under Seed Production Programme.

6. Poor seed multiplication ratios (SMRs) and lack of exit plan: In Dhanbad, pulses and oilseed crops are grown under rain-fed and marginal conditions, viz. chickpea, groundnut and soybean in particular. They tend to have higher seed rates and low SMRs, leading to higher seed prices and relatively higher seeding costs. This leads to poor SRRs and VRRs, leaving farmers to go for farm saved seed. Re-sowing and/or gap filling further increase the requirement of quality seed in these areas (Singh, 2013).

Major Recommended Variety for Kharif season in Dhanbad District

Sl No	Crop	Variety
1	Paddy	CR DHAN-310[2016], CR DHAN-45[2016], SUKHA DHAN-5[2015], Samba Sub-1 (IET 21248)[2015], IR-64 DRT-1 (DRR DHAN-42)[2015], Indira Aerobic- 1(R1570-2649-1-1546-1) (IET 21686)[2015], CO 51[2015], BIRSA VIKAS DHAN-203[2015], BIRSA VIKAS DHAN-111[2015], DRR-44[2014], SUNBHAGI DHAN (IET 19576) (IR74371-70-1-1-CRR-1)[2011], SWARANA-SUB 1 (CR 2539-1) IET-20266[2009], CR Dhan 40 (IET 19253)[2008], Rajendra Mahsuri-1[2007], Abhishek (IET - 17868)(RR-272-829)[2007], Naveen (CR-749-20-2) (IET-14461)[2006], HAZARIDHAN[2005], Basmati [2005], Birsa Vikas Dhan-110[2005], Birsa Vikas Dhan-109[2005],VANDANA (RR-167-982)[2002], VIJETHA (MTU-1001)[1997], LALAT (IET-9947)[1989]
2	Maize	Birsa Vikas Makka-2[2005],
3	Arhar	TT-401[2009], Narendra Arhar-2 (NDA-98-1)[2008], Malviya Chamawtkar (MAL-13)[2005], Bahar [1986], UPAS-120[1976]
4	Urd bean	IPU 02-43[2009], Pant Urd-31[2008], Sulata (WBU 109)[2008], Shekhar-3(KU-309[2004],
5	Moong bean	IPM 02-3[2009],
6	Kulthi	Gujarat Dantiwada Horsegram-1 (GHG-5)[2012], Indira Kulthi-1 (IKGH-01-01)[2011], BIRSA KULTHI-1 (STRAIN-43)[1987]
7	Ground Nut	GJG-18[2016], Girnar-3 (PBS 12160)[2010], GPBD 5[2010], BIRSA BOLD-1[1994], TMV-2[1976]
8.	Til	Kanke safed

Conclusion

As per the National Seed Policy, 2002 emphasis was placed to increase the seed replacement rate (SRR) among different crops. According to Kumara Charyulu *et al*. (2014, p. 21), "Seed, the vehicle for delivering the benefits of technology, is the most important basic input, influencing the growth and sustainability in agriculture" Quality seeds have the potential to produce healthy plants which is the key to food production and food security. Furthermore, seed is a potential commodity for overall agricultural development and entrepreneurship as well as an important component of agricultural biodiversity. From the present study it has been established that seed is a critical input factor to increase production and productivity. The rice crop received the highest attention and the SRR has been achieved, because it excluded the area under hybrid rice which is quite significant (approximately ~25 percent). The case of maize is more or less the same. In pulses and oilseeds the SRR is erratic except in chickpea (gram) where it is

extremely low (<5 percent) and requires immediate attention, because chickpea is very important for food and nutritional security. For other crops, consistent and persistent efforts are needed to improve SRRs. The identified constraints to increasing VRRs and SRRs needs to be tackled on a priority basis with consistent and persistent efforts. The most challenging task is to correct the conversion ratio (the seed multiplication ratio) in different categories of seed (Singh, 2013). The conversion ratio can be increased by improving seed multiplication rates (SMRs) and ultimately through good agronomic practices (GAPs). The adverse effect of climate change on seed production and supply can be minimized by various approaches to seed chain management, i.e. breeding, seed production, seed certification and seed marketing.

References

1. Ayyappan S, Kochhar S. Indian agriculture in the new millennium:Innovative strategies for productivity enhancement prospects and challenges. Indian Seed and Planting Material, 2010; 3(1):1-10.
2. Bhaskar UK, Kamble UR, Prasad SR, Singh SR, Natrajan S, Pal G. ICAR seed project: Seed production in agricultural crops, Annual Report, (Institutional publication No. DSR/2014/01). Kushmaur, Mau: ICAR-Directorate of Seed Research. 2013-2014.
3. Gautam M. Strategies for quick spread of new varieties among the farmers. In Rathore, R. S., Srivastava, D. K. & Singh, RP. (Eds) Advancement in agriculture through quality seeds. Lucknow: Beej Vikas Nigam and Varanasi: National Seed Research and Training Centre, Ministry of Agriculture, Government of India. 7004 Singh and Singh, 2013, 49-53.
4. GOI. Agricultural statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of. 2012.
5. Agriculture Government of India. Retrieved from eands.dacnet.nic.in/ latest_2012.htm
6. GOI. Agricultural statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of. 2013.
7. Agriculture, Government of India. Retrieved from eands.dacnet.nic.in/ latest_2013.htm
8. GOI. Agricultural statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of, 2014.
9. Agriculture, Government of India.
10. Gowda CLL, Srinivasan S, Gaur PM, Saxena KB. Enhancing the productivity and production of pulses in India. In P. K. Shetty, S. Ayyappan, & M. S. Swaminathan (Eds), Climate change and sustainable food security. Bangalore: National Institute of Advanced Studies and New Delhi: Indian Council of Agricultural Research. 2013,145-149.
11. ICRISAT. Village seed systems: Improving smallholders' access to seed and agricultural technologies. *State-of-the-Art on Semi-Arid Agriculture (SASA)*, 2010; 5:1-9. Retrieved from http://archive-org.com/page/5244644/2015-01-02/http:/ /www.icrisat.org/what-we-do/SASA/sasa_apr 2010.htm
12. Kranthi KR, Venugopalan MV, Yadav MS. Hybrid cotton revolution in India. *Seed Times*, 2012; 5(4):29-38. Kumara Charyulu D, Bantilan C, Rajalaxmi A, Reddy BVS, Borikar ST, Kumar AA. e*t al*. Development and diffusion. 2014.
13. Of sorghum improved cultivars in India: Impact on growth and stability in yield (Working Paper Series No. 50). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).
14. Ministry of Agriculture. Proceedings of the workshop. In Union Agriculture Minister (Chair), Agriculture scenario in Eastern India: Review and future prospects. Workshop held at NASC Complex, DPS Marg, Pusa Complex, New Delhi. Retrieved from http://bgrei-rkvy.nic.in/Minutes/ Minutes of the one day workshop on Agriculture Scenarioin EasternIndai- Reviewandfutureprospect.pdf. 2015.
15. Mohapatra T. Technologies to enhance rice productivity and nutritional security in Eastern India (Souvenir - Eastern Zone Regional Agriculture Fair 2013-14). Cuttack: Central Rice Research Institute. 2014.
16. National Seed Plan. *Seednet* India. Retrieved from *seednet.gov.in/ PDFFILES/National%20Seed%20Plan.pdf* Optimizing seed replacement rates in Jharkhand 7005, 2005.
17. NITI Ayog. Comment on the concept note on agriculture: Challenges and way forward Jharkhand. Retrieved from http://niti.gov.in/writereaddata/files/ Jharkhand_Report_0.pdf. 2015.
18. Paroda RS. Indian seed sector: The way forward. Indian *Seed Congress* 2013. Conducted by the National Seed Association of India (NSAI) at Hotel Leela Kempinsky, Gaurgaon, Haryana. Retrieved from http:// www.taas.in/documents/pub31.pdf. 2013.
19. Patil SA, Hanchinal RR, Nadaf HL, Biradar P, Motagi B N. UAS public-private sector-farmer partnerships in promoting new crop varieties/ hybrids through integrated seed supply system. Public-private sector for promotion of hybrid rice. International Workshop sponsored by Government of Maharashtra, Government of India, Indian Council of Agriculture Research (ICAR), and International Rice Research Institute (IRRI), conducted in Pune, India. 2004, 73-79.
20. Pattanaik BB. Quality seeds: Contribution of national seeds corporation. in A. K. Singh (Ed.), *Golden Jubilee Souvenir* 2012-13. New Delhi: National Seeds Corporation Ltd. 2013, 14-18.
21. Planning Commission. Report of the working group on crop husbandry, agricultural inputs, demand and supply projections and agricultural, statistics for the Twelfth Five Year Plan *(2012-2017).* Government of India. Retrieved. from ttp://planningcommission.gov.in/aboutus/ committee/ wrkgrp12/agri/AHD_REPORT_Final_rev.pdf. 2011a.
22. Planning Commission. Faster, sustainable and more inclusive growth. An approach to the Twelfth Five Year Plan (2012-17). Government of India. Retrieved from. 2011b. http://planningcommission.gov.in/plans/planrel/12appdrft / appraoch_12plan.pdf
23. Planning Commission. Report of the working group on agricultural research and education for the Twelfth Five Year Plan (2012-17), New Delhi: Planning Commission, Government of India. Retrieved from http:/ lanningcommission.gov.in/aboutus/committee/wrkgrp12/ agri/ wgrep_research.pdf. 2011c, 1.
24. Singh H, Chand R. The Seeds Bill, Some reflections. *Economic and Political Weekly*, 2011; 156(51): 22-25.
25. Singh RP. New frontiers in seed sector in Jharkhand - Role of SAU. *Seed Times*, 2012; *5*(3):75-88.

26. Singh RP. Issues and strategies to correct missing links in seed sector of India. Journal of Research. (BAU), 2013; 25(1):1-15.
27. Venkateswarlu B, Prasad JVNS. Carrying capacity of Indian agriculture: Issues related to rainfed agriculture. *Current Science*, 2012; 102(6): 882-888.
28. Witcombe JR, Packwood AJ, Raj AGB, Virk DS. The extent and rate of adoption of modern cultivars in India. In J. R. 1998.
29. Witcombe DS Virk, J Farrington. (Eds.), Seeds of choice: Making the most of new varieties for small farmers (pp. 53-68). New Delhi: Oxford and IBH Publishing Company. 1998.