

A STUDY ON SOURCES, MANAGEMENT AND REPLACEMENT OF POTATO (*SOLANUM TUBEROSUM* L.) SEED IN WESTERN UTTAR PRADESH

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ABSTRACT: Presently in India, the actual potato yield is far below the potential yield. Enhancing the seed replacement rate is one of the important strategies to narrow the gap between the actual and potential yields. Hence, the present study was conducted to examine the sources, replacement rate and management of potato seed and constraints for availing quality seed in Western Uttar Pradesh. The primary data was collected from 85 randomly selected farmers of Bulandshahar and Meerut districts. The study revealed that the Kufri Bahar, Kufri Pukhraj and Kufri Khyati were the major potato varieties. Local varieties were still prevalent among farmers. The major seed sources were farm saved seeds, fellow farmers and formal sources like department of agriculture, SAUs and research institutes. Farmers have good knowledge of seed management activities like maintenance of spacing, seed rate, seed retention period and followed them properly. The overall seed replacement rate for certified seed was around 39 percent. There was a direct relationship between seed replacement rate and farm size. The overall seed replacement rate of seed of improved potato varieties was about 92 percent. The identified constraints were high cost of quality seed, poor quality of seed, lack of proper storage and transportation facilities, lack of seed of required varieties and lack of information about improved varieties. The study suggested that extension strategies and institutional mechanisms should be formulated for popularization of the new varieties and reliable seed sources and for regular supply of certified and quality seeds to all categories of farmers to enhance the seed replacement rate.

KEYWORDS: Potato seed, Seed replacement rate, Seed sources, Certified seed, Constraint analysis

INTRODUCTION

Potato was designated as “Food for Future” by Food and Agriculture Organization (FAO) in 2008, to reflect its importance as a food crop to address future global food and nutrition security (FAO, 2008). In term of human consumption, it is the third most important food crops after rice and wheat. It also plays a very important role in Indian agriculture as it alone contributes about 21.0 percent of the total vegetable area and 28.0 percent of total vegetable production of India (DAC&FW, 2018). India has achieved a phenomenal growth in potato production in the past seven decades. The production has increased from around 1.5 million tons in 1950-51 to over 48.5 million tons during 2019-20. Although

there has been a remarkable achievement in potato production, the present productivity in India is still low when compared with most of the potato growing developed countries, and is still far below India’s potential yield of about 400 q/ha. Due to increase in population, changes in lifestyle and economy, it is estimated that by the year 2050, India would require about 125.0 million tons of potato from an area of 3.6 million ha (CPRI, 2015). Increasing potato productivity from current status i.e., about 23.0 t/ha to 34.5 t/ha in 2050 would be a herculean task to achieve. At present level of farm management practices, India actually able to harvest only 42.0-45.0 percent of the achievable yield, which could be improved to 80.0 percent by efficient and

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effective dissemination and implementation of improved technologies (CPRI, 2015).

The quality seeds of improved potato varieties are the basic and crucial determinants of productivity and account for 30.0-40.0 percent of the total potato production cost (Kharumnuid *et al.*, 2018). The use of good quality seed of improved varieties along with other improved technologies will play a major role narrowing the yield gaps. It is estimated that the direct contribution of quality seed alone to the total production is about 15.0-20.0 percent, depending upon the crop and it can be further raised up to 40.0-50.0 percent with effective management (Singh and Singh, 2016, Singh, 2013; Natrajan *et al.*, 2009). As potato seed degenerates quickly due to viral infection, it should be replaced every 4 years to avoid yield reduction. In the Indian context, for ages, seed requirement of farmers is mainly met by farm saved seed, i.e., still 65.0 percent of the farmers are using their own saved seed (DSR, 2015), leading to low seed replacement rate (SRR) in most crops. Against this background, the present study was undertaken to examine the sources and management of potato seed, seed replacement rate and major constraints in availing certified and quality seeds of improved potato varieties in Western Uttar Pradesh.

MATERIALS AND METHODS

Sampling procedure and sources of data

The *Ex-post facto* research design was implemented for this study. We purposively selected Uttar Pradesh state of India, since it is the highest potato producer in the country, producing more than 30 percent of total potato production. The primary data pertaining to 2017-18 crop season, was collected by personal interview with 85 randomly selected potato growers of Western Uttar Pradesh (43 growers from Unchgaon, Jahangirabad and Syana blocks of

Bulandshahar district and 42 potato growers of Kharkhoda, Macchara and Daurala blocks of Meerut district) using a pre-structured interview schedule, which consisted of both close-ended and open-ended questions. The sampled farmers were later stratified into 5 strata on the basis of their size of operational holdings. They were marginal (below 1 ha), small (1-2 ha), semi-medium (2-4 ha), medium (4-10 ha) and large (10 ha & above) farmers. The final sample consisted of 7 marginal, 16 small, 25 semi-medium, 24 medium and 13 large farmers.

Measurement of variables

The SRR for potato crop was worked out for certified seed and seed of improved varieties separately. SRR is defined as the percentage of area sown with certified/quality seeds out of the total cultivated area under a crop in a season (Singh and Chand, 2011). It is calculated using the following equations:

$$SRR = \frac{C \times 100}{A \times K}$$

(a) Certified seed:

Where, SRR=Seed replacement rate, C=Certified seeds used by the farmers (in quintal), A=Area under the potato crop (ha), and K=Seed rate per unit of area (quintal/ha)

$$SRR = \frac{V \times 100}{A \times K}$$

(b) Seed of improved varieties:

Where SRR, A and K stand for the same notations as in above equation and V=seed of improved varieties used by the farmers (in quintal).

Furthermore, we also identified the seed sources and salient management of potato seed by direct questioning method. Thirdly, the constraints faced by farmers in availing/procuring the potato seed was identified by asking the respondents to indicate the extent

of their agreement to each constraint related statement on a three-point continuum scale. The ranking of constraints was done based on Weighted Mean Score (WMS) which was calculated by the formula $WMS = \frac{FW_i}{F_i}$, where F is the frequency of farmers; W is weight of each scale; i =3 for most severe; 2 for severe and 1=for not severe).

RESULTS AND DISCUSSION

Variety wise area and quantity allocation for potato

The variety wise area and quantity allocation of seed for potato crop in the study areas was analyzed and presented in the Table 1. The Table revealed that Kufri Bahar was the

Table 1. Variety wise area (ha) and quantity (q) allocation for potato crop in Western Uttar Pradesh (N=85)

Varieties	Year of release	Marginal		Small		Semi-Medium		Medium		Large		Overall	
		Area (ha)	Qty (q)	Area (ha)	Qty (q)	Area (ha)	Qty (q)	Area (ha)	Qty (q)	Area (ha)	Qty (q)	Area (ha)	Qty (q)
Kufri Bahar	1980	1.66 (62.37)	59.40 (65.74)	4.66 (44.31)	165.30 (44.44)	11.29 (32.44)	374.85 (31.93)	19.43 (28.73)	761.48 (29.82)	38.28 (43.65)	1361.56 (42.64)	75.32 (37.05)	2722.59 (36.88)
Kufri Pukhraj	1998	0.32 (12.17)	12.00 (13.28)	1.54 (14.64)	45.60 (12.26)	10.36 (29.77)	361.60 (30.80)	18.30 (27.05)	694.27 (27.19)	12.26 (13.98)	473.58 (14.83)	42.78 (21.04)	1587.05 (21.50)
Kufri Khyati	2008	0.20 (7.61)	6.00 (6.64)	1.21 (11.50)	41.40 (11.13)	4.05 (11.64)	146.64 (12.49)	10.04 (14.84)	402.08 (15.75)	8.90 (10.15)	340.98 (10.68)	24.41 (12.00)	937.10 (12.69)
Kufri Chipsona-1	1998	0.00 (0.00)	0.00 (0.00)	0.32 (3.08)	14.40 (3.87)	1.01 (2.90)	34.80 (2.96)	0.69 (1.02)	20.40 (0.80)	14.69 (16.75)	474.21 (14.85)	16.71 (8.22)	543.81 (7.37)
S-4	Not known	0.23 (8.82)	6.96 (7.70)	1.17 (11.12)	45.30 (12.18)	1.34 (3.84)	39.60 (3.37)	4.45 (6.58)	153.05 (5.99)	3.36 (3.83)	149.41 (4.68)	10.55 (5.19)	394.32 (5.34)
Kufri Chipsona-3	2006	0.00 (0.00)	0.00 (0.00)	0.20 (1.90)	7.50 (2.02)	0.65 (1.87)	21.00 (1.79)	2.06 (3.05)	61.20 (2.40)	7.16 (8.17)	303.42 (9.50)	10.07 (4.95)	393.12 (5.32)
302	Not known	0.00 (0.00)	0.00 (0.00)	0.81 (7.70)	30.00 (8.06)	2.71 (7.79)	87.30 (7.44)	2.87 (4.24)	98.22 (3.85)	0.00 (0.00)	0.00 (0.00)	6.39 (3.14)	215.52 (2.92)
Kufri Garima	2012	0.04 (1.52)	1.50 (1.66)	0.32 (3.08)	12.00 (3.23)	0.81 (2.33)	12.00 (1.02)	0.65 (0.96)	21.62 (0.85)	3.04 (3.46)	90.00 (2.82)	4.86 (2.39)	137.12 (1.86)
Kufri Frysona	2009	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.28 (0.81)	10.50 (0.89)	3.77 (5.57)	139.51 (5.46)	0.00 (0.00)	0.00 (0.00)	4.05 (1.99)	150.01 (2.03)
2001	Not known	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.70 (4.88)	50.50 (4.30)	1.01 (1.49)	37.51 (1.47)	0.00 (0.00)	0.00 (0.00)	2.71 (1.33)	88.01 (1.19)
Kufri Pushkar	2005	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.02 (2.99)	75.02 (2.94)	0.00 (0.00)	0.00 (0.00)	2.02 (0.99)	75.02 (1.02)
Kufri Surya	2006	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.34 (1.98)	59.42 (2.33)	0.00 (0.00)	0.00 (0.00)	1.34 (0.66)	59.42 (0.80)
Kufri Anand	1999	0.00 (0.00)	0.00 (0.00)	0.28 (2.66)	10.50 (2.82)	0.00 (0.00)	0.00 (0.00)	1.01 (1.49)	29.53 (1.16)	0.00 (0.00)	0.00 (0.00)	1.29 (0.63)	40.03 (0.54)
Kufri Sadabahar	2008	0.20 (7.61)	4.50 (4.98)	0.00 (0.00)	0.00 (0.00)	0.20 (0.58)	6.00 (0.51)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.40 (0.20)	10.50 (0.14)
S-1	Not known	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.40 (1.15)	29.10 (2.48)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.40 (0.20)	29.10 (0.39)
Total	-	2.66 (100.0)	90.36 (100.0)	10.52 (100.0)	372.00 (100.0)	34.80 (100.0)	1173.9 (100.0)	67.64 (100.0)	2553.31 (100.0)	87.69 (100.0)	3193.15 (100.0)	203.31 (100.0)	7382.72 (100.0)

Note: Figures in parentheses indicate the percentage of the total area/quantity of particular varieties in respective farmers' categories

most popular variety and covered about 37.05 percent of total potato area of the sampled farmers, which was followed by Kufri Pukhraj (21.01%). A recently released variety Kufri Khyati (12.69%) was the third major potato variety. Processing varieties like Kufri Chipsona-1 (7.37%) and Kufri Chipsona-3 (5.34%) also covered significant potato area. Local and unnotified varieties like S-4, 302, 2001 and S-1 are still adopted by farmers. Similar percentage was seen in the variety wise allocation of quantity for potato seed by the farmers. It is evident that about 90.00 percent area were under improved varieties developed by ICAR-Central Potato Research Institute. The trend was almost similar for all the categories of farmers. Younger varieties like Kufri Garima and Kufri Frysona are covered only small areas, which may be due to the unavailability of seeds.

Sources of potato seeds

The important seed sources of farmers in the study areas were analyzed and presented in Table 2. The analysis revealed that the most important seed source was farm saved seeds, which was used by about 38.90 percent of farmers and covered about 48.10 percent of potato area. Using of self-retained seeds by farmers may be due to lack and high

Table 2. Sources of potato seeds of sampled farmers (N=180)

Seed Sources	Farmers		Area (Ha)	
	f	%	Area	%
Farm saved seeds	70	38.90	97.70	48.10
State agricultural department, SAUs, KVKs	38	21.10	54.60	26.80
Fellow farmers' seeds	42	23.30	31.60	15.60
Seed traders/local markets	22	12.20	7.70	3.80
Commercial seed growers	6	3.30	5.30	2.60
CPRI	2	1.10	6.40	3.10
Total	180	100	203.3	100

Note: Total farmers=180, since some farmers procured seeds from more than two sources, f=frequencies of farmers

cost of quality seed of required varieties. As mentioned earlier, potato seed is very expensive; the marginal and small farmers could not afford to purchase them. The second important source was the seed exchanged or purchased from fellow farmers (23.30% farmers, 15.60% potato area). Thus, it is evident that informal seed sources contributed more to potato seed supply in the study area. About 22.00 percent of farmers procured certified/quality seeds of improved varieties from formal sources like State Agriculture/Horticulture Departments, State Agricultural Universities, Krishi Vigyan Kendras (KVKs) and research institutes. The farmers perceived that quality of seeds from formal sources was excellent, however, their quantity was limited and the cost was comparatively higher than the seeds sold by the village traders. Mostly, progressive farmers who were having good knowledge about seed sources and varieties and have good contact with the extension agents could get such seed. Besides these, some farmers also purchased seeds from other seed sources like local seed dealers, private companies and commercial seed producers. Therefore, government should take measures to ensure regular supply of quality seeds at prices affordable by all categories of farmers, and extension activities like trainings, frontline demonstrations, etc. should also be organized for farmers on scientific production of quality seeds.

Salient seed management practices

The important seed management practices of farmers in Western Uttar Pradesh have been presented in Table 3. It is evident that sampled farmers in the study areas properly followed the recommended seed management practices. On an average, the seed rate was found to be about 34.92 quintal of seed per hectare. This is because farmers mostly used whole seed rather than cut potato seed. The

Table 3. Salient potato seed management practices followed by sampled farmers in Western Uttar Pradesh.

Farm size categories	Seed rate (q/ha)	Seed retention period in year (% of farmers)					Use of seed potato (% of farmers)		Spacing (cm)	
		1	2	3	4	≥ 5	Whole	Cut	Row-Row	Plan-Plan
Marginal	33.36	42.86	14.29	28.57	0.00	14.29	71.43	28.57	61	20
Small	35.50	31.25	18.75	37.50	0.00	12.50	81.25	18.75	61.75	20.25
Semi-Medium	33.97	32.00	12.00	36.00	8.00	12.00	88.00	12.00	56.64	18.96
Medium	35.75	33.33	12.50	37.50	8.33	8.33	91.67	8.33	56.67	18.87
Large	36.04	15.38	7.69	46.15	15.38	15.38	92.30	7.70	61	19.61
Total	34.92	30.59	12.94	37.65	7.06	11.76	87.06	12.94	59.42	19.53

findings revealed that overall, about 88.20 percent of sampled farmers replaced seeds within the recommended 4 years period. In potato cultivation, it is recommended to use whole seed tubers rather than cut tubers to prevent the crop from spread of seed borne diseases from one tuber to others. This practice of planting whole seed tuber was again followed by majority (87.06%) of the sampled farmers. It is observed that there is a direct relationship between utilization of whole seed and farm size; the larger the farm size, the more is the utilization of whole tuber seed. In the case of maintenance of spacing, on an average the row-to-row spacing was about 59.43 cm and the plant-to-plant spacing was 19.50 cm, which is almost equal to the recommended spacing. This is because, majority of farmers used tractor operated planters for planting of potato in the study areas. Overall, the seed management practices were properly followed by farmers, which may be due to high extension contacts because of the presence of various research institutes and agricultural departments near the study areas.

Seed replacement rate of potato

The SRR for certified seed and seed of improved varieties used by farmers was analyzed separately and presented in Table 4. In case of certified seed, the overall SRR of the selected farmers was 29.88 percent which

Table 4. Seed replacement rate of potato crop of sampled farmers in Western Uttar Pradesh (N=85)

Farm size categories	Certified seed	Seed of improved varieties
Marginal	0.00	93.89
Small	12.69	79.45
Semi-Medium	8.13	81.82
Medium	21.89	87.89
Large	45.82	96.29
Overall	29.88	91.78

is quite good, since the recommended SRR for potato crop should be more than 25 percent. However, the farm category-wise analysis revealed a direct relationship between SRR and farm-size. The SRR for certified seed was found to be 0.00, 12.69, 8.13, 21.89 and 45.82 for marginal, small, semi-medium, medium and large farmers, respectively. This may be due to better financial conditions of larger farmers to purchase seeds from formal sources and also of their good contacts with extension agents in the seed system. Most of the farmers, especially the marginal and small farmers, reported the high price of certified seed as their major constraints in potato production. The overall SRR of seed of improved potato varieties in the study areas was high at about 91.80 percent. This is because majority of farmers adopted improved potato varieties during 2017-18. There is no specific relationship between farm

size and SRR in the case of seed of improved varieties. The SRR of seed of improved varieties was found to be 93.89, 79.45, 81.82, 87.89 and 96.29 percent for marginal, small, semi-medium, medium and large farmers, respectively.

Major constraints in availing of certified seeds and seed of improved varieties

Finally, we analyzed the constraints faced by farmers in availing the certified seed and seed of improved varieties and presented in Table 5. It is evident from the table that high cost of quality seeds with an overall weighted mean score (WMS) of 2.25 was ranked as the first major constraint in the study areas. Since the cost of potato is very high, poor farmers, especially the marginal and small farmers have to either use their self-retained seeds or poor-quality seeds from the local traders, leading to low productivity. The second constraint was poor quality of seed sold by the village traders (WMS=2.16). Some farmers reported that the seeds sold by local traders are not of good quality, and they did not want to use them even if they have money at their disposal. The farmers also experienced the lack of proper storage and transportation facilities (WMS=2.01). Due to lack of transportation facility or high transportation cost, farmer found it difficult to purchase seed from the formal sources which are generally located either in the district headquarter or

in faraway places. Lack of seed of required varieties (WMS=1.94) was the fourth constraint, because of which, farmers have to stick to same old varieties. Moreover, many seed agencies did not supply seed in time, so farmers have to cultivate their own farm saved seeds. Lack of information about improved varieties (WMS=1.84) was another constraint that hinder farmers from obtaining good quality seeds.

CONCLUSION

The study revealed that majority of farmers adopted improved varieties, however, more area was under older varieties. The informal seed sources like farm saved seeds, peer farmers, and local seed traders formed the major sources which provided seed to about 70.00 percent of sampled farmers. The study also revealed that the formal seed sources also played an important role in the supply of certified and good quality seeds; however, their supply is limited. The overall SRR for certified seed was around 30.00 percent. The farm category-wise analysis revealed a direct relationship between seed replacement rate and farm size. The overall SRR of seed of improved potato varieties was high at about 92.00 percent. Furthermore, the findings revealed that the sampled farmers faced some constraints in availing certified/quality potato seeds, which lead to low seed replacement rate. Thus, extension strategies and institutional mechanisms like frontline demonstrations, popularization of new varieties and reliable seed sources, capacity building of farmers for production of quality seeds, creation of community seed villages and encouragement of PPP in quality seed production and dissemination, are recommended for enhancing the seed replacement rate for improving potato productivity and farmers’ income.

Table 5. Major constraints in procuring certified seeds and seed of improved varieties in Western Uttar Pradesh during 2017-18 (N=85)

Constraints	WMS	Rank
High cost of quality/certified seeds	2.25	I
Poor seed quality of available varieties	2.16	II
Lack of storage and transportation facilities	2.01	III
Lack of seed of required varieties	1.94	IV
Lack of information about improved varieties	1.84	V

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