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Forage seed production scenario in India: Issues and way forward

J S CHAUHAN[1], A K ROY[2], SATINDER PAL[3], DINESH KUMAR[4], P R CHOUDHURY[5], A K MALL[6] and D R MALVIYA[7]

Indian Council of Agricultural Research, Krishi Bhawan, New Delhi 110 001

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ABSTRACT

Non-availability of good quality seeds especially in case of the improved varieties is the major reason for slow adoption of improved forage production technologies. The productivity and availability of quality seeds are vital because the forage crops have been bred for enhanced vegetative potential and as such they are shy seeders with very low seed productivity. The paper discusses the varietal scenario of forage crops in the seed chain, seed quality assurance, seed standards and seed certification. Of the 163 varieties of 11 forage crops notified till 2016, 90 varieties are in the seed chain comprising, 49 cultivars belonging to seven forage crops; guar (5), maize (3), sorghum (19), cowpea (12), teosinte (1), pearl millet (7) and rice bean (2) during the *kharif* season and 41 of four forage crops, namely, oat (18), berseem (15), lucerne (5) and gobhi sarson (3) during the *rabi* season. The paper also describes the status of breeder seed production and brings out issues plaguing quality seed production in these crops, assess the future seed requirement and possible approaches to address the daunting task of producing 208.1 tonnes of breeder seed by 2020 from the current level of 78.5 tonnes in the backdrop of lack of effective seed chain and very poor lifting of available breeder seed, as the forage seed production is largely concentrated in the unorganised as well as resource poor sector.

Key words: Breeder seed, Forage crops, Seed certification, Seed chain, Seed quality assurance, Varieties

Livestock sector has been contributing significantly to the country's GDP (4%) especially agricultural GDP (23.8%) during 2010-11 (Anonymous 2014). The livestock population has been steadily increasing and stood 512.06 million at the annual compound growth rate of 2.2% during 2007-12, consequently, rising in number of stall feeding cross-bred cattle and buffaloes. This necessitates increased demand for fodder. The availability of good quality seeds are estimated to be around 15-25% only for cultivated forages. Non-availability of good quality seeds is the major reason for slow or non-adoption of improved varieties. The productivity and availability of seed are vital because the forage crops have been bred for enhanced vegetative potential and as such they are shy seeders with very low seed productivity.

Forage seed production is largely concentrated in the unorganised sector and effective seed production chain is lacking. It is mainly because of a large number of crops and their suitability to specific niches. Of the 163 varieties of 11 crops notified/ recommended for notification up to 74th meeting of Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops held on 12 April 2016, 90 varieties are in the seed chain comprising 49 cultivars of guar *(Cyamopsis tetragonoloba* L.*)*, maize (*Zea mays* L.), sorghum (*Sorghum bicolor* L.), cowpea (*Vigna unguiculata* L.), teosinte (*Euchlaena mexicana* Schrad.), pearl millet (*Pennisetum glaucum* L.) and rice bean [*Vigna umbelleta* (Thunb.)], during *kharif* season (Table 1) and 41 cultivars of oat (*Avena sativa* L. and *A. sterilis* L. var. culta), berseem (*Trifolium alexandrinum* L.), lucerne (*Medicago sativa* L.) and gobhi sarson (*Brassica napus* L.*)* during *rabi* season.

SEED QUALITY CONTROL

There are adequate provisions under existing seed legislations (Seeds Act 1966 and Seed Rules 1968) to regulate the quality of seeds keeping in view the federal structure of the country. State governments have powers to

[1]Assistant Director General (Seed) (e mail: adgseedicar@gmail.com), ICAR, New Delhi. [2] Project Coordinator (e mail: pcforage@gmail.com), All India Coordinated Research Project on Forage Crops, Indian Grassland and Fodder Research Institute, Gwalior Road, Jhansi, Uttar Pradesh. [3]Chief Technical Officer (Seed) (e mail: toseed9@gmail.com), [4]Principal Scientist (Food and Fodder Crops) (e mail: dinesh.icar@ymail.com), [5]Principal Scientist (Seed) (e mail: prc71@rediffmail.com), ICAR, New Delhi. [6]Senior Scientist (Plant Breeding) (e mail: Ashutosh.Mall@icar.gov.in), [7]Principal Scientist (Plant Breeding) (e mail: malaviya2007@yahoo.co.in), Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh.

Table 1 Varieties of forage crops in the seed chain during 2004-05 to 2015-16

Crop	Number of varieties	
	Notified	Seed chain
Guar	14	05
Maize	03	03
Sorghum	29	19
Cowpea	33	12
Teosinte	01	01
Pearl millet	17	07
Rice bean	11	02
Oat	23	18
Berseem	16	15
Lucerne	13	05
Gobhi sarson	03	03
Total	163	90

Salient features of the varieties of forage crops in the seed chain (Pandey and Roy 2011) are given in Table 2.

appoint Seed Analysts and Seed Inspectors. Seed Inspectors are vested with adequate powers for quality control, viz. to draw the sample; enter and search; examine records, registers and documents; seize the stock and issue 'Stop Sale' order in case the commodities under reference contravene provisions of law (Trivedi and Gunasekaran 2014). Inspectors are authorized to take punitive action/launch proceedings against dealers found to be selling sub-standard seeds. The seed in respect of which the contravention has been committed can be forfeited under Section 20 of the Seeds Act. Penalties are provided under Section 19 of the Act. State governments have the powers of enforcement and implementation, however, uniformity and consistency is maintained through standards for certification, labelling etc. prescribed by Government of India (GOI). The Joint Secretary (Seeds), GOI is the Controller of Seeds for the country as a whole. Also, the Government of India can give directions under Section 23 of the Act to the states. The Central Seed Certification Board and the Central Seed Committee advise the central and state governments on various aspects of seed.

The Seeds Act/Rules are applicable to notified seeds

Table 2 Salient features of varieties of the forage crops in seed chain during 2004-05 to 2015-16

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
Guar					
Guara 80	1973	Pedigree method of selection from the cross (FS 277 × Strain No. 119)	PAU, Ludhiana	Punjab and Haryana	Resistant to *Xanthomonas cyamopsis*
Ageti Guara 112	1983	Pedigree method of selection from the cross (326 × FS 277) × 315	PAU, Ludhiana	Punjab	
Bundel Guar 1	1993	Selection from local germplasm of Rajasthan	IGFRI, Jhansi	Arid and semi-arid zone of Punjab, Haryana and Rajasthan	Moderately resistant to leaf blight, lodging resistant and drought tolerant
Bundel Guar 2	1995	Selection from indigenous material of Rajasthan	IGFRI, Jhansi	Semi-arid zone of Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh and Madhya Pradesh	
Guar Kranti	2005	Selection from the cross RGC 936 × RGC 986/ P-10	ARS, Durgapura	Rajasthan	Resistant to lodging, nutritive fodder, suitable for late sown areas
Maize					
African Tall	1983	Composite of seven genotypes. Modified mass selection	MPKV, Kolhapur/ Rahuri	All forage maize growing areas in the country	Resistant to major foliar diseases and insect pests
J 1006	1992	Selection from the cross Makki safed 1-DR × Turpeno PB	PAU, Ludhiana	Punjab,Haryana, Himachal Pradesh and western Uttar Pradesh	Resistant to *Maydis* blight, brown striped downy mildew and stem borer
Pratap Makka Chari 6	2009	Composite of 11 early to medium white seeded entries	MPUA&T, Udaipur	Punjab, Haryana, Rajasthan and western Uttar Pradesh	Forage harvest in 60 days. Tall, thin stemmed, tolerant to stem borer, nematodes and leaf blight

(Contd)

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
Sorghum					
MP Chari	1978	Selection fromthe cross [K 49 (Sudan grass) × J 57 (Sorghum)]	JNKVV, Jabalpur	All forage sorghum growing areas in the country	Fast regeneration, multi-cut
Pusa Chari 6	1980		IARI, New Delhi	All forage sorghum growing areas in the country	
HC 136	1982	Selection from the cross 3214 × PJ 7R	HAU, Hisar	All forage sorghum growing areas in the country	Dual purpose, tolerant to foliar diseases
Pusa Chari 23	1985	Selection from an exotic F_1 hybrid Martin × 907010 (Sudan group)	IARI, New Delhi	All forage sorghum growing areas in the country	Multi-cut, suitable for early as well as late planting, tolerant to drought and flood
Pusa Chari 9	1985	Derived form IS 4870, Durra group of jowar, collected from Himmatpur	IARI, New Delhi	All sorghum growing areas in the country under irrigated conditions	Tolerant to major insects, pests, drought and temporary water logging
HC 171	1987	Selection from the cross SPV 8X × IS 4776	HAU, Hisar	All forage sorghum growing areas in the country	Resistant to foliar diseases
Punjab Sudex Chari 1	1995	Selection from the cross 2077 A (Sorghum) × SGL 87 (Sudan grass)	PAU, Ludhiana	Punjab	Multi-cut, highly resistant to anthracnose
HC 308	1996	Selection from the cross SPV 8X × IS 4776	HAU, Hisar	All forage sorghum growing areas in the country	Resistant to foliar diseases, tolerant to drought, suitable for both early and late sown conditions
Pant Chari 5	1999	Selection from the cross CS 3541 × IS 6953	GBPUA&T Pantnagar	All forage sorghum growing areas in the country	Highly resistant to anthracnose, zonate leaf spot and other foliar diseases
CO (FS)29	2001	Pedigree method of selection from the cross TNS 30 × *S. sudanense*	TNAU, Coimbatore	Tamil Nadu	Tolerant to shoot-fly/ stem borer, multi-cut, perennial, high in crude protein and digestibility
Gujrat Fodder Sorghum 5	2005	Derivative of cross (SPV1087 × GSSv 148)	GAU, Banaskantha	Gujarat	Resistant to leaf spot and grain mold diseases
CSH 20MF 2219 (A & B)	2005	Derivative of the cross 2219 A × UPMC 503 (SDSL 92140-MCT-36-93- a line selected from Zimbabwe germplasm)	GBPUA&T Pantnagar	Uttar Pradesh, Uttarakhand, Delhi, Haryana, Punjab, Rajasthan, Bihar and Gujarat	Multi-cut, high leafiness, resistant to major foliar diseases
Pusa Chari 615	2006	Selection from the cross Pusa Chari 40 × Pusa Chari 67	IARI, New Delhi	NCR, Delhi	Tolerant to major foliar diseases and insect pests
Pant Chari 6	2006	Selection from Zimbabwe germplasm line EC 438401	GBPUA&T, Pantnagar	Uttarakhand	Resistant to major foliar diseases, zonate leaf spot, downy mildew, grey leaf spot, anthracnose, sooty stripe
HJ 513	2007	Selection from the cross (PJ 7R × SPV 80) × HC 136	CCS HAU, Hisar	Haryana	Dual purpose, tolerant to major foliar diseases, grey leaf spot, zonate leaf spots, sooty stripe

(Contd)

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
CSH 24MF 467 (A & B)	2009	Pedigree: ICSA 467 × Pant Chari 6 (UPMC 503)	GBPUA&T, Pantnagar	All forage sorghum growing areas of India	Resistant to foliar diseases, non-lodging, good yielding ability, thick, juicy and semi-sweet stem
Pratap Chari 1080	2010	ICSR 17 × SPV 946	MPUAT, Udaipur	Forage sorghum growing regions in Rajasthan state with loam to light soils and moderate to low rainfall	Single cut, tan pigmentation
CSV 30 F	2014	NSS 223 × NARI 111 (NARI 111 is selection from NST 9)	MPKV, Rahuri	All forage sorghum growing areas of India	Non-tan, drooping leaf, tolerant to shoot fly, stem borer and foliar diseases
CSV 32 F	2015	(HC 260 × B 35)-5-3-1-1	IIMR, Hyderabad	Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, South Gujarat, Telangana and Tamil Nadu	Tall, drooping leaves, bold seed, stem borer resistant and drought tolerant
Cowpea					
EC 4216	1978	Selection from exotic material	IARI, New Delhi	All forage cowpea growing areas of India	High crude protein and moderately drought tolerant
GFC 3 (Gujarat Forage Cowpea 3**)**	1980	Pure line Selection from local material of Chharodi area of Gujarat	GAU, Banaskantha	Gujarat	Good quality
UPC 5286	1982	Selection from the indigenous material CK 72-5286	GBPUA&T, Pantnagar	All forage cowpea growing areas of India	Resistant to YMV, root/ collar rot, anthracnose and BLB
UPC 5287	1986	Selection from the cross CK 74-5287	GBPUA&T, Pantnagar	All forage cowpea growing areas of India	Resistant to YMV and pod borer
Bundel Lobia 2	1994	Selection from IL 978	IGFRI, Jhansi	Punjab, Haryana, Rajasthan, Uttrakhand and Uttar Pradesh	Good yielding
UPC 8705	1996	Derived from the cross N 425 × H 288	GBPUA&T, Pantnagar	All forage cowpea growing areas of India	Dual purpose, stay green
Haryana Lobia 88	1997	Pedigree selection from the cross C 28 × HFC 42-1	HAU, Hisar	Haryana	Resistant to cowpea YMV
UPC 9202	1999	Pedigree selection from the cross V 260 × UPC 9805-7-2-4	GBPUA&T, Pantnagar	Madhya Pradesh, Gujarat, Maharashtra and Uttar Pradesh	Dual purpose
CO (FC) 8	2005	Cross derivative of CO 5 × N 331	TNAU, Coimbatore	Tamil Nadu	Indeterminate type of growth, resistant to cowpea YMV and root rot
CL 367	2006	Selection from the cross Cowpea 74 × Strain No.90 and bulked in F_6 generation	PAU, Ludhiana	Punjab	Tolerant to stem anthracnose and YMV
UPC 625	2009	Pedigree Selection from the cross CL 2 × HLD 1-1-5-1.	GBPUA&T Pantnagar	Himachal Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Asom and Jharkhand	Resistant to CMV, anthracnose, collar rot and bacterial blight
UPC 628	2010	Pedigree breeding	GBPUA&T Pantnagar	Plains and lower hills of Uttarakhand	Resistant to YMV, collar / root rot, anthracnose, leaf blight, pod borer and flea-beetle

(Contd)

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
Teosinte					
TL 1	1996	Mass selection from indigenous material	PAU, Ludhiana	Punjab	Less incidence of leaf spot disease
Pearl millet					
Giant Bajra	1985	Inter-varietal hybridization between Australian and local cultivar from Dhule district	MPKV, Rahuri	All forage pearl millet growing areas of India	Good for hay and silage making, moderately resistant to downy mildew and ergot diseases
Raj Bajra Chari 2	1990	Full sib selection in random mating population of 20 crosses of 4 inbreds from West Africa	RAU, Bikaner	Rajasthan	Resistant to foliar diseases and insect pests, adaptability to saline condition
CO 8	1993	No.732 A × Sweet Giant Bajra	TNAU, Coimbatore	Tamil Nadu	Soft stem, high leaf stem ratio, short duration, highly palatable
FBC 16	2007	Composite of 5 late maturing lines	PAU, Ludhiana	All forage pearl millet growing areas of India, particularly Punjab	High fodder productivity and low in oxalates
PCB 164	2007	Composite	PAU, Ludhiana	All forage pearl millet growing areas of India, particularly Punjab	Early maturing
Avika Bajra Chari 19	2009	Selection from the material collected from Nagore, Rajasthan	IGFRI- RRS Avikanagar	Rajasthan, Punjab, Haryana, Uttar Pradesh and Uttrakhand	Resistant to downy mildew, blast and nematodes, dual purpose
BAIF Bajra 1	2010	Pure line selection from Giant Bajra	BAIF, Urulikanchan	Rajasthan, Punjab, Haryana, Uttarakhand, Uttar Pradesh, Gujarat, Madhya Pradesh, Maharashtra	Moderately resistant to downy mildew, leaf blight and leaf spot
Rice bean					
Bidhan 1	2001	Selection from a local landrace	BCKV, Kalyani	West Bengal, Odisha, Jharkhand, Asom, Sikkim, Mizoram, Manipur, Nagaland and Bihar	Tolerant to drought and cold, dual purpose
Bidhan 2	2005	Selection from a local landrace	BCKV, Kalyani	West Bengal, Odisha, Asom, Jharkhand , Sikkim, Mizoram, Manipur, Bihar and Nagaland	
Oat					
Kent	1975/ 1978	Introduction from USA	PAU, Ludhiana	All oat growing areas of India	Resistant to rust, blight diseases and lodging, medium late type
OS 6	1984	Selection from the cross HFO 10 × HFO 55 P2	HAU, Hisar	All oat growing areas of India	Tolerant to major diseases and pests
JHO 822	1989	Pedigree selection from the cross IGO 4268 × Indio 6-5-1	IGFRI, Jhansi	Uttar Pradesh, Madhya-Pradesh, Gujarat and Maharashtra	Plump and bold seed
UPO 212	1990	Selection from the cross VS1492 × Kent	GBPUAT, Pantnagar	Punjab, Uttarakhand, Uttar Pradesh, Madhaya Pradesh, Rajasthan, Haryana, Gujarat and Maharashtra	Multi-cut
Sabazar	1990	Pure line selection	SKUAST, Kashmir-Srinagar	Temperate and high altitude areas – Jammu & Kashmir	Dual purpose

(Contd)

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
HJ 8	1998	Selection from the cross OS 7 × S 3021 P15	HAU Hisar	Haryana	Two cuts
JHO 851	1998	Selection from exotic Japanese germplasm "Hiugo Karyokuro"	IGFRI, Jhansi	All oat growing areas of India	Tolerant to crown rust, leaf blight, Sclerotial wilt, multi-cut, high protein
JHO 99-2	2005	Inter-varietal hybridization followed by pedigree method of selection.	IGFRI, Jhansi	Punjab, Rajasthan, Haryana, Uttarakhand, Bihar, Odisha, West Bengal, Uttar Pradesh and Asom	Tolerant to major disease and pest
Bundel Jai 2004 (JHO 2000-4)	2006	Inter-specific hybridization (*A. sativa* JHO851×*A. maroccana* 16/30) followed by induced polyploidy and pedigree method of selection	IGFRI, Jhansi	Punjab, Haryana, *tarai* region of Uttrakhand and Uttar Pradesh, Rajasthan, eastern Uttar Pradesh, Jharkhand, West Bengal, Odisha and Asom plains	Tolerant to root rot, crown rust, leaf blight and powdery mildew, good quality
Phule Harita	2007	Selection from base population of Kent	MPKV, Rahuri	Maharashtra	Resistant to leaf blight disease, multi cut
Bundel Jai 991(JHO 99-1)	2007	Inter-varietal hybridization (OS 7 × IGO 320-1139-19) followed by pedigree method of selection	IGFRI, Jhansi	Hilly zone of Jammu & Kashmir and Himachal Pradesh	Moderately resistant against leaf blight, nematodes, grasshoppers and aphids
RO 19	2007	Selection	MPKV, Rahuri	Rajasthan, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra,	Multi-cut, resistant to leaf spot, high crude protein
OS 346	2010	Selection from the cross OS 6 × Kent	CCS HAU, Hisar	Madhya Pradesh, Gujarat, Maharashtra and southern Uttar Pradesh	Bold seeded, better in nutritional quality; moderately resistant to leaf blight
JO 03-91	2010	Selection from the cross OS 6 x JHO 822	JNKVV, Jabalpur	Madhya Pradesh, Gujarat, Maharashtra and southern Uttar Pradesh	Tolerant to leaf blight, *Sclerotium* root rot and powdery mildew
NDO 1	2011	Mass selection	NDUAT, Faizabad	Uttar Pradesh	Suitable for salt affected soil
NDO 2	2012	Pedigree selection from the cross JO 6 x OL 1389	NDUAT, Faizabad	Uttar Pradesh	Suitable for salt affected soil
Shalimar Oat 1 (SKO 20)	2013	-	SKUAST, Kashmir-Srinagar	Temperate areas of Jammu & Kashmir	Long and wide lemma
OL 10	2016	Pedigree selection from cross Kent x OL 1245	PAU, Ludhiana	Punjab irrigated areas	Multi-cut
Berseem					
Mescavi	1975	Introduction from Egypt followed by selection	HAU, Hisar	All berseem growing areas of India	Highly adaptable and productive, high crude protein, multi-cut
Pusa Giant	1975	Polyploid breeding, autotetraploid line of C 10	IARI, New Delhi	All berseem growing areas of India	Thick stem, broad leaf, bold seed
BL 1	1978	Selection from Mescavi	PAU, Ludhiana	Punjab	

(Contd)

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
JB 1	1981	Single plant selection from the local germplasm of Chindwara followed by pedigree method of selection	JNKVV, Jabalpur	Madhya Pradesh and Chhattisgarh	
Wardan	1982	from the large genetically diverse polyploid material	IGFRI, Jhansi	All berseem growing areas of India	Tolerant to bacterial wilt and other diseases
BL 10	1985	Selection from local germplasm	PAU, Ludhiana	Punjab, Haryana, Delhi, Himachal Pradesh and Jammu & Kashmir	
BL 22	1988	Irradiation of variety Mescavi followed by pedigree selection	PAU, Ludhiana	Temperate zone, Jammu &Kashmir, Haryana, Punjab and Himachal Pradesh	Long duration, green fodder up to June end
BL 2	1989	Multi line selection	PAU, Ludhiana	Punjab	
Bundel Berseem 2 (JHB 146)	1997	Mass selection from indigenous material no. 25776	IGFRI, Jhansi	Punjab, Haryana, Uttarakhand, Uttar Pradesh, Madhya Pradesh Maharashtra	Fairly tolerant to acidic conditions
Bundel Berseem 3	2001	Colchiploidy followed by selection	IGFRI, Jhansi	Asom, Bihar, Jharkhand, Odisha, Uttar Pradesh and West Bengal	Tolerant to stem rot, root rot and downy mildew diseases
Jawahar Berseem 5	2005	Recurrent selection from colchicine treated materials	JNKVV, Jabalpur	Madhya Pradesh, Uttar Pradesh, Maharashtra, Gujarat, Chhattisgarh	
BL 180	2006	Irradiation of variety BL 10 followed by selection	PAU, Ludhiana	Punjab, Haryana, Uttarakhand, Jammu & Kashmir and Himachal Pradesh	Long duration
Hisar Berseem 1	2006	Selection from germplasm (307011.11-OP)	CCS HAU, Hisar	Haryana	Long duration
BL 42	2007	Irradiated population of BL 2	PAU, Ludhiana	Punjab, Haryana and Himachal Pradesh	Resistant to stem rot
Hisar Berseem 2	2014	Mutation breeding, selection from gamma irradiated material	CCS HAU, Hisar	Haryana	Long duration
Lucerne					
Sirsa Type 9	1975	Mass selection from the germplasm	Fodder Research Station, Sirsa (HAU, Hisar)	Punjab, Haryana, Delhi and Uttar Pradesh	Quick growing with deep green foliage
CO 1	1982	Mass selection from Coimbatore local collection	TNAU, Coimbatore	Tamil Nadu	Perennial
Anand 2	1984	Selection from perennial type from Bhuj	Gujarat Agricultural University, Banaskantha	Gujarat, Maharashtra and Rajasthan	
RL 88	1996	Selection from local material collected from Ahmednagar, Maharashtra	MPKV, Rahuri	All lucerne growing areas of India	Perennial
Anand Lucerne 3 (AL 3)	2009	Pure line selection and population improvement of the material collected from Kutch	AAU, Anand	Gujarat and Maharashtra	High regeneration capacity

(Contd)

Table 2 (*Concluded*)

Crop / varieties	Year of notification	Breeding method/ source	Breeding institution	Area of adoption	Specific feature(s)
Gobhi sarson					
GSL 1	1987	Pure line selection from farmer's field of Punjab	PAU, Ludhiana	Punjab, Jammu and Kashmir, Haryana, Delhi, eastern Rajasthan	
HPN 1	1995	Selection from EC 129127 of Polish origin	ORS, HPKVV Kangra	Himachal Pradesh	
Him Sarson 1	2007	Pure line selection from exotic line EC 129127	CSK HPKVV Palampur	Jammu & Kashmir, Uttarakhand, Himachal Pradesh	Tolerant to temperature extremes and lodging

while Seeds (Control) order (1983) to both notified and non-notified varieties. Seed Act (1966) under Section 5 prescribes the notification of varieties, but it is voluntary. When notified variety is sold in the market, it should be labelled as prescribed under section 6 (a) of the Seeds Act, 1966 that deals with the standard of germination and physical purity and section 6(b) that deals with colour, content and size of the label. Export or import of seed of any notified kind or variety is subject to conditions such as conforming to the minimum limits of germination and physical purity, etc. Exemption under Section 24 from the provisions of the Act covers farmers' seeds**.** The Seeds (Control) Order, 1983 brought seed under the ambit of Essential Commodities Act, 1955 and made it mandatory that the business of selling, exporting and importing of seeds can be carried out only under a license issued by the state government. The dealers can also be directed to distribute seeds in specified manner in public interest. Seed dealers are required to maintain books and accounts and display the stock position and its price. A dealer's license is liable to be suspended / cancelled for contravention and the penalties are imposed as per the Essential Commodities Act, 1955. Seed testing has been recognized as an essential aspect of seed quality. Accordingly, Section 4(2) of the Seeds Act, 1966 empowers the state government to establish one or more State Seed Testing Laboratories in the state. Presently, there are 124 state and 2 central laboratories in the country. The central laboratories include National Seed Research and Training Centre at Varanasi and the laboratory at Central Institute for Cotton Research, Nagpur (for GM cotton only). Of these, one public and five private seed testing laboratories have been accredited by International Seed Testing Association, Switzerland.

SEED CERTIFICATION

In the Seeds Act, provision exists for seed certification of varieties to ensure genetic identity and purity. The Certification Regulations include the Indian Minimum Seed Standards and Seed Certifications procedures (Fig 1). State Seed Corporations and Seed Certification Agencies were also established in different state under Section 23 of the Seeds Act, 1966. Presently, there are 15 state seed corporations in the country to over see seed production and quality control. Isolation distance for production of foundation and certified

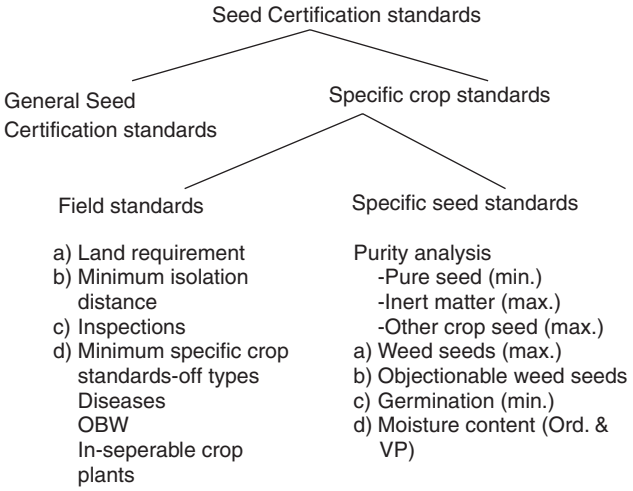

Fig 1 Schematic representation of seed certification standards

seed depends upon the mode of pollination of the crop. In forage crops, it varied from 3 m (oat) - 400 m (berseem) for foundation seed; while 3 m (oat) - 100 m (sorghum) for certified seed. A minimum of 150 m isolation distance is recommended between seed plot and fields of another species known to cross or suspected of being able to cross (Trivedi and Gunasekaran 2013) for both foundation and certified seeds (Tables 3 and 4).

Certification standard for foundation and certified seed production for selected forage crops are given in Table 5.

BREEDER SEED PRODUCTION SCENARIO

Breeder seed indent and production of forage crops showed an inconsistent trend during the last 10 years (Anonymous 2008, 2011a, 2015, 2016). Breeder seed indent showed an increasing trend from 456 q in 2006-07 to 985 q in 2008-09 then reduced for the next two years. In 2011-12 and 2012-13, indent for breeder seed jumped to 1627 q and 1832 q , respectively, and again consistently came down to the extent of 774 q in 2015-16 (Table 6). Breeder seed production also showed an inconsistent trend increasing from 1 043 q (2006-07) to 1 543 q (2008-09), then reduced in the next two years, attained highest production (1 708 q) in 2011-12 and consistently declined to 803 q during 2015-16 (Table 6).

Table 3 Isolation distance (m) for production of foundation (FS) and certified seed (CS) of selected forage crops

Crop	Field of other varieties		Fields of the same variety not conforming to varietal purity requirements for certification		Fields of another species known to cross or suspected of being able to cross	
	FS	CS	FS	CS	FS	CS
Guar	10	5	10	5		
Sorghum	200	100	200	100	400	400
Teosinte	200	100	200	100		
Rice bean	50	20	50	20		
Oat	3	3	3	3	150	150
Berseem	400	100	400	100		
Lucerne	400	100	400	100		

Trends in breeder seed production for the last 10 years

The indent for guar (grain and fodder) enhanced until 2009-10 and decreased thereafter in 2010-11 and again showed increasing trend till 2013-14 and then again decreased to 269 q in 2015-16, thus found to be inconsistent. The increase in indent during 2015-16 was 313.8% over that of 2006-07 (Table 6). Its production varied from 448 q in 2006-07 to 257 q in 2015-16 showing a decrease of 42.6% during this period. Indent and production for maize also showed an inconsistent trend. The indent of varied from 30 q in 2006-07 to 76 q in 2015-16 registering an increase of 153.3%, the production ranged from 65 to 83 q during the corresponding period with an increase of 27.7%. Indent of sorghum was 24 q (2006-07) and 17 q (2015-16) showing a decrease of 29.2%. Its production was 20 q in 2006-07 and 28 q in 2015-16 with an increase of 40%. An all time high production of sorghum (221 q) was recorded in 2009-10. Indent for cowpea varied from 12 q during 2006-07 to 2 q during 2015-16, a decrease of 83.3%. Its production was 29 q (2006-07) and 3 q (2015-16) showing a decrease of 89.7%. The indent for pearl millet varied from 3 q in 2006-07 to 0.1 q in 2015-16 showing a decrease of 96.7% whereas, its production varied from 3 q in 2006-07 to 4 q in 2015-16 showing an increase of 33.3 %.

Production and indent of oat showed variable trend. The indent varied from 228 q in 2006-07 to 358 q in 2015-16 showing an increase of 57.0% with the highest being 1278 q in 2012-13. The production varied from 380 q (2006-07) to 373 q (2015-16) showing an overall decrease of 1.8%. The production of oat seed was more than indented during 2006-07 to 2010-11 but showed a decreasing trend from 2011-12 to 2015-16. Oat is the major contributor to the total forage seed production. Its share in total seed indent and production varied between 25.4% - 69.8% and 24.2%-52.1%, respectively. Indent for breeder seed of berseem varied from 71 q during 2006-07 to 47 during 2015-16 showing a decrease of 33.8%. Similarly, production showed an inconsistent trend from 72 q in 2006-07 to 51q in 2015-16 registering 29.2 % decrease. The indent for lucerne ranged from18 q during 2006-07 to 5 q during 2015-16

Table 4 Specific requirements for seed production of selected forage crops

Crop	Off-types		Objectionable weed plants		Plants affected by seed borne diseases		Inseparable other crop plants		Off-types that have shed or are shedding pollen when 5.0% or more of the plants have receptive silks		**Heads infected by Kernel smut or Grain smut [*Sphacelotheca sorghi* (Link) Clinton] and Head smut [*Sphacelotheca reliana* (Kuhn) Clinton] at final inspection	
	FS	CS	FS	CS	FS	CS	FS	CS	FS	CS	FS	CS
Guar	0.10	0.20			0.10	0.20						
Sorghum	0.10*	0.20*									0.05	0.10
Teosinte									0.10	0.50		
Rice bean	0.10	0.20										
Oat	0.05	0.20	0.01	0.02	0.10	0.50	0.01	0.05				
Berseem	0.20	1.00	None	0.05								
Lucerne	0.20	1.00	None	0.05								

*At any one inspection and at after flowering. **Seed fields can, however, be certified if diseased ear heads are removed and burnt and the fields show, on re-inspection, infection not more than maximum permissible level. Only one such re-inspection is permitted.

Table 5 Certification standards for foundation seeds and certified seeds of selected forage crops

Criterion	Guar		Sorghum*		Teosinte		Rice bean		Oat		Berseem		Lucerne	
	FS	CS	FS	CS	FS	CS	FS	CS	FS	CS	FS	CS	FS	CS
Pure seed (%, minimum)	98	98	97	97	98	98	98	98	98	98	98	98	98	98
Inert matter (%, maximum)	2	2	3	3	2	2	2	2	2	2	2	2	2	2
Other crop seeds/ kg (no., maximum)	10	20	5	10	5	10	None	None	10	20	10	20	10	20
Total weed seeds/kg (no., maximum)	None	None	5	10	None	None	5	10	10	20	10	20	10	20
Germination (%, minimum)	70	70	75	75	80	80	70	70	85	85	80	80	80	80
Moisture (%, maximum)	9	9	12	12	12	12	9	9	12	12	10	10	10	10
Vapour-proof container (%, maximum)	8	8	8	8	8	8	8	8	8	8	7	7	7	7
Objectionable weeds /kg (no., maximum)									2	5	5	10	5	10
Other distinguishable varieties/kg (no., maximum)	10	20	10	20			10	20	10	20				

*Ergot (*Claviceps* spp.) Sclerotia, seed entirely or partially modified as Sclerotia or ergotted (*Sphacelia sorghi* Mc Rae & *Claviceps* spp.) seeds (max, % as well as by no.) should be 0.02 and 0.04 for forage sorghum foundation and certified seed production, respectively.

Table 6 Forage breeder seed production (q) during the last decade

Crop	2006-07		2007-08		2008-09		2009-10		2010-11		2011-12		2012-13		2013-14		2014-15		2015-16		Total	
	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**	I*	P**
Kharif																						
Guar#	66	448	422	841	450	842	480	389	248	520	277	575	289	431	344	206	342	273	269	257	3232	5053
Maize	30	65	106	91	74	75	54	72	63	94	75	77	99	109	89	138	136	153	76	83	835	1027
Sorghum	24	20	36	19	27	27	55	221	23	29	34	53	33	74	33	19	39	64	17	28	351	562
Cowpea	12	29	11	20	11	21	8	17	9	16	43	12	29	14	20	10	5	2	2	3	167	163
Teosnite	5	5	4	4	9	5	4	4	5	10	0	-	-	-	-	-	-	-	-	-	31	33
Bajra	3	3	3	5	3	4	1	2	2	9	6	6	6	9	3	6	0	1	0	4	28	54
Ricebean	2	2	2	2	2	2	3	3	-	-	3	3	3	2	3	4	-	-	-	-	20	21
Rabi																						
Oat	228	380	255	339	314	422	224	371	202	305	1082	890	1278	611	402	398	283	216	358	373	4821	4580
Berseem	71	72	73	72	76	126	45	60	69	50	94	84	87	77	35	37	41	41	47	51	689	706
Lucerene	18	18	20	11	21	20	8	8	6	6	13	7	7	7	6	5	4	2	5	4	115	98
Gobhi sarson									0	1	1	2	0	2	0	0	-	-	0	0	2	6
Total	456	1043	931	1403	985	1543	883	1145	627	1040	1627	1708	1832	1336	935	824	850	751	774	803	10289	12302

I*: Indent; P**:Production; # includes grain and fodder varieties.

Table 7 Requirement of breeder, foundation and certified seeds by 2020

Crop	Area (lakh ha)	Seed rate (kg/ha) for		Seed multiplication ratio	Seed (tonnes)		
		Fodder production	Seed production		Certified	Foundation	Breeder
Guar	2.0	35	15	60	7020	117	2.0
Maize	9.0	40	20	75	36000	480	6.4
Sorghum	26.0	40	10	100	104000	1040	10.4
Cowpea	3.0	40	15	40	12000	300	7.5
Pearl millet	9.0	20	10	80	18000	225	2.8
Oat	2.5	100	75	20	25000	1250	62.5
Berseem	20.0	25	20	25	50000	2000	80.0
Lucerne	10.0	25	15	26	24750	950	36.5
Total					277000	6362	208.1

showing a decrease of 72.2%. Similarly, its production varied from18 q in 2006-07 to 4 q in 2015-16 registering a decrease of 77.8%.

ISSUES

Considering the growing population of livestock, demand for nutritious and good quality fodder has been on rise and would continue to do so. It is estimated that by 2020, the requirement of certified seeds of major forage crops would be 277 000 tonnes (Anonymous 1997, 2011b) which necessitates the production of 208.1 tonnes of breeder seed (Table 7) assuming 100% effective seed chain, from the current level 78.5 tonnes.

This is a daunting task in view of lack of effective seed chain. Indenting for breeder seed for forage crops and its lifting is very poor. The seed production is not backed by any incentive to the producer or minimum support price for these crops. The production is largely confined to unorganized sector. Forage seed production depends on a number of environmental and physiological factors such as photoperiod, thermo-period, humidity, soil conditions, etc. Each forage crop is suited to only specific area for seed production such as berseem in the northern plains and lucerne in the north-west India. Similarly, pasture grass like *Lasiurus* is best adapted and productive under low rainfall situations of western Rajasthan, Congo signal grass and guinea grass in the highly humid regions of Kerala (Hazra 1995). Further, post-harvest processing and proper storage not yet worked out in most of the forage crops. Suitable machinery for extracting PGS from fluffy grass seed harvest, for range grasses and legumes seed collection to reduce the cost of seed production are lacking.

STRATEGY

'Seed production atlases' with emphasis on identification and mapping of disease free zones should be prepared for the entire country for commercial seed production and marketing. There is also an urgent need for developing variety and region specific package of practices with low cost innovative seed harvesting and processing technology for remunerative seed production. For large scale rangeland and pasture improvement, seed pelleting for grass seeds and value addition to seed by seed coating of forage crops for enhanced germination and vigour need to be followed systematically. Similarly, disease and pest infestation in seed crops is quite different than crop for production and needs detailed studies. Role of pollinators in berseem and lucerne seed production deserve systematic investigations. Practically seed production chain in forage crops is lacking, therefore, seed chain linking milk federations, state line departments, NSC, SSC and other community based organizations be initiated for popularization and production of forage crops for enhanced demands. Village based fodder seed bank concept can also be introduced through establishment of fodder seed villages/farmers, fodder seed producer organizations/groups with facilities for seed processing and storage (Ghosh and Mahanta 2016). Creating awareness among the farmers/ livestock keepers/policy makers about new varieties, incentives and assured market for encouraging seed production would play an important role in creating demand, usage of quality fodder and consequently seed production of forage crops. At national level, there should be a broad based effective functional monitoring team to oversee the planning and implementation of the programme.

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