

Kudrat revolution: A series of improved crop varieties

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Abstract

Improving quality of crop, increasing productivity and preserving loss of biodiversity is crucial for meeting demands of increasing population. This necessitated need for research institutes to release suitable plant varieties so as to enhance production, tolerance to insect, pests and. National Innovation Foundation- India has been forefront in recognizing and popularizing several of farmer developed varieties. Shri Prakash Singh Raghuvanshi is one among the progressive farmer who has been continuously practising successive selection method and developing new varieties of crops like paddy, wheat, pigeon pea and mustard. These varieties are popularly named as “Kudrat”. NIF-India has supported scientific validation and dissemination of these varieties at farmers’ field of Uttar Pradesh, Chhattisgarh and Orissa and researchers have come up with data revealing higher yield, bolder grain size, resistant to biotic stresses, etc. therefore, these varieties are widely accepted and appreciated by the growers.

Crops are the important source of several nutritional components viz., proteins, carbohydrates, fibres, vitamins and mineral nutrients like calcium, iron, sodium, magnesium, serving the world’s population. Despite the production of crop is increasing at a steady rate, it is not enough to feed the increasing population. With the estimated world population to reach upto 9 billion by 2050 (World Population Prospects, 2016: World Population Clock, 2017), the huge challenges lie ahead. Production of agricultural crop is also affected by several abiotic stressors like temperature, water, salt, radiation, chemicals etc. It is reported that average 50% yield losses in crop production are caused by abiotic factors (Wang *et al.*, 2007).

Paddy (*Oryza sativa*) is principal crop for the inhabitants of India with more than 40% of contribution in total food grain cultivation and production (Singh, 2016). There is steady increase in the production of paddy in India as per the demand raised, during 2010-11 it was 96.7 million tonnes which increased to 105.31 million tonnes in 2011-12 and then 105.5 million tonne in 2014-15, however there is no noteworthy change under the area of cultivation for the same period. (Anonymous, AGRICOOP 2017). The major paddy producing states are West Bengal with total contribution of 16145.3 tonne followed by Uttar Pradesh as 12894 tonne, then Punjab contributing 11194 tonne followed by Andhra Pradesh as 9447.3 tonne and Arunachal Pradesh, Mizoram and Nagaland are the lowest contributor as 0.8 tonnes, 1.3 tonnes and 8.1 tonnes respectively.

Wheat (*Triticum aestivum*) is ranked as the second important food crop in India. The area under the wheat

cultivation has increased from 26.48 million hectares during 2005-06 to 31.46 million hectares in 2014-15. During the same period the production of wheat increased from 69.35 million tonne in 2005-06 to 94.88 million tonne in 2011-12 there was again a fall in the production to 86.53 million tonnes in 2014-15 due to unseasonal rain and hailstorms during March to April 2015 (Directorate of Economics and Statistics, Ministry of Agriculture, 2015-16). The major wheat producing states are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal, Uttaranchal, Himachal Pradesh, and Jammu and Kashmir. Uttar Pradesh ranked first in terms of area and production during 2015-16 with total production of 25425.2 tonne followed by Madhya Pradesh contributing 17688.7 tonne, trailed by Punjab, Himachal Pradesh and Rajasthan with contribution of 16077 tonne, 11352 tonne, 9871 tonne (Khatkar *et al.*, 2016).

Pigeonpea (*Cajanus cajan*) is one of the most popular and widely demanded pulse due to higher protein content. However, the production of pigeonpea is not corresponding with the pace of demand. During 2005-06 the production was 2738 tonne which dropped to 2654 during 2011-12 and then substantial increase was seen during 2014-15 as 2807 tonne. It has been estimated by Ministry of Agriculture and Farmers welfare, Govt. of India that production of pigeonpea would rise upto 4600 tonne during 2016-17. Madhya Pradesh is the highest contributor in the total production of country’s pigeon pea which was around 578 tonne during 2015-16 followed by Maharashtra (561 tonnes), Karnataka (270 tonne), Uttar Pradesh (238 tonne).

Mustard (*Brassica juncea*) is one of the main oilseed crop and also the good source of omega-3 fatty acids, vitamin B-1, magnesium, phosphorus and copper. It is also considered as one of the major source of income for growers of mustard. India holds third position in world's total production of Rapeseed and Mustard. India saw a fluctuated production of Rapeseed and Mustard from 8.13 million tonnes during 2005-06 to 6.60 million tonnes in 2011-12. The production again increased to 7.88 million tonnes in 2013-14 and fell down to 6.82 million tonnes during 2014-15. Rajasthan is the leading producer of Rapeseed and Mustard in India. It contributed percent 46.09 (2.89 million tonnes) in total production of country in 2014-15. The other leading producers were Madhya Pradesh, Haryana, Uttar Pradesh, West Bengal and Gujarat (India Stat., 2016).

Seed replacement rate plays a strong role and has and direct correlation between crop production and productivity. Seed replacement rate for wheat variety in India increased by 0.77% from 2009 to 2010, it was 32.63% during 2010 and very nominal increase to 32.55% was observed during 2011. For paddy the percentage increase was found to be increased from 33.6% to 37.47% in 2009 to 2010 and then subsequently to 40.42% in 2011. There was tremendous fluctuation in the percentage of pigeon pea, it was 27.79% in 2009 sudden fall from 27.79% to 17.51% was observed from 2009 to 2010 and then a raise to 22.16% was seen. Among Mustard crop seed replacement rate was found 74.8% in 2009 than it declined to 63.64% in 2010 and then it again increased from 63.64% to 78.88% in 2011 (Seednet India portal). National seed policy, 2002 advocates the emphasis on enhancement of the seed replacement rates of various crops which would have direct impact on food production targets. Availability of good quality seeds is a major problem that farmers are facing despite of huge institutional framework available for seed production due to high price of HYV, inadequate supply of HYV, lack of awareness among farmers, low purchasing power, often exchange traditional varieties within the community, non-availability of quality seeds (Kakoty and Barman, 2015; Singh and Kumar, 2014; Singh *et al.*, 2013). Sustained increase in agriculture production and productivity necessarily requires continuous development of new and improved varieties of crops and efficient system of production and supply of seeds to the farmers. To enhance the productivity and in order to meet the demand of burgeoning population, several improved varieties are being developed by the research institutes, scientists and farmers. Among several developed varieties

of important crops like paddy, wheat, pigeon pea and mustard, “Kudrat” series varieties have emerged recently. These varieties are the outcome of successive selection method, based on the unique traits (Choudhary *et al.*, 2016; Chodvadiya *et al.*, 2016).

Kudrat revolution: Kudrat revolutionist Shri Prakash Singh Raghuvanshi is an enterprising farmer born on 7th November, 1959. He resides in a small village Tadiya of Varanasi district, Uttar Pradesh. Educated only upto 9th class, he was forced to leave school due to loss of more than 60% vision due to wrong medication and penicillin reaction. Since his childhood he loved doing experiments, his poor eye sight could not stop him from following his passion though there were deep wound in



Shri Prakash Singh Raghuvanshi

both his eyes and he underwent treatment for more than 5 years. But somehow he managed and started helping his father with the farm activities. He felt the problems that farmers were facing in his village; they were dissatisfied with the higher agricultural inputs and lower output, which was putting pressure on people to migrate in pursuit of better livelihood. From there the idea came in his mind of developing the seeds by farmers themselves as he believed that seeds developed by farmer would be suitable to local environmental conditions as the one available in market are generalized and may not suit to the environment. Plant varieties developed by the farmer would also help in effectively reducing input cost and improving the output. He shared the main source of motivation for coming up with developing improved variety for him was his father and Dr. Mahatim Singh, former Professor at Banaras Hindu University (B.H.U.) and former Vice Chancellor, G.B. Pant University of Agriculture and Technology (GBPUAT). Dr. Singh encouraged him to develop improved varieties that would help farmers in raising better income thus improving their livelihood. Shri Raghuvanshi has an insight that each and every farmer of the country should get good quality organic seeds and high yielding varieties of crops. He believes:

अपनी खेती अपना खाद, अपना बीज अपना स्वाद, देशी बीज आजादी का बीज।

(One own's farming, one's own fertilizer)

“बीज बचाओ देश बचाओ”

(Save seeds, save the nation)

Since 1995, he started with the battle of the development of new plant varieties he initiated with paddy and then followed by wheat, pigeon pea and mustard. Financially he was not very strong; to carry the experiment he took a loan from bank and relatives. He faced lots of tides and falls in the way of crop improvement, and was in heavy debt. After several attempts finally, he succeeded with the development of a paddy variety with improved characteristics and at present, he has developed more than 15 varieties (eg. 'Kudrat' series) with better yield and other anticipated unique traits. Since the variety developed by him is free from chemicals and is natural so he named the variety as 'Kudrat'. Initially, when the variety was developed to know the feedback about the variety he started 'BEEJ DAAN MAHADAAAN' campaign in which he started distributing the seeds to the farmers and requested to distribute the seeds to other fellow farmers' based on their feedback. Shri Raghuvanshi has bred improved varieties of wheat, paddy, mustard and pigeon pea through a mass selection breeding method based on specific morphological characters of the plants. For dissemination of the varieties, his efforts and unique style are appreciable along with posters and banners which are commonly used; he uses appealing (catchy) slogans to attract the public and also participates in various rallies, *Haats*, *Kisan melas*.

Shri Prakash Raghuvanshi has received several awards and appreciations to his credit. He has been appreciated largely for his efforts towards protecting indigenous plant varieties by his active participation in various campaigns, fairs, workshops etc. He was conferred with national award for the varieties in the year 2009 by Smt. Pratibha Devi Singh Patil in 5th National Biennial Award Function organized by National Innovation Foundation- India (NIF database). He has also been privileged to be a part of NIF informal Research Advisory Committee (RAC) for evaluating the technologies developed by other grassroots innovators received at NIF for the national biennial competitions. Addition to this he has received a number of awards at various levels (both district and national) for his exemplary work. The varieties have been covered by print, electronic and social media.

Thousands of farmers' growing the varieties developed by Shri Prakash Singh Raghuvanshi are benefitted by the higher yields, lower input cost and higher profits.

Improved crop varieties : Shri Prakash Singh has developed number of improved wheat, paddy, mustard and pigeon pea varieties, which are high yielding, bold seeded with good aroma/taste and tolerant to major pests and diseases. These varieties have been developed using mass selection breeding method based on specific morphological characteristics of the plants.

Kudrat paddy varieties: Four improved varieties of paddy viz., *Kudrat 1*, *Kudrat 2*, *LalBasmati* and *Kudrat 5* were developed from HUVR-2-1, Pusa Basmati and HMT varieties, respectively. The specific feature of *Kudrat 1* is smaller seeds and highly rich in vitamin A, whereas unique trait for *Kudrat 2* is thin, long aromatic grains, tolerant to blight and stem borer, *Lal Basmati* is sweeter in taste with thin and long grains. *Kudrat 5* has very smaller size of seeds and resistant to blight disease.

Kudrat wheat varieties: The creative farmer had developed four wheat varieties i.e. *Kudrat 9*, *Kudrat 3*, *Kudrat 7* and *Kudrat 21*. The yield of *Kudrat 9* and *Kudrat 3* were about 55-60 q/ha and *Kudrat 7* and *Kudrat 21* give good yield i.e. 60-65 q/ha (Table 2). The plant height of *Kudrat 9*, *Kudrat 3*, *Kudrat 7* and *Kudrat 21* is 92 cm, 88 cm, 89 cm, 90 cm, respectively. The wheat varieties in general are characterized by higher number of ear bearing tillers, lengthy spikes, and more number of seeds per spike, robust stem and high protein content.

Kudrat pegeonpea varieties : The popular pigeon pea varieties *Kudrat 3*, *Chamatkar* and *Karishma* developed by the innovator are long duration category with maturation period of 230-235, 260-265 and 220-230 days respectively and produce higher yield ranging from 10-15q/acre (Table 3).

Kudrat mustard varieties: Three mustard varieties were developed using selection method viz., *Kudrat Vandana*, *Kudrat Gita* and *Kudrat Soni* have an average seed yield of 14.30 q/ha, 14.05 q/ha and 7.42 q/ha with an average oil content of 42.30 %, 39.00 % and 35.50 %, respectively. Special features of *Kudrat Vandana* is having higher number of seeds per pod and higher oil content; whereas,

Table 1 : Salient features of paddy varieties

Characteristics	(<i>Kudrat1</i>)	(<i>Kudrat2</i>)	(<i>Lal basmati</i>)	<i>Kudrat 5</i>
Yield (q/ha)	60-70	50-55	45-50	63-75
Days to maturity	125-130	115-120	90-100	120-125
Plant height (cm)	75-80	85-90	75-80	75-80
No. of tillers/plant	30-35	15-20	15-17	30-35



Fig. 1 : Kudrat paddy variety

both *Kudrat Gita* and *Kudrat Soni*, are characterised by bunched pods and bolder seeds.

Incubation support by National Innovation Foundation- India: NIF identified the extraordinary effort of the unsung hero and helped him in getting due recognition, respect and reward for his varieties and facilitated the validation trials in research institute of respective crops, SAUs and on-farm trials at farmers' field throughout the country. NIF has facilitated the registration of *Kudrat* varieties under Protection of Plant Varieties and Farmers' Rights Act, 2001 (PPV&FRA, 2001). The varieties *Kudrat 7, 17, 11* (wheat) and *Kudrat 3* (Pigeonpea) are under examination after DUS testing. The variety of wheat '*Kudrat 9*' has been registered via Reg. No. 15 of 2012 (Registrar, PPV&FRA, 2012). NIF has also facilitated the validation and on-farm research



Fig. 2 : Kudrat wheat variety

trial of the varieties. The validation trials on the varieties of wheat, pigeonpea and mustard were conducted at Chandrashekar Azad University of Agriculture and Technology (CSAUK), Kanpur, Indian Institute of Pulses Research (IIPR), Kanpur and Directorate of Rapeseed-Mustard Research (DRMR), Bharatpur respectively. The report of wheat varieties revealed that highest number of grain/ear was found in *Kudrat 21* (100-120) followed by *Gajraj 7* (90-110), *Kudrat 9* and *3* (60-70), *Kudrat 7* (50-60) and *Kudrat 11* (50-55). Yield was found highest in *Gajraj 7* as 65-70 q/ha, *Kudrat 7, 11* and *21* being the same with 65-70 q/ha and *Kudrat 9* and *3* with 55-60 q/ha. The experimental trial on four wheat varieties (*Kudrat 2, 7, 9, 11*) in comparison to local checks was also

Table 2 : Salient features of wheat varieties

Characters	<i>Kudrat 9</i>	<i>Kudrat 3</i>	<i>Kudrat 7</i>	<i>Kudrat 21</i>
Yield (q/ha)	55-60	55-60	60-65	60-65
Ear length (cm)	16.0	13.5	10.5	19
Grain colour	Red	White	Amber	Amber
Grain shape	Elliptical	Oblong	Elliptical	Elliptic
No. of tillers	12-15	10-12	13-17	8-9
No. of grain/ear	60-70	60-70	50-60	100-120

Table 3: Salient features of pigeonpea varieties

Characteristics	<i>Kudrat 3</i>	<i>Chamatkar</i>	<i>Karishma</i>
Yield q/ha	30-38	25-30	25-30
Plant height (cm)	260-270	250-255	255-265
Growth type	Perennial	Annual	Annual
Pod length (cm)	6-8	4-6	4-6
Pod type	NC-locules	Non-constricted	Constricted
No. of pods/plant	500-700 pods	400-600 pods	450-650 pods
No. of seeds/pod	4-6 seeds	3-5 seeds	3-5 seeds



Fig. 3 : Kudrat pigeonpea variety

conducted in Banaras Hindu University, Varanasi. The maximum plant height was recorded in *Kudrat 7* (106 cm) followed by *Kudrat 2* (105 cm), PBW 343 (100 cm), HUW 234 (95 cm), *Kudrat 9* (94 cm) and *Kudrat 11* (92 cm). Highest biomass was obtained in *Kudrat 11* followed by *Kudrat 7*, HUW 234, PBW 343, *Kudrat 9* and *Kudrat 2*. The highest yield was in local check variety HUW 234 as 59 t/ha, PBW 343 as 56 t/ha, *Kudrat 11* as 52 t/ha, *Kudrat 7* as 49 t/ha and *Kudrat 2* as 47 t/ha. HUW 234 was the early maturing variety as 111 days followed by *Kudrat 2* (113 days) whereas *Kudrat 11* and *Kudrat 9* taken 114 days to mature followed by *Kudrat 7* and PBW 343 (116 days).

The performance report on mustard varieties received from DRMR, Bharatpur revealed that the highest number of seeds per siliqua was recorded in *Kudrat Vandana* (39.9) following by *Pusa Gold* (29.1), *Kudrat Gita* (14.6), *Kudrat Soni* (14.3) and *Varuna* (12.6). The highest oil content was found in *Kudrat Vandana* with 42.3% and 41.1%, 39.5%, 39% and 35.55% for *Pusa Gold*, *Varuna*, *Kudrat Gita* and *Kudrat Soni*, respectively. The maximum yield was in *Varuna* (15.89 q/ha) followed by *Kudrat Vandana* (14.30 q/ha), *Kudrat Gita* (14.05 q/ha), *Pusa Gold* (12.10 q/ha) and *Kudrat soni* (7.42 q/ha). During *Kharif 2016*, *Kudrat Gita* was given to farmers for trial in two districts of Uttar Pradesh (Faizabad and Meerut), at 12 farmers' field and found be at par in terms of yield with other varieties cultivated in those areas.; Moreover, the variety had more number of branches, bolder seeds and good plant height (40-45 inches).

The validation trial of two innovator's pigeonpea varieties (*Kudrat 3* and *Chamatkar*) along with three checks (Mal 6, Bahar and Virat) was conducted at IIPR, Kanpur. The result revealed the outstanding performance in term of grain yield in *Kudrat 3* (3617 kg/ha) and



Fig. 4 : Kudrat mustard variety

Chamatkar (2185 kg/ha) followed by Mal 6 (2140 kg/ha), *Bahar* (1687 kg/ha) and JP 6 (1176 kg/ha). Maturity period for all the variety was found 235 days except for *Chamatkar* which was 265 days. *Kudrat 3* pigeonpea variety was also found to be superior in terms of yield and yield attributing traits and was suitable for cultivation under Gandhinagar, Gujarat condition (Choudhary *et al.*, 2016). All the varieties were reported as bolder seeds than the locally available varieties.

The field experiment on paddy varieties developed by Shri Raghuvanshi was conducted by Chandrashekhar Azad University of Agricultural and Technology, Kanpur. In 2016, NIF- India conducted on-farm trials on *Kudrat 5* in Angul district of Odisha and it was found that the tested variety is early maturing and requires lesser amount of water; it is tolerant to water logging and lesser loss of grain in the field during harvesting. NIF-India has also provided financial support to the Innovator for carrying out experiments, cultivation, establishing seed processing unit and scaling up marketing channels for the varieties under Micro Venture Innovation Fund (MVIF). In the first phase he was granted with Rs. 1,90,000/- which he has paid back with benefit sharing and in the second phase of MVIF, Rs. 3.0 lakh has been sanctioned to the innovator.

For disseminating the variety, he participated in various fairs, *Kisan mela* and traditional food festival, *Sattvik* (organized by SRISTI, Ahmedabad) where he got good response and order for the improved varieties. With the various campaigns, workshops done by Shri Prakash Singh and continuous support of NIF, the varieties have been disseminated successfully to incalculable farmers of fifteen states including Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Maharashtra, Rajasthan, Gujarat, Utrakhand, West Bengal, Jharkhand, Bihar, Karnataka, Orissa, Haryana and Punjab. Feedback received from the growers was appreciable.

NIF has also signed an agreement with Aarti Seeds and Research Agritech Pvt. Ltd. for production and marketing of *Kudrat* series of pigeonpea and Wheat

varieties developed by Shri Prakash Singh Raghuvanshi. **Conclusion:** The journey of Shri Prakash Singh Raghuvanshi from a common man to a renowned national award winner farmer is motivational. His exemplary efforts for developing the improved varieties have been a source of inspiration for millions of farmers of our country. It is required to disseminate such farmers' developed varieties at broader scale and strengthen the link between researchers, institutes and farmers. NIF- India not only rewarded and recognized the efforts of Shri Raghuvanshi but has also facilitated the mass scale spread of his varieties throughout the country and provided incubation support as well to maximize the reach of *Kudrat* seed revolution.

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