Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP5: 450-458

Detail of authors are at bottom of this article

(Special Issue- 5)
International Conference on
"Food Security through Agriculture & Allied Sciences"
(May 27-29, 2019)

Stakeholder's repulsive approach leading to distorted seed chain: Lesson from the case study of participatory seed production in Jharkhand State

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Abstract
Jharkhand state separated as southern plateau from the erstwhile Bihar, is richest in terms of country's mineral resources but among poorest by virtue of various developmental indexes and agricultural development is no way exception. Jharkhand agriculture is characterized as traditional one being subsistence type practiced on highly undulated topography and predominantly mono-cropping which the hallmark of state agriculture is. The state is inhabited predominantly by the resource poor marginal and small farmers (85%) who apply low external inputs under the rainfed marginal environmental conditions. The cropping intensity and productivity among all crops except pulses grown in state is far below than national average due to increased vulnerability, variability in yield and high yield gaps which seriously affect the food and nutritional security of the people in the state. The challenges before the Jharkhand agriculture is to increase crop production and productivity on sustainable basis by mitigating and adapting climate change effects, in order to make state not only self-sufficient in meeting its requirement of various food items, but also increasing farm income as the state is having highest level of farm household poverty in the country. To attain the set target of enhancing productivity, ensuring timely availability of quality seed in adequate quantity at affordable price to farmers is of paramount importance. The infrastructure related to seed production, processing, storage and distribution in the state is in nascent stage and depending on the outside agency to cater its requirement. Nevertheless, timely availability of seed of the appropriate varieties is very critical and therefore, the production of seed at local level is necessary which was started three years ago using participatory approach. In the present paper, the gained experience in seed production, certification, procurement, post-harvest management including processing and storage has been discussed. It is learnt that the assigned role of various stakeholders and their co-ordination is extremely important and the repulsive and/or non-supporting attitude of even one stakeholder may lead to the policy, program, distorted seed chain and enterprise failure. Moreover, this experience sharing may well be a lesson for other developing states/countries having similar kind of conditions and willing to enter in this venture. Nevertheless, corrective measures for different stakeholders including emphasis on the strengthening of semi-formal kind of seed system is advocated to promote climate resilient agriculture.

Keywords: Yield variability, participatory seed production, stakeholder's repulsive approach, distorted seed chain, semi-formal seed system, climate resilient agriculture

Introduction
India as a nation is committed firmly to achieve the Sustainable Development Goals (SDGs), which have been adopted globally to end poverty and hunger, achieving food security and improved nutrition, and promoting sustainable agriculture (SDGs 1 & 2), for enhancing adaptation to climate change (CC). In 2016, India has been ranked as 4th most vulnerable country in 2015 globally in terms of facing extreme weather-related events. For India, climate risk index (CRI), categorically emphasizing as a "warning sign" at risk of either frequent extreme weather events or, in rare cases, extraordinary catastrophes [1]. Indian Economic

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Survey [2], predicted long-term trend of rising temperatures, declining average precipitation, and increase in extreme precipitation events culminated in two major findings with significant implications of CC on agriculture The impact of temperature and rainfall is felt only in the extreme cases, such as when temperatures are much higher, rainfall significantly lower, and the number of "dry days" greater, than normal

i) These impacts are significantly more adverse in rainfed (area) crops as compared to irrigated (areas) crops.

Furthermore, the projected long-term weather patterns predict that CC can reduce average annual agricultural incomes to the tune of 15-18%, which can go up to 20-25% for rainfed areas. Jharkhand is a rainfed state and experiencing the climate change effects in terms of increased frequencies of facing droughts, cyclones and increased temperature extremes. In state like Jharkhand which is totally rainfed with variety of problems and having high multidimensional poverty index (MPI), multidimensional poverty headcount (%), and high percentage of underweight children (below 5 years), require holistic approach to increase production and productivity on sustainable basis, while to accomplish the agricultural sustainability in Jharkhand state seems to be a herculean task. Nevertheless, sustainable agricultural growth has been kept by SDGs as key strategy to reduce poverty, hunger and malnutrition.

Niti Aayog [3] emphasized categorically that Jharkhand State as a whole suffers from several critical gaps in agriculture and allied sectors in spite of the fact that a number of opportunities exists to make the state self-sufficient in agricultural production. One of the key strategies to improve soil health, cropping intensity, productivity and profitability on sustainable basis is to increase crop diversification [2]. Moreover, in the state, despite good rainfall, the cropped area and cropping intensity are low. The level of technology adaptation including quality seed is also poor leading to lower crop productivity and pointed out that quality seed is most critical for enhancing agriculture production and therefore, maintaining a strong local seed system with linkage to R&D system in the university or other research institutes is necessary [3]. To increase production, productivity and ultimately sustainability while reducing vulnerability, the development and deployment of new varieties is pre-requisite as the 50% contribution through varietal improvement in yield [4]. Moreover, not only the generation of new varieties but ensuring the availability of quality seed locally at affordable prices is extremely important for the adaptation, adoption and diffusion for the promotion of climate resilient agriculture, increasing productivity on sustainable basis and reducing poverty and vulnerability.

Jharkhand being rainfed state, always faces the problems of availability of quality seed and virtually any discussion regarding the improvement in agriculture inevitably concludes on the use and availability of quality seed. Seed security is pre-requisite to food security and therefore the food sovereignty of the nation is possible only when seed sovereignty is assured [5]. To avoid dependency on the external agencies for supplying seed of suitable varieties in the state, it is necessary that seed of locally adapted and adopted varieties be produced locally for ensuring the timely availability of most appropriate and climate resilient varieties for ensuring seed and food security in state. To do so, the seed production program was started in state and virtually in each District since 2015-16 using participatory approach and involving stakeholders from the state department of agriculture, state seed certification agency, state agricultural development corporation limited, state agricultural university and its farm science centers (Krishi Vigyan Kendras). In the present paper, the state profile of the Jharkhand and the experience gained including constraints encountered so far are discussed along with the correction measures which need to be incorporated for making this venture successful.

State profile: Jharkhand came into existence on 15th November, 2000 as 28th state carved out from erstwhile Bihar (southern plateau) having 14th and 16th ranks in country with respect to population and geographical area respectively. The newly created state being rural with the majority of its population thrives on agriculture. In spite of the richest state in terms of having largest minerals in the country, the state is backward due to its poor agricultural production and productivity. Jharkhand agriculture is characterized by having good natural resources in terms of ideal climatic conditions, sufficient rainfall but deficient water availability for irrigation, ideally suited land topography for high value crops. But due to improper management of natural resources (soil erosion including leaching out of soil nutrients due to quick run-off, inadequate water harvesting and loss of agro-biodiversity in the form of traditional/farmers varieties) in addition to insufficient infrastructure, poor post-harvest management including processing and market facilities. The state is having predominantly marginal and small farmers (M&SFs 85%) with the highest poverty among farm household 45.3% in Jharkhand as compared to 22.5% at national level [6], the relatively high level of illiteracy among M&SFs, who apply relatively low external inputs (seed, fertilizers, irrigation and farm power machinery etc.) due to poverty, monsoon based agriculture (with relatively high level of risk involved) resulted into mono-cropping traditionally which has been the hallmark of Jharkhand agriculture with low productivity except in pulse crops and cropping intensity (125 vs 150) as compared to national average. Moreover the increased frequencies of extreme events (droughts and temperature extremes) is responsible for the increased vulnerability, variability in yield and yield gaps. The state of Jharkhand also faces the ill effects of climate change and drought being the predominant one in this plateau region. The climate change is reality now and every year is warmer than the previous one. Droughts are regular features of the state and after every two-three years there is a drought in the state. In addition the cyclones also affected crop production particularly post monsoon season crops. The average annual rainfall of the state is 1280mm but due to its inadequate distribution more than 80% water runoff, rainfall which generally, used to go around for 100 rainy days, reduced to only 70 rainy days due to climate change and therefore the rainfall intensity has increased drastically with erratic and asymmetrical distribution.

Typically the performance of Jharkhand Agriculture still depends upon the onset of monsoon and proper distribution of rainfall during crop season. Since its creation, the area coverage under different field crops (cereals, pulses and oilseeds), production and productivity heavily depended upon the monsoon setting, its performance during crop season affecting crops coverage area, production and productivity, clearly demonstrated the fact that during last fifteen years (2001-02 to 2015-16) six times, area coverage remained

below than the previous year, while nine times production and eight times productivity levels remained below than the preceding year depicting the picture of vulnerability of Jharkhand Agriculture against drought and other extreme climatic events. Moreover, the state of Jharkhand agriculture is characterized with a number of (resources, technology, ensuring timely supply of seed) serious constraints which affect crop production and productivity adversely. Overall, the whole story of Jharkhand agriculture could be narrated as monsoon magic with highly unstable production and fluctuating productivity with no sustainability which ultimately culminated into food and nutritional insecure state.

Seed a critical factor for enhancing crop productivity in Jharkhand

In India, according to the 70th Round of National Sample Survey, at national level, on average basis, out of the total expenditure incurred on crop production by each cultivating agricultural household on various input factors such as on seed it is only 11% in comparison to 24% on fertilizers and manures and 21% on human labor [7]. Therefore, quality seed being having the lowest cost as input in India, but using it alone 20-25% increased productivity could be obtained. The formal seed sector in India accounts for about 30-35 per cent of the total seed distributed in country while informal seed sector comprising mainly farm-saved seed (FSS) which accounts for the remaining 65-70% [8]. In India, in general and Jharkhand in particular where traditional agriculture is still dominating the scene, farm-saved seed (FSS) is the most prominent source to raise crop year after year since farmers are familiar with the seed they grow themselves and know that the variety is adapted to local conditions and preferences. It is reported that more than 70 percent seed usage in India, particularly for food crops is through the farm-saved seed which leads to low SRR. Use of "Farm-Saved-Seed" is the time tested household tradition ingrained in the farming practices. The state of Jharkhand is no way different and the same practice is followed here too. However, the yield potential cannot be realised if due care is not taken regarding varietal and physical purity, seed health and vigour. Seed viability and seed vigour are the important two traits significantly influencing the crop performance. The use of quality seed solve 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.

It is well known fact that SRR has a strong positive correlation with the productivity and production of crops. The National Policy 2002, clearly emphasis that "it has become evident that in order to achieve the food production targets of the future, a major effort will be required to enhance the seed replacement rate of various crops. This would require a major increase in the production of quality seed". There is a "strong co-relationships between the quality of seeds, the seed replacement rate and the yields". One of the major reasons for low yields is disappointingly low rate of seed replacement rate. However, the desirable seed replacement rates (SRR), are 33% for self-pollinated crops, 50% for cross pollinated crops and 100% for hybrid.

International policies' perspectives on participatory approach: Issues like declining agro-biodiversity, climate change, hunger and malnutrition, poverty and water are haunting the administrators, policy planners, researchers and academicians and are being debated globally. Seed is in the mainstay to all these issues [9]. The formal seed system in spite of having contributed very significantly, do have some inherent weakness and is highly regulated by enforcing seed legislations, regulations and intellectual property regime (IPRs) in the form of proprietary material, is unable to meet the ever changing and diverse requirement for different cropping patterns/systems in different agro-ecological conditions. Louwaars [10], questioned the desirability and necessity to have a formal seed sector that is capable to meet the entire demand completely of the seeds of all crops planted while, Wattnem [11] stressed on the fact that virtually nowhere in the world and not even in the industrialized countries do formal seed systems exist without parallel and unregulated farmers' seed systems and therefore, recognizing the very importance of informal seed system (farmer's managed) which are absolutely necessary for the conservation of *in situ* agro-biodiversity for the present and future varietal development [12]. Various international instruments including the International Seed Treaty, known as international treaty of plant genetic resources for food and agriculture (ITPGRFA) of the FAO, is a comprehensive international agreement and in harmony with Convention on Biological Diversity (CBD) with the aims to ensure food security, also advocates participatory approach of the promotion of seed villages, community seed banks and protection/promotion of Farmers right. Moreover, at international level, Global Crop Diversity Trust (GCDT), the Global Partnership Initiative for Plant Breeding Capacity Building (GIPB), revised Global Plan of Action (GPA) for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (FAO) and the Nagoya Protocol (CBD) also emphasize on the strengthening of local seed systems which could only be done through participatory approach (Singh *et al*., 2015) in order to improve resiliency of the seed systems [13]. The PPB was also recommended by De Schutter the Special Rapporteur to the United Nations on the Right to Food [14]. Various International Centers for Agricultural Research under the aegis of consultative group on international agriculture research (CGIAR system organization) such as ICARDA, ICRISAT, IITA, CIAT and CIMMYT are engaged in PPB as a way to reach groups of farmers and areas that were bypassed by the green revolution [15, 16, 17].

Participatory approach: Both formal (conventional breeding and regulated seed production) and informal seed systems (farmers managed including seed exchange) have their own strength and weakness but any kind of seed system alone can't satisfy the diverse requirement of farmers in different agro-ecologies and therefore make it mandatory to take the best of both seed systems which can complementing each other in order to provide more and more options to farmers to chose from. PPB increase the response to selection, adoption, and benefit/cost ratio is possible by combining decentralized selection and farmers' participation in a PPB program proved to be more efficient in terms of response to selection [18], increasing adoption and, hence, increasing the benefit/cost ratio [15]. Ashby and Lilja [19] on the basis of meta-analysis PPB as compared to conventional breeding for over 150 projects and concluded that the overall level of benefit from the PPB, increased effectiveness of reaching women and the poor, improved research efficiency, varieties developed being more acceptable, faster varietal adoption and diffusion, and changed costs without lowering cost–benefit ratios [20]. In

order to identify and aquatinted with smallholder farmer's criteria for selection and adoption of new rice varieties, Burmana *et al.* [21] applied PVS programme from 2008 to 2014 in coastal zones during different seasons in the coastal region of India and demonstrated that farmers' preference criteria were entirely different from researcher's. Interestingly, yield was important, but not the only reason for varietal selection, and Farmers preferred tall (140-170cm), long duration (160-170 days), lodging resistant and high yielding (HY) rice varieties because these traits are required in lowlands where water stagnates in the field for about four months (July to October) during wet season whereas, during dry season, farmers' preferences were for HY salt tolerant, early maturing (115-130 days) varieties with long slender grains and good quality to fetch higher price.

i) Participatory Plant Breeding in Jharkhand

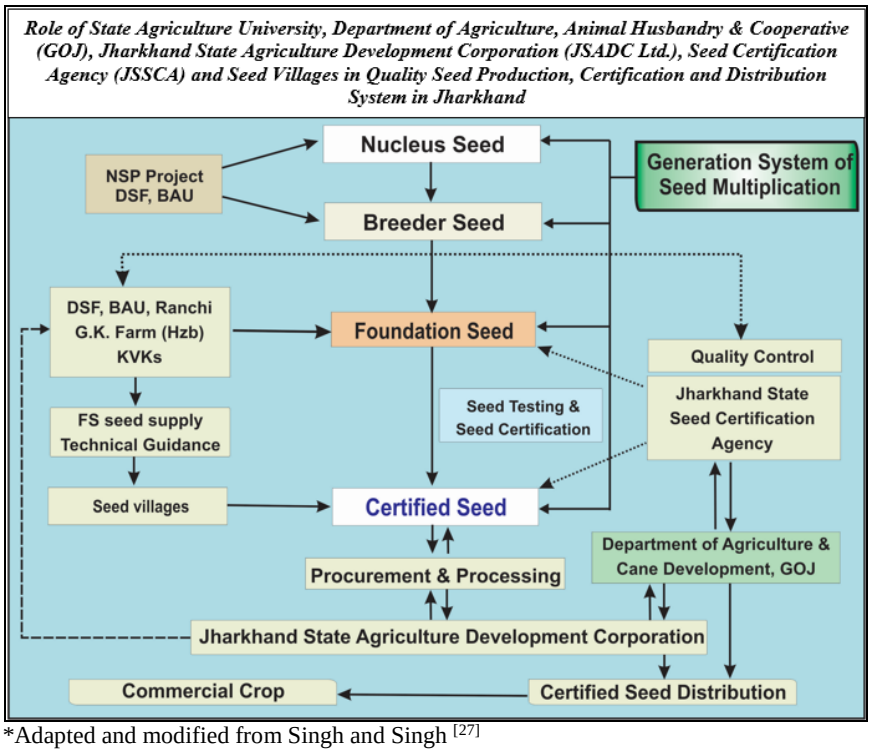
Witcombe *et al.* [22] and Witcombe and Jayavendra [23] while working on the participatory approach in the marginal environments in eastern India, established that organized formal crop breeding programs with centralized selection are unable to fulfil the demand of diverse local needs particularly those of smallholder farmers who value yield stability over yield in addition to have different breeding goals such as straw yield and culinary properties. Nevertheless, through PVS approach, Kalinga III variety of upland rice in Jharkhand state of Eastern India has been released for its cultivation while through client oriented breeding (COB) and another upland rice varieties Ashoka 200F (BVD 109) and Ashoka 228 (BVD 110). Originally released in Jharkhand, Ashoka 200F is now also recommended in Gujarat, MP and Rajasthan and Ashoka 228 in MP. Similarly, for rainfed, maize variety BVM-2 for eastern India was released [24]. Witcombe *et al.* [25] advocated for efforts to provide seed of varieties produced by client-oriented breeding (COB) for upland rice in India for which the university is producing breeder and foundation seed of these rice varieties but non lifting against the indented/ produced seed is a serious problem and hampering their widespread adoption and diffusion. The progressive status of breeder seed indent placed by Department of Agriculture and Cooperation (DAC Ministry of Agriculture, GOI) of different varieties of rice and maize developed through participatory approach is detailed in Table 1.

Table 1: Status of Breeder Seed Indent (in quintals) Placed by Department of Agriculture and Cooperation (DAC Ministry of Agriculture, GOI) of different varieties of rice and maize developed through participatory approach

	Breeder seed indent (q) placed by Department of Agriculture and Cooperation (DAC)			
S. N.	Year	Rice		Maize
		Ashoka 200F (BVD 109)	Ashoka 228 (BVD 110)	BVM-2
1.	2008	0.43	0.51	-
2.	2009	-	8	-
3.	2010	5	5	0.14
4.	2011	-	0.5	-
5.	2012	58	8	3
6.	2013	78	10	2
7.	2014	4	-	-
8.	2015	21	2	-
9.	2016	20	3.5	-
10.	2017	15	3.5	-

ii) Participatory seed production

Farmers managed seed systems and social networks are important to strengthen farmers' capacity through research and development to adapt and mitigate the climate change effects [26]. A massive seed production program through participatory approach was taken in 2016 as per the directives given by the chief secretary, Jharkhand Government. In the process, various stakeholders such as department of agriculture, Jharkhand state agricultural development corporation ltd, Jharkhand state seed certification agency, state agricultural university and its KVKs (farm science centers) in addition to large number of farmers in each district were involved in seed production activities. The role of different stakeholders is depicted in the Figure 1.



*Adapted and modified from Singh and Singh [27]

Fig 1: Role of different stakeholders in quality seed production, certification and distribution in Jharkhand*

In Jharkhand, the spread of quality seed among farming community exerted very good impact and increased the average productivity and profitability of the crop due to quality seed replacement over the farmers saved seed. Also, the income of farmers as seed producer increased significantly [28]. Participatory seed production program was started by different KVKs of the university in 2011-12 and was continued till 2014-15, the range of activities taken up by the different KVKs in order to create awareness with respect to use of quality seed for crop production program (Table 2) along with entrepreneurship development by imparting trainings/seed days/field days BAU under the aegis of ICAR Seed Project, Tribal Sub Plan (TSP) not only helped in dissemination of technologies at untapped far flung tribal areas of Jharkhand but also helped in enhancement of their income, development of huge human resource in seed sector through the establishment of seed villages [29]. After having gained the required experience and as per the decision taken by the Government seed production program was expanded in a big way covering most of the popular crops and varieties in the state. As per directive of Chief secretary, Jharkhand each KVK had to form 25 seed villages in their respective district with an area of 50 ha per seed villages resulting in a huge number of 600 seed villages with an area of 30000 ha in the state. Against the set target around 300 seed villages with an area of around 15000 ha were formed and made functional as per the availability of foundation seed in the state.

The progressive status of seed production through participatory approach since before 2015-16 and after is given in Table 2. As can be seen the quantity of quality seed produced along with the number of crops in which seed production activities were extended increased and virtually each and every crop was included under this program.

Table 2: Participatory Certified Seed/truthfully labeled Seed Production (*Quintals*) in farmers' field-2011-12 to 2017-18

S.N.	Crop	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Monsoon season								
1	*Rice*	12400	16682	12550	7550	12223	90323	164393
2	*Fingermillet*						270	240
3	*Pigeonpea*	5	280	240	100	30	2045	1218
4	*Green gram*						215	67
5	*Blackgram*						352	485
6	*Kulthi*						260	
7	*Sesame*					3	46	83
8	*Groundnut*	12					100	2009
9	*Sub total*	12417	16962	12790	7650	12256	93611	168496
Post monsoon								
10	*Wheat*		550	1050	275		8577	472
11	*Gram*					94	7997	314
12	*Lentil*						1389	121
13	*Field pea*						20	91
14	*R&M*		70		75	80	5159	882
15	*Linseed*						205	137
	Sub Total		620	1050	350	174	23347	2016
	G. Total	12417	17582	13840	8000	12430	116958	170513

Under Central Government (Ministry of Agriculture, Farmers Welfare and Cooperatives) sponsored scheme namely National Food Security Mission(NFSM), pulse seed hub program was also launched in the state in 2016 with the objectives to increase pulse production and productivity domestically in order to ensure their availability to the consumer at the affordable prices, encouraging farmers to grow pulse crops with higher minimum support price (MSPs), 10-20% over and above the prevailing market price of nearest mandi (local market) while reducing import of pulses as India is the largest producer, consumer and importer of pulses in the world. Under this program task assigned was to provide quality seed of new improved varieties (with the age of less than 10 years) among various pulse crops to popularize them in the state in order to increase their adoption and diffusion. Nevertheless, by the use of new climate resilient varieties among different pulse crops, the adaptation and mitigation could be enhanced to climate change effects vis-à-vis increased pulse production and productivity of pulses in Jharkhand. Moreover, the investment made on the development of these new varieties could also be realized. The seed production status of various pulse crops under NFSM pulse seed hub program is mentioned in Table 3.

Table 3: Certified Seed (FS/CS) production (q) under Pulse Seed-Hub Programme (NFSM)-GOI in Jharkhand during 2016-17 and 2017-18

S. N.	Crop	2016-17		2017-18	
		FS	CS	FS	CS
1	Pigeonpea	368	-	421	400
2	Chickpea	-	653	670	-
3	Lentil			112	-
4	Field pea	280	10	150	-
5	Green gram	90	20	440	-
6	Blackgram	62.5	31	98	60
7	Horse gram			8	-
	Total	800.5	714	1899	460

Constraints experienced: The main constraints encountered during two years of participatory seed production program have been related to the procurement of the produced certified seed from the seed growers and inordinate delay in making payment followed by cumbersome seed certification process, inadequate logistic facilities in terms of collection, processing and proper seed storage facilities. Technically, non-availability of qualified and experienced seed certification personnel, their repulsive approach, non-coordination among officials from different stakeholders such as department of agriculture (DOA-GOJ), Jharkhand state seed corporation limited (JSSC Ltd) created in 2012-13 and later renamed as Jharkhand state agricultural development corporation limited (JSADC Ltd) as major inputs supplier agency and Jharkhand state seed certification agency (JSSC Agency) further complicated and exaggerated problems, while administratively, adoption of 'ad hoc' approach, no advance indent given to the university with regard basic generation seed, adoption and enforcement of different seed pricing purchase policy from the seed growers, high level of bureaucratic and hierarchical approach. All these factors culminated in the institutional failures and seed growers sold the seed as grain and suffered huge loss economically and also lost confidence to move on further in the same venture. The failure of participatory seed production may be attributed to sudden decision of launching massive seed village programme without proper planning, absence of a 'seed production, procurement, processing and marketing module', lack of resource inventory consisting adequate number of seed processing machines and transport system as well as administrative lapses from the State Department of Agriculture/Jharkhand State Agriculture Development Corporation/Jharkhand State Seed Certification Agency.

The same problems equally encountered with regard to NFSM

pulse seed hub program with similar fate and results. Only stakeholder which performed its role is state agricultural university and its Krishi Vigyan Kendras (farm science centers) who performed seed production activities by developing seed villages, providing foundation seed and imparted trainings to farmers for quality seed production. All issues with respect to the requirement of different kind of seed, the responsibilities of various stakeholders, the different kind of constraints and possible remedial measures are enlisted in Table 4.

Strategies for healthy and efficient seed chain management system

1. A blue print of seed plan involving all the stake holders viz. State officials, State Agriculture University, KVKs, Seed certification agency, Jharkhand State Agriculture Development Corporation and Seed villages with their role and responsibility should be developed and a time line for different earmarked activities supported with proper fund and resources must be fixed. A tight monitoring system with a team of expert will have to be formulated to ensure the implementation of blue print in given time frame in respect of production to marketing.
2. Jharkhand State Seed Corporation Ltd. (JSSC Ltd.) should be restored back instead of Jharkhand state agricultural development corporation limited (JSADC Ltd) and need to be made functional and it should come out of shadow from Directorate of Agriculture. Moreover, JSSC Ltd. need to strengthened basic infrastructure and need to take lead by developing and/or strengthening backward as well as forward linkage in addition to develop better coordination among various stakeholders.
3. Jharkhand state seed certification agency (JSSCA) need to be strengthened by recruiting seed certification officers/seed inspector/seed analyst based upon the prescribed qualification and experience as per seed act 1966 on regular basis in order to certify 40-45000ha area under seed production (certified and foundation seed).
4. As per the mandate, the University is responsible for the production of basic generation seed categories (breeder and foundation) which has also been endorsed by NITI Aayog in the concept paper on Jharkhand Agriculture. Altogether, the University is having land to produce the desired quantity of breeder seed only but as per norms the breeder seed has to be produced under the strict supervision of concerned crop breeder and most of the KVKs do not have breeders in place and KVKs shall continue to produce the foundation seed as usual. Based upon the requirement of foundation seed the breeder seed shall be produced by the University which need lot of resources to produce the BS category as per genetically and physical purity norms.
5. Since most of the popular varieties of different cereals, pulses and oilseed crops have been developed by other institutes under ICAR/different SAUs and therefore, to obtain their nucleus seed arrangements need to be made by Directorate of Research, BAU for obtaining their nucleus seed legally due to intellectual property rights (IPRs) come into play. Presently, Jharkhand Agriculture is exploiting the advantage of spill over technologies in terms of superior high yielding varieties.
6. The foundation seed shall be produced by the selective progressive farmers in specific areas with the technical support from the University but for that a written agreement (MOU) is required between the State Department of Agriculture and the University.
7. An advance (atleast 2-3 years before) indent is prerequisite for the desired quantity of foundation seed from the Department of Agriculture along with partial advance so that the progressive farmers be chosen and engaged in foundation seed production activities.
8. If an MOU is signed between Jharkhand State Agriculture Development Corporation/Directorate of Agriculture Govt. of Jharkhand and BAU Ranchi to produce the foundation seed then BAU Ranchi will enter into agreement individually with selective progressive farmers of the state in order to produce Foundation seed on the behalf of University under the supervision of BAU Ranchi so as to have sound supply chain management system.
9. In India, farmers have been recognized as "breeders" under the protection of plant varieties and farmers right act (PPV&FR Act) 2001. Moreover, under PPV&FR Act 2001, a large number of farmer's rice varieties (FVs) have been protected by issuing PVP certificates. In Jharkhand state traditionally rainfed agriculture is practiced and rice crop is extremely important for food security point of view. Farmer's rice varieties particularly for upland conditions are still very existing and the need of the hour is to bring those FVs which are having PVP certificates into seed chain in order to maintain and use the agro-biodiversity which can only be done through participatory seed production approach [30].
10. For this, to take the full advantage of the rich genetic diversity in the form of farmers varieties (FVs) an alternative registration and certification system developed by the Food and Agriculture organization of the United Nations known as "Quality Declared Seed (QDS)" system is advocated to channelize and commercialize FVs using formal system [28]. The QDS system being semi-formal with low operational cost and loosely regulated as compared to conventional seed certification has several advantages in difficult areas. Under QDS system different categories of varieties may be included such as

i) Varieties developed through formal seed systems
ii) Farmers/local varieties
iii) Varieties developed through alternative plant breeding approaches such as participatory plant breeding according to the Food and Agriculture Organization of United Nations [31].

Also, the adoption and implementation of QDS policy of the FAO in parallel can easily accommodate and integrate the registered farmers varieties (FVs) as per PPV&FR Act (2001) into seed chain effectively and efficiently to maintain and sustain genetic diversity at local level.

11. Strengthening of Seed Certification and Quality Assurance Mechanisms: National Seed Policy 2002 emphasized on the ensuring the availability of high quality of seeds and check the sale of spurious or misbranded seeds. To ensure the quality of seeds, State Governments appoint Seed Inspectors under Seeds Act, 1966 and the Seeds (Control) Order, 1983. These inspectors draw the sample from seed packets being sold in the market and send the same to the notified seed testing laboratories for quality checking. If any seed is found substandard or any seed dealer contravenes the provisions of the Seeds Act or Seeds Rules, legal proceedings can be initiated against such seed dealers or distributors [32]. A system of "Licensed Seed Inspectors", who are well qualified and are trained under

SAUs/ICAR institutes, may be introduced. These Inspectors can get license after through training in a programme on techniques of seed testing, maintenance of genetic purity and post-harvest handling of the seeds. The licensed Inspectors could either work in their independent capacity or could be retained by seed producing agencies. This was recommended after deliberations in Seminar on Seed Certification and Seed Law Enforcement-Session I, Seed Certification System-Strength & Weakness [33]. On the possible alternatives and suggestions for improvement, certification is desirable for better quality of seed and to control seed borne diseases and have healthy seed chain. Furthermore, policing at different levels is highly undesirable and it is suggested that the system adopted in OECD and UK can be adopted in which certification is done by licensed seed certification inspectors.

12. As the frequencies of extreme events due to climate change (droughts, extreme temperatures, and reducing number of rainy days from about 100 to just 70 odds, erratic rainfall distribution, cyclones etc.) in Jharkhand have increased during last decade have rendered state farmers more vulnerable and remain stressed due to low crop production coupled with high level of yield variability and high yield gaps. To mitigate these challenges the adaptation at local level is essential and this can only be achieved through participatory approach (participatory plant breeding, varietal selection and seed production at local level) involving farmers and rural youth and women through developing entrepreneurship and strengthening seed system locally [34]. Also, the popular farmer's varieties being resilient need to be incorporated in the active seed chain particularly in case of upland rice in order to make available the quality seed of FVs and finally appropriating the much needed farmer's rights [35, 36].

Table 4: Summary of standard operational procedures (SOPs) of stakeholders, constraints experienced and remedial measures for healthy and effective seed chain management in Jharkhand

S.N.	Seed category	Annual capacity		Enforcing Agency	Constraints Experienced			Remedial Measures
		Requirement of CS seed (Q)	Requirement of area (Ha)		Logistic constraints	Technical	Administrative	
1.	Certified Seed (CS)	6.5-8 lakh qtl. including contingency seed planning	40000-50000	i) Jharkhand state Agriculture	i) Inadequate facilities; Seed processing plant With the annual capacity of 3000 MT	i) Non availability of trained and qualified persons in seed certification	i) Adoption of 'ad hoc' approach	i) Advance indent is prerequisite for the desired quantity of FS from DOA-GOJ and/or JSADC Ltd
				ii) Development	Construction Of building receiving shade, drying platform etc. for annual capacity of 3000 T	ii) Lack of co-ordination among officials of JSADC Ltd, JSSC Agency and DOA-GOJ	ii) No advance indent given to the university with regard basic generation seed	ii) JSADC Ltd should take lead for strengthening of required infrastructure.
				iii) Corporation limited (JSADC Ltd.)	ii) Seed storage facilities (1000 MT one unit & the requirement is to develop capacity to store 2000MT annually) Advance indent to be placed for nucleus seed	iii) Non lifting/partial lifting/delay in lifting of the seed produced by the farmers	iii) Inordinate delay in making payments to seed growers	iii) JSADC Ltd should take lead for strengthening of backward and forward linkage.
				iv) Jharkhand State Seed Certification Agency (JSSC Agency)	iii) Transportation of seed in good condition	iv) Cumbersome registration process for seed growers	iv) Different and ever changing seed purchase policy	iv) JSSC agency should work on recruiting qualified persons on regular basis.
				v) Directorate of Agriculture (DOA-GOJ)		v) Poor time management	v) Bureaucratic and hierarchical approach	v) Minimum 25% of the estimated cost of the advance indent need to be deposit to the university.
2.	Foundation Seed (FS)	0.25 lakh qtl.	1900-2000	Birsa Agricultural University (SAU) with the support of selected progressive farmers			vi) No incentive to scientist involved in this venture	vi) An MOU is required between JSADC Ltd, DOA-GOJ and university
3.	Breeder Seed (BS)	0.02 lakh qtl.	150-160	National Seed Project (NSP-BAU)				vii) The desired quantity of FS seed shall be produced by selective progressive farmers on the basis of an MOU between BAU & selective progressive farmers individually

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