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Supply-demand Gap of Formal Seeds for Fodder and Green Manure Crops in the Eastern Plain Zone of U.P.

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ABSTRACT

Background: Formal seed is the most critical input to enhance the productivity of fodder and green manure crops. Better accessibility of formal seeds of fodder and green manure can ensure twin effects- productivity and sustainability. The present study throws the light in respect of the supply-demand gap of formal seeds, causes and seed replacement rates of fodder and green manure crops.

Methods: The study was based on a survey conducted on a well-structured schedule during 2022 and 2023. Three stages of random sampling were adopted to select the Blocks, Villages and farmers. One bock with 06 villages and 60 farmers (10 farmers from each village) was selected randomly from each district for the study. So that study was comprised of a total of 05 blocks, 30 Villages and 300 farmers.

Result: The study found that there was a gap in the supply-demand of formal seeds of fodder and green manure crops. The study further reported an inverse relationship between farm size and use of the formal seeds for fodder and green manure crops. The seed replacement rate (SRR) was less for all categories of farms. Farm size is negatively associated with seed replacement rate. Low SRR signifying the need to strengthen the seed supply systems. It was further observed the seeds from the informal sector were given less preference by formers, in terms of quality, over to formal seeds provided by public and private sectors. Despite this, the reason for the gap was that the formal seeds belonging to the public sector were not available in proper time and quantity. The availability of seeds of desired varieties through the public sector was also an issue of concern. Whereas, access to formal seeds belonging to the private sector was limited due to higher prices in comparison to the farmers' saved seeds and formal seeds of the public sector causing a supply-demand gap for the fodder and green manure crops.

Key words: Demand, Fodder, Formal seeds, Green manure, SRR, Supply.

INTRODUCTION

Fodder plays an important role in the profitability of the livestock sector. One of the major constraints to the low productivity of livestock enterprises in India is the feed and fodder deficit. A deficit of 65 per cent of green fodder and 25 percent of dry fodder is expected for Indian livestock by 2025 (Chaudhary *et al*., 2012; Singh *et al*., 2013). Uttar Pradesh has also a shortage of green and dry fodder 38.28 per cent and 0.66 per cent, respectively (Govt. of UP, 2019-20). The regional deficits are more important than the national deficit, especially in fodder which is not economical to transport over long distances. Further, there is a major problem of low-quality crop residues for the forage requirement of livestock which is not enough for the maintenance of animal health and productivity.

On the other hand, green manure is a remedial approach towards agriculture. These crops are grown for the benefit of soil fertility and economic viability, which reduces the environmental impact of agriculture. Uttar Pradesh has a strong agriculture base being the largest producer of foodgrains, sugarcane, potato and milk. Despite this, the output per hectare of almost all the crops in the state is low particularly Eastern plain zone of the state where the soil nutrients exhaustive cropping system *i.e.*, Paddy-Wheat, is predominately practiced. The share of cropped area under wheat and paddy is still very high in the Easter Plain Zone of Uttar Pradesh accounting for about 68 percent of the total cropped area in this zone of U.P.

Seed is the most critical input to enhance the productivity of fodder and green manure crops. Good quality seed/planting material is one of the major limitations towards less area and production in forage crops (Parihar, 2010). Seed, being the principal input in determining productivity, seed replacement should be given utmost priority. In the Indian context, for a long period, the seed requirement of farmers has mainly been met by farm-saved seed, *i.e.*, 65 per cent of the farmers are using their own saved seed or seed distributed among them. Making quality seed available at the right time is a greater challenge than

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production per se. The Indian seed delivery system consists of both formal and informal systems. Even with investment in the formal system, as about 60-65 per cent of seed in use is un-labelled. It shows the deficiency in the seed delivery system and provides the scope for improvement in the seed delivery system of these crops. Inadequate availability of quality seeds of desired species at reduced cost is one of the major problems in the adoption of green manure practices.

There are different sources of seed supply developed by government of India in order to meet the increasing demand of seed by farmers and others. This has to some extent reduced the dependence of farmers on own saved seeds but has not been able to diminish it fully (Poonia, 2013). One of the basic reasons for the declining share of private sector in recent years is the increased dependence of Indian farmers on farm saved seeds. In India it is estimated that over two-thirds of farmers produce seeds from their own harvest (Sahai, 2000). According to Reddy *et al*. (2007), almost all smallholder farmers continue to take recourse in farmer-obtained seed (including their own) is not only because of their inadequate access to the formal sector but also because the few cultivars and varieties on offer in the formal seed sector do not meet their needs. The production of certified seed by following an efficient chain is still a major concern (Niti Ayog, 2018).

Considering the importance of fodder and green manure crops seed in the sustainable development of agriculture and livestock sectors, the proposed study entitled "Supply-demand gap of formal seeds of fodder and green manure crops in the Eastern Plain Zone of U.P." will throw light on respect of supply-demand gap, causes of the gap and seed replacement rates of fodder and green manure crops. The following hypotheses were made for the study:

1. There is a gap between the demand and supply of fodder and green manure crop seeds.
2. There is an inverse relationship between farm size and the use of formal seed of fodder and green manure crops.
3. The seed replacement rate is low for fodder and green manure crops.

MATERIALS AND METHODS

The study was based on a survey conducted on a well-structured schedule during 2022 and 2023 at Dept. of Agricultural Economics, Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh. U.P. Three stages of random sampling were adopted to select the blocks, villages and farmers while the Eastern Plain Zine and sample districts were chosen purposively for the study. Uttar Pradesh is divided into nine agro-climatic zones. Of these, the Eastern Plain Zone was selected purposively following the criterion of agricultural productivity (foodgrains) and yield gap. Tripathi (2019) in his report on 'Doubling the Farmers' Income in Uttar Pradesh by 2022: Opportunities and Constraints' mentioned that the Eastern Plain Zone has the lowest agricultural productivity (23.43 qtl./ha) among all the agro-climatic zones of the state except Vindhayan zones (17.62 qtl./ha) and Bundelkhand (14.58 qtl./ha). Verma *et al*. (2019) in their study found that the yield gap (potential and actual yield) of major crops in the Eastern Plain Zone varies 29 qtl./ha for rice, 30 qtl./ha for maize, 18 qtl./ha for bajra, 24 qtl./ha for gram, 31 qtl./ha for wheat.

After the selection of the agro-climatic zone, the sample districts were chosen from the sample zone *i.e.,* Eastern Plain Zone. The Eastern plain zone comprises 12 districts namely Barabanki, Ayodhya including Ambedkar Nagar, Sultanpur, Pratapgarh, Azamgarh, Mau, Ghazipur, Ballia, Jaunpur, Varanasi, Chandauli and Bhadohi (86%). Out of 12 districts of the sample zone, 05 districts namely Ayodhya, Azamgarh, Varanasi, Jaunpur and Ballia were selected purposively because these districts are demarcated medium to low productivity districts. Verma (2019) in his study found that these districts fall in the category of medium to low productivity index for foodgrains (crop yield indices range 68.58-104.16). Further, according to the data of ICRISAT downloaded from its website http://data.icrisat.org/dld/src/crops.html on 18th March, 2022, a large area of fodder crops was grown in the districts was selected for the study. The area under fodder crops (th. ha) in Ayodhya, Azamgarh, Varanasi, Jaunpur and Ballia districts is 11.23, 5.93, 5.23, 3.59 and 3.6, respectively.

In the next step, three stages of random sampling were adopted to select the Blocks, Villages and farmers. One Block with 06 villages and 60 farmers (10 farmers from each village) was selected randomly from each district for the study. So that study was comprised of a total of 05 Blocks, 30 Villages and 300 farmers. Further, the total number of farmers to be selected from each village was the sum of the proportionate number of marginal, small and large farmers. Those farmers were included in the sample who had grown either one fodder or one green manure crop or both.

RESULTS AND DISCUSSION

Acreage under fodder and green manure crops

District-wise acreage under fodder crops in the Eastern plain zone of U.P. was estimated and presented in Table 1. The table reveals that the percentage area under fodder crops to the net sown area in districts of the Eastern plain zone varied 0.39 per cent to 3.58 per cent. The Eastern plain zone accounted 1.55 per cent of acreage under fodder crops to net sown area. The table further reveals that the area under kharif fodder was more as compared to the area under *Rabi* and *Zaid* fodder crops in all districts, except Ghazipur, indicating the disproportionate distribution of area under fodder crops across the season. It is further reported (Table 2) that the area under green manure crops varied 0.03-1.16 per cent in the districts of the zone indicating insignificant proportionate coverage to the net sown area.

Supply-demand gap of formal seeds for fodder crops

Presently, the country faces a net shortfall of 35.6 per cent of green fodder, 10.5 per cent of dry crop leftovers and

44 per cent of concentrate feed ingredients. The option for increasing land area under fodder cultivation is very limited (Singh *et al.*, 2022). Hence, it is a big challenge in front of us to utilize the available meager land wisely with its fullest potential to produce the fodders for the animals. The productivity of forage crops depends upon various factors and appropriate seed is one of them (Rahman and Cho, 2016). Non-availability of quality seeds of forage crops is also limiting fodder productivity in India.

Hence, crops-wise and farmers category wise supply-demand gap of formal seeds for fodder and green manure crops was estimated and presented in Table 3 and 4. Findings presented in Table 3 reveal that the supply-demand gap of formal seeds of fodder crops was 56 per cent for sorghum and Perlmillet (bajra), 50 per cent for maize, 52 per cent for barseem (*Trifolium alexandrinum*). The formal seeds of oats, cowpea, lucerne and napier grass were found negligible. The gap in the supply-demand gap of formal seeds of fodder crops across the various categories of the farms *viz.*, marginal and small farmers (<1 ha), medium farmers (1-2 ha) and large farmers (>1 ha) was also estimated and found that significant gap in the supply-demand of formal seeds of fodder was reported in the study area. The supply-demand gap was found 34 per cent, 39 per cent and 41 per cent for sorghum at the marginal and small farms, medium farms and large farms, respectively.

Similarly, supply-demand gap was found 42 per cent, 44 per cent and 54 per cent for sorghum at the marginal and small farms, medium farms and large farms, respectively. The estimated gap for barseem was reported 56 per cent, 58 per cent and 48 per cent at the marginal and small farms, medium farms and large farms. From the

Table 1: District-wise area under fodder crops in the Eastern plain zone of U.P., 2021-22.

Districts	Net sown area (ha.)	Area under fodder crops (ha.)				% Area of fodder to net sown area
		Kharif	*Rabi*	Zaid	Total	
Azamgarh	424058	2786 (57.37)	1479 (30.46)	591 (12.17)	4856 (100)	1.15
Jaunpur	399713	2005 (54.19)	1062 (28.70)	633 (17.11)	3700 (100)	0.93
Ballia	299265	421 (36.08)	480 (41.13)	266 (22.79)	1167 (100)	0.39
Varanasi	152678	2577 (67.99)	842 (22.22)	371 (9.79)	3790 (100)	2.48
Ayodhya	260266	3031 (48.95)	1567 (25.31)	1594 (25.74)	6192 (100)	2.38
Mau	171626	648 (38.57)	858 (51.07)	174 (10.36)	1680 (100)	0.98
Ghazipur	333214	8289 (69.53)	2138 (17.93)	1494 (12.53)	11921 (100)	3.58
Ambedkar Nagar	236203	1424 (41.58)	967 (28.23)	1034 (30.19)	3425 (100)	1.45
Sultanpur	265881	3760 (51.88)	1928 (26.60)	1560 (21.52)	7248 (100)	2.73
Pratapgarh	361629	1239 (46.79)	715 (27.00)	694 (26.21)	2648 (100)	0.73
Barabanki	388587	3445 (50.65)	1756 (25.82)	1601 (23.54)	6802 (100)	1.75
Chandauli	253374	1288 (64.50)	639 (32.00)	70 (3.51)	1997 (100)	0.79
Bhadohi	103102	767 (77.55)	107 (10.82)	115 (11.63)	989 (100)	0.96
Total	3649596	31680 (56.16)	14538 (25.77)	10197 (18.07)	56415 (100)	1.55

Source: Sankhyiki Patrika, Government of U.P., 2021-22.

Table 2: District-wise area under green manure crops in the Eastern plain zone of U.P., 2021-22.

District (s) Name	Net sown area (ha.)	Area under green manure crops (ha.)	% Area of green manure crops to net sown area
Azamgarh	424058	120	0.03
Jaunpur	399713	1264	0.32
Ballia	299265	228	0.08
Varanasi	152678	479	0.31
Ayodhya	260266	1732	0.67
Mau	171626	55	0.03
Ghazipur	333214	644	0.19
Ambedkar Nagar	236203	1377	0.58
Sultanpur	265881	3076	1.16
Pratapgarh	361629	3643	1.01
Barabanki	388587	313	0.08
Chandauli	253374	50	0.02
Bhadohi	103102	107	0.10
Total	3649596	13088	0.36

Source: Sankhyiki Patrika, Government of U.P., 2021-22 *includes Urd, Moong, Sunhemp, Dhaincha.

Table 3: Supply-demand of formal seeds (Fodder crops).

Crops	Land holding groups									Total		
	Marginal and small (<1 ha)			Medium (1-2 ha)			Large (>2 ha)					
	Demand (kg)	Supply (kg)	Gap (kg)	Demand (kg)	Supply (kg)	Gap (Kg)	Demand (kg)	Supply (kg)	Gap (kg)	Demand (kg)	Supply (kg)	Gap (kg)
Sorghum	158.54	104.63	53.90	219.78	134.07	85.71	372.02	219.50	152.52	750.34	327.71	422.67
(n=52:39:31)	(3.96)	(2.62)	(34%)	(5.49)	(3.35)	(39%)	(9.30)	(5.49)	(41%)	(18.75)	(8.18)	(56%)
Maize	58.25	33.38	24.87	196	109.17	86.82	344	156.52	187.48	598.25	299.07	299.17
(n=17:23:28)	(1.46)	(0.84)	(42%)	(4.90)	(2.73)	(44%)	(8.60)	(3.9)	(54%)	(14.96)	(7.47)	(50%)
Bajra	23.76	11.45	12.31	64.26	30.39	33.86	106.68	43.42	63.26	194.70	85.86	109.43
(n=53:48:51)	(2.37)	(1.15)	(51%)	(6.43)	(3.04)	(52%)	(10.67)	(4.34)	(59%)	(19.47)	(8.53)	(56%)
Berseem	61.26	26.40	34.85	113.04	46.80	66.24	205.76	106.79	97.97	380.06	179.99	199.06
(n=68:66:51)	(2.45)	(1.06)	(56%)	(4.52)	(1.87)	(58%)	(8.23)	(4.27)	(48%)	(15.2)	(7.2)	(52%)
Oats	-	--	-	-	-	--	49.69	49.69	-	49.69	49.69	-
(n=0:0:8)							(0.66)	(0.66)		(0.66)	(0.66)	
Cowpea	-	-	-	-	-	-	31.52	23.00	8.51	-	-	-
(n=0:0:9)							(0.79)	(0.58)	(27%)			
Lucerne	-	-	-	5	5	-	-	-	-	negl.	negl.	negl.
(n=0:0:1)				(0.125)	(0.125)							
Napier	15186	15186	15186	1125	-	1125	562 slips	-	562 slips	negl.	negl.	negl.
(n=2:2:2)	slips	slips	slips	slips		slips	(0.019)					
	(0.051)	(0.051)	(0.051)	(0.038)								

Source: Primary survey, 2022-23; figures in parentheses indicates cropped area (ha) of respective crops.

above analysis, we may say that the size of the farm and gaps in demand and supply of formal seeds for fodder crops in the study area was positively associated. Thomas and Thomas (2019) in their study reported that only 25-30 per cent of the required quantity of quality seeds is available in cultivated fodders. So, there is a need to evolve superior varieties of forage crops with high yield and quality and also development of new technologies for multiplication.

Supply demand gap of formal seeds for green manure crops

The urd (*Vigna mungo*), moong (*Vigna radiata)* and dhaincha (*Sesbania bispinosa*) were the main crops grown for green manuring in the study area. The supply-demand gap was estimated for seeds of green manure crops (urd, moong, dhaincha, pea, sunhemp) and presented in Table 4. Table shows that the supply-demand gap for urad, moong and dhaincha was 59 per cent, 57 per cent and 35 per cent, respectively. The farm's category-wise supply-demand gap was highest for large farmers and lowest for marginal farms indicating an inverse relationship between the size of the farm and the use of formal seeds for green manure crops in the study area. The gap at marginal and small farms, medium farms and large farms for urd was 46 per cent, 52 per cent and 64 per cent, respectively. Similarly, the marginal and small farms, medium farms and large farms reported supply-demand gaps of 49 per cent, 52 per cent and 64 per cent for moong and 6.5 per cent, 39 per cent and 39.8 per cent for dhaincha crop. The formal seeds of pea and sunhemp were found negligible.

Seed replacement rates (SRRs) for fodder and green manure crops

Seed replacement rate (SRR) is a criterion to assess the use of certified and/or quality seed of a crop and indicates the area under quality seeds. The seed replacement ratio is a measure of how much of the total cropped area was sown with certified seeds in comparison to farm-saved seeds (Chand, 2007). Improving SRR helps in enhancing the productivity of the crop. Table 5 shows that the SRR was highest for cowpea (49.6%) followed by sorghum, maize, perlmillet (bajra) and barseem accounted 48.3 per cent, 46.2 per cent, 45.4 per cent and 42.3 per cent, respectively. Further, oats and lucerne accounted 100 per cent use of formal seeds but these were grown by only a few large farmers.

Similarly, Table 6 shows seed replacement rates (SRR) for green manure crops indicating the share of formal seeds as percentage of cropped area. The SRR was highest for dhaincha (65.00%) followed by moong (42.35%), urd (40.18%). Table 6 further reveals that marginal and small farmers use proportionate more land for cultivation of fodder and green manure crops by formal seeds compared to large farmers. Alternatively, the proportion of land allocated for formal seeds declines with the size of landholdings for fodder and green manure crops. Seed replacement for fodder and green manure crops were positively associated with the price

Table 4: Supply-demand of formal seeds (Green manure crops).

Crops	Land holding groups								Total		
	Marginal and small (<1 ha)			Medium (1-2 ha)			Large (>2 ha)				
	Demand (Kg)	Supply (Kg)	Gap (Kg)	Demand (Kg)	Supply (Kg)	Gap (Kg)	Demand (Kg)	Supply (Kg)	Gap (Kg)	Demand (Kg)	Supply (Kg)	Gap (Kg)
Urd	9.0	4.80	4.20	34.35	16.32	18.03	72.95	25.61	47.35	116.3	47.73	69.58
(n=11:23:21)	(0.75)	(00.40)	(46%)	(2.86)	(1.36)	(52%)	(6.08)	(2.13)	(64%)	(9.69)	(3.89)	(59%)
Moong	20.09	10.15	9.95	53.10	22.46	30.64	65.86	25.88	39.57	139.05	58.49	80.16
(n=12:29:27)	(01.67)	(0.85)	(49%)	(4.43)	(1.87)	(57%)	(5.49)	(2.16)	(60%)	(11.59)	(4.88)	(57%)
Dhaincha	368.00	203.57	164.55	1354.69	820.94	533.75	3123.81	2127.26	996.50	4846.50	3151.77	1694.7
(n=35:75:70)	(14.73)	(8.14)	(6.5%)	(54.18)	(32.84)	(39%)	(124.95)	(85.09)	(39.8%)	(192.85)	(126.7)	(35%)
Pea	-	-	-	-	-	-	117.19	57.07	60.12		-	-
(n=0:0:5)							(1.56)	(0.76)	(51.30%)			
Sunhemp	-	-	-	-		-	13.99	4.46	9.50	-	-	-
(n=0:0:7)							(0.70)	(0.22)	(68.1%)			

Source: Primary survey, 2022-23; figures in parentheses indicates cropped area (ha) of respective crops.

and timely availability of the formal seeds (Table 7). Farm size is negatively associated with SRR of the fodder and green manure crops in the study area. Low SRR signifies the need to strengthen the seed supply systems for fodder and green manure crops.

Perceptions of the seed characters by farmers

The distribution of farmers on various parameters of accessibility of formal seed is provided in Table 7. The attitude of the farmers toward access to formal seeds from different sources was found to be the significant cause of

Table 5: Seed replacement rates (%) for fodder crops.

Crops	Land holding groups			Total
	Marginal and small	Medium	Large	
Sorghum	50.2	43.5	41.1	48.3
Maize	57.3	55.7	45.5	46.2
Perl millet (Bajra)	48.2	47.3	40.7	45.4
Berseem	43.1	41.4	41.9	42.3
Oats (Jai)	-	-	100.00	100.0
Cowpea (Lobia)	-	54.2	46.1	49.6
Lucerne	-	-	100	100

Source: Primary Survey, 2022-23.

Table 6: Seed replacement rates (%) for green manure crops.

Crops	Landholding groups			Total
	Marginal farmers	Small farmers	Large farmers	
Urd	53.2	47.5	35.1	40.18
Moong	50.5	42.3	39.3	42.35
Dhaincha	93.41	60.6	60.15	65.00
Pea	-	-	48.7	-
Sunhemp	-	-	31.9	-

Source: Primary Survey, 2022-23.

Table 7: Perceptions of the seed characters by farmers.

Market chain systems		Seed quality (%)		Seed price (%)		Seed availability (%)	
Formal seed sector	Public seed production	Very good	2	Very cheap	12	Abundant	-
		Good	68	Cheap	47	Reasonably abundant	-
		Fair	28	Fair	41	Fair	18
		Bad	2	Expensive	-	Poor	67
				Very expensive	-	Very poor	15
	Private seed production	Very good	14	Very cheap	-	Abundant	-
		Good	76	Cheap	-	Reasonably abundant	23
		Fair	6	Fair	17	Fair	66
		Bad	4	Expensive	69	Poor	11
				Very expensive	14	Very poor	-
Informal seed sector	Farmers saved seed	Very good	2	Very cheap	3	Abundant	-
		Good	59	Cheap	61	Reasonably available	55
		Fair	33	Fair	36	Fair	38
		Bad	6	Expensive	-	Poor	7
				Very expensive	-	Very poor	-
	Farmer's produced grains (used as seed)	Very good	-	Very cheap	-	Abundant	-
		Good	47	Cheap	16	Reasonably available	66
		Fair	42	Fair	58	Fair	34
		Bad	11	Expensive	16	Poor	-
				Very expensive	-	Very poor	-

the supply-demand gap mentioned above (Table 4 and 5). It is clear from Table 7 that the formal seeds produced by the private sector were the best on the quality scale among the seeds that were made available from different sources. However, the seeds of the public sector also had a significant place in terms of quality. On the other hand, seeds from the informal sector were given less preference by farmers in terms of quality. Despite these, the reason for the gap found in the access to formal seeds belonging to the public sector was its non-availability in time and quantity. The availability of seeds of desired varieties through the public sector was also an issue of concern. Whereas, access to formal seeds belonging to the private sector was limited due to higher prices in comparison to the farmers' saved seeds and formal seeds of the public sector causing the supply-demand gap for the fodder and green manure crops.

The informal seeds were found cheapest among all as almost 64 per cent of farmers believed that the seed prices through the informal system varied from cheap to very cheap in prices. The public sector also provided the seeds at lower prices in comparison to the private sector and informal sectors but farmers thought that the seeds from the public sector were less available compared with seeds produced by farmers and the private sector. Whereas formal seeds provided through the private sector were made available in time and proper quantity as 66 per cent of farmers agreed to fair availability and 23 per cent of farmers reported reasonably abundant the seeds through the private sector. Apart from this, the informal seeds for fodder and green manure crops were made available timely at cheap prices. Hence, the question arises of how formal sectors, either private or public sector, channelize the formal seeds through the informal sector so that seeds are made available in time and at the possible lowest prices.

CONCLUSION

The most important input to increase the yield of crops used as green manure and fodder is seed. Inadequacies in these crops' seed distribution systems can have a negative impact on the productivity of livestock and agriculture. One of the main obstacles to the adoption of livestock enterprises and green manure practices is the inadequate supply of high-quality seeds of desired species at lower costs. It was observed that there were different sources of seed supply to meet the increasing demand of seed of fodder and green manure crops to the farmers. This had to some extent reduced the dependence of farmers on their own saved seeds but had not been diminished fully. Hence, a gap in the supply of the formal seeds of fodder and green manure crops was reported. The inability of the public sector seed distribution system to provide formal seeds in a timely and sufficient quantity, along with the higher cost of formal seeds from the private sector, contributed to the formation of the supply-demand gap. Due to their availability in appropriate quantities and at reasonable rates, farmers favoured informal seeds for green manure and fodder crops over formal seeds. Additionally, it was shown that the use of formal seeds and farm size had an inverse relationship, suggesting that large farmers have the capacity to generate their own seed. Therefore, it may be inferred that in order to meet the actual demand, large farmers could be encouraged to generate formal seeds for green manure and fodder crops by integrating public and private formal seed-producing systems. The seed replacement rate indicates that fodder and green manure crop seed supply systems need to be strengthened.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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