

Spread of Gujarat Maize-6 (GM-6): A maize variety bred by participatory plant breeding released in Gujarat and recommended in Madhya Pradesh and Rajasthan in Western India.

Prepared by

**J.P.Yadavendra
Former Research Scientist and ICAR Unit Head
Main Forage Research Station
Anand Agricultural University
Anand, Gujarat, India**

August-2013



ग्रामीण विकास ट्रस्ट

GRAMIN VIKAS TRUST

(Established & Supported by KRIBHCO)

Dated: 13-09-2013

FOREWORD

The Gramin Vikas Trust (GVT) owes its origins to the successful management by KRIBHCO of the KRIBHCO Rainfed Indo-British Farming Project (KRIBP) in western India. This project was aimed at improving the livelihoods of resource-poor farmers in the hilly regions of Gujarat, Madhya Pradesh and Rajasthan. These farmers were dependent on maize as a staple crop and KRIBP undertook participatory research to breed a new maize variety that better suited the needs of these farmers.

This publication describes an impact assessment, carried out independently of GVT, into the extent of dissemination and adoption of the maize variety that resulted from this research, namely Gujarat Makka-6 (GM-6). It describes how the participatory approaches promoted in KRIBP, that continue to this day in GVT, have produced a real success story that has benefited hundreds of thousands of rural households.

Sunil Chander Sharma
CEO, Gramin Vikas Trust
New Delhi

निगम कार्यालय : पांचवा तल, ए-विंग, कृमको भवन, ए-10, सैक्टर-1, नोएडा-201301 (30 प्र0)
Corporate Office: 5th Floor, 'A' Wing, Kribhco Bhawan, A-10, Sector-1, Noida (U.P.)-201 301
दूरभाष/Phone: 0120-2535623/622/618 (निर्जी/Direct) **फैक्स/Fax :** 0120-2535619
E-mail : honoida@gvtindia.org, **Website :** www.gvtindia.org
प्रधान कार्यालय : प्लॉट संख्या 60, ब्लाक-ए, कैलाश कॉलोनी, नई दिल्ली-110048
Principal Office: Plot No. 60, Block-A, Kailash Colony, New Delhi-110048

Index

S.No.	Contents	Page
1	List of tables	i
2	List of figures	ii
3	Abbreviations used	iii
4	Key conclusions	1
5	Executive summary	1
6	Introduction	3
7	Methodology	4
8	Development of maize variety GM-6	8
9	Agencies responsible for various stages of seed production	9
10	Seed production	
	A. Gujarat	9
	1. Anand Agricultural University	9
	a. Main Maize Research Station, Godhra	9
	b. Regional Research Station, Anand	12
	2. Gujarat State Seed Certification Agency, Ahmedabad	13
	3. Gujarat State Seed Corporation, Gandhinagar	16
	4. Collectives for Integrated Livelihood Initiatives, Ahmedabad	18
	5. Prakriti Foundation, Jhalod	18
	6. Gramin Vikas Trust, Dahod	19
	7. Anandi Foundation, Devgad Baria	20
	B. Madhya Pradesh	20
	1. Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jhabua (now Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya, Jhabua), M.P.	20
	2. Madhya Pradesh Seed Certification Agency, Indore.	22
	C. Rajasthan	22
	1. Maharana Pratap University of Agriculture and Technology, Banswara (MPUAT), Rajasthan.	23
	2. Rajasthan State Seed Corporation, Jaipur, Rajasthan.	24
	3. Rajasthan State Seed and Organic Produce Certification Agency, Jaipur, Rajasthan	25
11	Conclusions	
	a. Non certified seed production	26
	b. Certified seed production	27
	c. Total seed production	28
	d. Area covered by maize variety GM-6	32
12	References	33

List of tables

Table No.	Contents	Page number
1	Area, production and yield of maize in Gujarat, MP and Rajasthan and their white maize growing districts.	3
2	Methodology used in preparing the report.	5
3	Details of the persons met related to the maize seed production during 2012.	6
4	Details of the persons met related to the maize seed production during 2013.	7
5	Agencies responsible for the seed production of different seed stages.	9
6	Maize varieties/composites registered with PPV and FRP.	10
7	Maize GM-6 seed production programme by MMRS, Godhra.	10
8	Maize varieties/composites developed by Main Maize Research Station, AAU, Godhra and their beneficial impact on farmers.	11
9	Maize GM-6 seed production programme by Regional Research Station, AAU, Anand.	12
10	Total seed production by Anand Agricultural University over years.	12
11	Maize varieties foundation and certified seed certification by GSSCA 2003 to 2013.	13
12	Details of variety wise total maize foundation and certified seed certification by GSSCA, Ahmedabad, Gujarat (2002 to 2013).	14
13	Details of maize GM-6 variety foundation and certified seed certification by GSSCA, Ahmedabad, Gujarat, (2003 to 2013).	15
14	Total area and production of maize GM-6 foundation and certified seed certified by GSSCA from 2003-04 through 2011-12 in Gujarat, India.	16
15	Maize foundation seed produced by GSSC (including GM-4 during 2008-11).	16
16	Certified GM -6 seed marketed by Gujarat State Seed Corporation, Gandhinagar.	17
17	Total GM-6 foundation and certified seed production and marketing (t) by GSSC, Gandhinagar, Gujarat.	17
18	Maize seed production by CINI under KMS project.	18
19	Maize seed production undertaken by Prikriti Foundation, Dahod, Gujarat.	19
20	Maize seed production undertaken by Gramin Vikas Trust, Dahod, Gujarat.	19
21	Maize GM-6 seed production by Anandi Foundation, Devgad Baria, Dahod, Gujarat.	20
22	Information on area registered and certified quantity of maize seed in Indore division, MP by MPSSCA.	22
23	Maize seed produced and marketed by RSSC during 2006 to 2011.	24
24	Details of maize varieties foundation and certified seed certification by RSSOPCA, Jaipur.	25
25	Nucleus (N), breeder (B) and truthfully labeled (TL) seed production 1999 to 2012.	26

26	Foundation and certified seed production programme in relation to GSSCA's certified production.	27
27	Total GM-6 seed production of all categories by various organizations.	28
28	Over all organization wise picture of GM-6 seed production including nucleus, breeder and truthfully labeled seed during 1999 to 2013. A. Total quantity of foundation and certified seed production by different agencies. B. Other than certified GM-6 seed (nucleus, breeder and truthfully labelled seed produced by different organizations) produced by different organization (t.). C. Cumulative production of certified and non certified seed. D. Annual and cumulative certified seed production of GM-6 in relation to total certified maize production	29
29	Total area covered by maize variety GM-6.	32

List of figures

Figure No.	Subject	Page number
1	Variety wise total maize total, foundation and certified seed certification (t) by GSSCA, Ahmedabad, Gujarat (2002 to 2013).	14
2	Variety wise per cent of total seed certification by GSSCA, Ahmedabad, Gujarat (2003-2013).	15
3	Organization wise percent of total GM-6 seed of all catagories produced (t) including other organization.	28
4	Total, amount of all categories of GM-6 seed produced by different organizations during 1999-2013.	29
5	Cumulative production of different categories of maize GM-6 seed.	31
6	Per cent GM-6 cumulative seed production as proportion total maize seed production and year.	32

Abbreviations used

Abbreviation	Full form	Abbreviation	Full form
AAU	Anand Agricultural University	B	Breeder
CARIAD	Centre for Advance Research in International Agricultural Research	CAZS-NR	Centre for Arid Zone Studies – Natural Resources
CINI	Collectives for Integrated Livelihood Initiatives	DOA	Department of Agriculture
F	Foundation	FRP	Farmers’ Rights Protection
GAU	Gujarat Agricultural University	GM	Gujarat Maize
GSSC	Gujarat State Seed Corporation	GSSCA	Gujarat State Seed Certification Agency
GVT	Gramin Vikas Trust	ICAR	Indian Council of Agricultural Research, Government of India, New Delhi.
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jhabua, Madhya Pradesh.	KVK	Krishi Vigyan Kendra
KMS	Kharif Maize Stabilization	MMRS	Main Maize Research Station
MP	Madhya Pradesh	MPSSC	Madhya Pradesh State Seed Corporation
MPSSCA	Madhya Pradesh State Seed Certification Agency	MPUAT	Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.
NGO	Non Government Organization	N	Nucleus
PPV	Protection of Plant Varieties	RRS	Regional Research Station
RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya	RSSC	Rajasthan State Seed Corporation
RSSOPCA	Rajasthan State Seed and Organic Produce Certification Agency	SAU	State Agricultural University
SSCA	Seed Certification Agency	SVRC	State Varietal Release Committee
T	Truthful	TL	Truthfully labeled

Spread of Gujarat Maize-6 (GM-6): A maize variety bred by participatory plant breeding released in Gujarat also recommended in Madhya Pradesh and Rajasthan in Western India.

Key Conclusions

1. The total seed (certified and truthful) produced and supplied of maize variety GM-6 from 1999 to 2013 was 2925t sufficient to sow 150600 hectares (mainly from 2004 to 2013) after subtracting the use of nucleus, breeder and foundation seed for seed production purposes.
2. The scientist from the Main Maize Research Station, GAU, Godhra has stated that the area covered by GM-6 after its release, by taking into account GM-6 grown from farm-saved seed, has been two million hectares with a benefit of Rs.10,401 million to farmers (which is equal to £104 million).
3. Exact calculations of benefits are complex and depend on the assumptions used. Hence, the estimate of £150 million pounds may be considered as an upper limit, with a lower limit of £50 million that increases over years.
4. From the current seed certification programme of GSSCA it is evident that the area of GM-6 is still increasing in the seed production system and increasingly grown by the tribal farmers so its overall impact will continue to increase.
5. Given this increasing rate of seed production of certified and TL seed of GM-6 and the substantial area that must be under GM-6, it is certain that even if the 2 M ha predicted by GAU scientists had not been achieved by 2013, this area will be reached within only two or three years, This will happen even if the amounts of farm-saved seed used for sowing are considerably below those found in a 2004 survey.

Executive Summary

1. The Main Maize Research Station, Godhra (a centre of Anand Agricultural University) and breeder John R. Witcombe, CAZS (now CARIAD) developed and released a maize variety Gujarat Maize-6 (GM-6) in 2002-03.
2. On the basis of its wider adaptability GM-6 was also recommended for cultivation in two more states of India: for the hilly regions (Badwani, Jhabua, Ratlam) of Western Madhya Pradesh, and the southern districts of Banswara, and Dungarpur of Rajasthan.
3. The contribution to the national production of maize of Gujarat is 6%, Madhya Pradesh (MP) 10% and Rajasthan 13%. In India, the maize crop occupies approximately an area of 8.6 million hectares producing 21.7 million tonnes with an average productivity of 2540 kg per hectare.
4. Anand Agricultural University, Gujarat, is responsible for supplying the breeder seed of GM-6 variety of maize for the subsequent production of foundation and certified seed.
5. The State Seed certification Agency in every state is responsible for the certification of foundation and certified seed production that can be undertaken by any organization (government, public or private) in that state.
6. State Agricultural Universities and government organizations, principally the State Seed Corporations are the major seed producing organizations in those states.
7. In Gujarat, MP and Rajasthan the state agricultural universities and the state seed corporations are the major seed producing agencies of maize, and private agencies play a minor role.

8. GM-6 maize seed production programme started in 1999-2000 in Gujarat, whereas agencies in Rajasthan and MP did not undertake any GM-6 seed production.
9. Gujarat State Seed certification Agency certified 1975.2 t of foundation (350.6 t) and certified seed (1624.6 t) of GM-6 from the 2003 season to the 2013 season (data for 2013 extrapolated from previous seasons).
10. During this period, 84% of the total maize foundation and certified seed certified by GSSCA was of GM-6.
11. Anand Agricultural University produced 323.7 t seed of GM-6 (nucleus 2.8 t, breeder 84.8 t, foundation 92.4 t, certified 35.1 t and truthfully labeled 108.6 t) from the 1999 season to the 2013 season.
12. Gujarat State Seed Corporation marketed 1174.6 t seed of GM-6 (foundation and certified) seed from the 2007-2008 season to the 2011-2013 season.
13. Non-Governmental Organizations involved in GM-6 maize seed production were CiNi, Prikriti Foundation, Gramin Vikas Trust and Anandi Foundation.
14. CiNi supplied 384.7 t of GM-6 certified seed to its project farmers in Gujarat , MP and Rajasthan
15. Prikriti Foundation produced 60 t of GM-6 certified seed and 591 t of truthfully labeled seed for supplying to the farmers in Dahod, Panchmahals districts of Gujarat and Banswara district of Rajasthan.
16. Gramin Vikas Trust produced 162.7t of GM-6 TL seed for meeting the demand of farmers in its project area and the National Agricultural Innovation Project.
17. Anandi Foundation produced 25.4 t GM-6 seed (foundation 5 t and certified 20.4 t) for supplying to the farmers.
18. In addition to these public and NGO seed producers there are other NGOs and private sector seed players who are also involved in seed business. The total amount of seed certification by GSSCA was 1975.2 t out of which 1772.3 t was produced by the above mentioned organizations. The remaining 202.9 t was produced by other organizations like NGOs and private players.
19. In the total amount of all categories of seed of GM-6 production (2925t), GSSC was the largest producer (40%) followed by Prikriti Foundation (22%), CiNi (13%) and AAU (11%).
20. Prakriti Foundation was the largest producer of truthfully labeled seed (591 t) followed by AAU (196.1 t)

Spread of Gujarat Maize-6 (GM-6): A maize variety bred by participatory plant breeding released in Gujarat also recommended in Madhya Pradesh and Rajasthan in Western India.

INTRODUCTION

In India, maize crop occupies an area of 8.55 million hectares producing 21.73 million tonnes with an average productivity of 2540 kg per hectare. The contribution national production of Gujarat is 6%, Madhya Pradesh (MP) 10% and Rajasthan 13 %. In Western Indian states of Gujarat, MP and Rajasthan maize crop is mainly grown in tribal regions where the farmers prefer to grow white maize. In Gujarat, white maize is cultivated in Dahod, Panchmahals, Kheda and Vadodara districts (*Annexure-I*), Jhabua, Badwani, Ratlam districts in MP and Banswara, Dungarpur districts in Rajasthan. In these districts 80 percent of area is under non-hybrid varieties having white endosperm (called white maize). The area, production and productivity of these nine districts along with the varieties recommended given in Table 1. These districts of three states are predominantly populated by tribal people and are characterized by poor soils, erratic rains and undulating topography.

Table 1. Area, production and yield of maize in Gujarat, MP, Rajasthan and their white maize growing districts.

State or District	Area (Mha)	Production (Mt)	Yield (kg/ha)	Varieties recommended
Total of Gujarat	0.5	0.82	1640	
Kheda	0.02	0.02	1094	GM-4, GM-6, Narmada Moti, HQPM-1
Dahod	0.14	0.12	1108	GM-4, GM-6, Narmada Moti
Panchmahals	0.15	1.17	927	GM-4, GM-6, Narmada Moti
Vadodara	0.05	0.07	1319	GM-4, GM-6, Narmada Moti
Total of 4 districts	0.36	1.39	1112	
Total of MP	0.83	1.05	1265	
Jhabua	0.11	0.16	1423	JVM 421, JM-12, GM-6
Ratlam	0.04	0.08	2020	JM-8, JM-12, JM-216, JVM-421, GM-6
Badwani	0.03	0.04	1076	JVM 421, JM-216, JM-8 JM-12, GM-6
Total of 3 districts	0.19	0.28	1506	
Total of Rajasthan	1.14	2.05	1798	
Banswara	0.14	0.2	1408	PEHM-2, GM-6, Mahi Kanchan, Navjot
Dungarpur	0.07	0.12	1682	PEHM-2, GM-6, Mahi Kanchan, Navjot
Total of 2 districts	0.22	0.32	1545	

Source: <http://agricoop.nic.in/acp.html>

There are large number of maize hybrids bred by private and public sectors of seed industry in India. Almost all hybrids have yellow seed colour while the tribal farmers of above mentioned nine districts prefer white maize. Maize hybrids in general are late maturing, high input requiring and less suitable for animal fodder due to their thick and hard stems which results in their non preference in tribal areas.

Gujarat Maize-6 is a maize variety first released in Gujarat state of India in 2002. Since this was the first variety bred through participatory plant breeding involving the SAU (Gujarat Agricultural University now Anand Agricultural University), NGO (Gramin Vikas Trust) in collaboration with CAZS, Bangor, UK (now CARIAD). The breeding of GM-6 is fully described in Witcombe et al., 2003. This variety was released in Gujarat state in 2002 whereas recommended in 2004 and 2005 in Rajasthan and MP states respectively.

METHODOLOGY

In June to July 2012, and in February to July 2013, Dr JP Yadavendra collected statistics on maize in Gujarat, Rajasthan and Madhya Pradesh and particularly on the seed production of Gujarat Makka 6 (GM-6). Key people in the breeding and seed production system were interviewed. These included:

- The Gujarat State Seed Corporation (GSSC), which has its headquarters in Gandhinagar, the amount of GM-6 seed it had produced and marketed; likewise RSSC at Jaipur in Rajasthan and MPSSC at Indore.
- The Gujarat State Seed Certification Agency (GSSCA), Ahmedabad, the maize seed certification statistics in Gujarat for foundation and certified seed during 2003-04 to 2012-13; MPSSCA at Indore and Rajasthan State Seed and Organic Product Certification Agency (RSSOPCA) at Jaipur.
- The maize research scientist of Anand Agricultural University the seed production data at the Regional Research Stations of Godhra and Anand.
- Similarly, the maize scientists at Zonal Research Station, Maharana Pratap University of Agriculture and Technology at Banswara and College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya at Indore were contacted.

While preparing this report the following criteria as given in Table 2 below were considered to estimate the spread of Gujarat Maize-6 in the above said districts of three states. The details of the persons contacted in Gujarat, Madhya Pradesh and Rajasthan are given in Tables 3 and 4.

For MP, the information has been gathered from a publication made by JNKVV in 2006 (personal interaction with Dr. M. Billore, Plant Breeder, RVSKVV, Indore) and a mention of GM-6 in the booklet (in Hindi language) by KVK, JNKVV, Jhabua, and the divisional office of Madhya Pradesh Seed Certification Agency (MPSSCA), Indore and is given in this report at appropriate place.

For Rajasthan, the information on inclusion of items in package of practices by MPUAT since 2002 to 2007 was provided by the Zonal Director of Research, Agriculture Research Station, MPUAT, Banswara which includes GM-6 in the year 2004 and appended in this report on page. This is only the documented evidence on the recommendation of GM-6 in Rajasthan state.

In addition, efforts were also made to collect the information on the maize seed certification by the Rajasthan State Seed and Organic Produce Certification Agency (RSSOPCA). The information on seed production programme of maize undertaken by Rajasthan State Seed Corporation (RSSC) was collected to know the varieties whose seed is produced in that state from 2004 onwards.

Table 2. Methodology used in preparing the report.

Criteria	Requirement	Source
Area, production and yield of maize cultivation in target districts of Gujarat, MP and Rajasthan	Agricultural crop statistics of Gujarat, MP and Rajasthan states	Three state Departments of Agriculture (DOA), Contingency Plan prepared by Ministry of Agriculture as available on ICAR website.
Districts predominantly cultivating white endosperm maize and its area in those districts	Seed of GM-6 produced and supplied by various agencies in respective state	SAUs, States Seed Corporations, Seed Certification Agencies and NGOs
Release and recommendations of GM-6 in the packages of practices by MPUAT and JNKVV	Release proposal for Gujarat and inclusion of GM-6 in recommended package of practices in MP and Rajasthan.	MMRS of AAU at Godhra, JNKVV of RVSKVV at Indore KVK at Jhabua, MP and ARS, MPUAT, Banswara, Rajasthan.
Seed certification	Maize seed certification statistics in Gujarat, MP and Rajasthan	State Seed Certification Agencies of Gujarat, MP and Rajasthan
Seed production programme of maize varieties	Maize seed production by various organizations	GSSC, Research Scientists (Maize), AAU, Godhra and NGOs in Gujarat RSSC, RSSOPCA, Jaipur in Rajasthan, MPSSCA, Indore, MP,
Total seed produced in different states	Amount of seed of different stages of maize varieties during 2003-04 to 2011-12	Various seed producing agencies involved in maize seed production in relevant districts in three states
Total certified/truthful seed of all stages	Aggregate of all the certified and the truthful seed	Various agencies of the states
GM-6 seed against all other maize varieties	GM-6 and other maize varieties seed certified by SSCAs.	SSCAs of the states
Total area covered by GM-6	Estimated on the basis of one ton for fifty hectares	Seed rate recommended by AAU for maize is 20 kg/ha.

Table 3. Details of the persons met related to the maize seed production during 2012.

Date	Name with designation	Address
05 th July, 2012	1. Dr. S.M. Khanorkar 2. Dr. D.B. Patel, 3. Research Scientists	Main Maize Research Station, Anand Agricultural University (AAU), Godhra-389001, Gujarat.
09 th July, 2012	1. Dr. B.R. Shah, Director of Agriculture	Krishi Bhavan, Secto-10A, CH Road, Gandinagar, Gujarat.
	2. Mr. U.D. Singh, Managing Director	Gujarat State Seed Corporation (GSSC), Beej Bhavan, Sector-10A, Gandhinagar, Gujarat.
10 th July, 2012	1. Mr. D.U. Vaghela, Manager Marketing, 2. Mr. B.B. Kundariya, Manager Production 3. Mr. Rami and 4. Mr. R.F. Patel	Gujarat State Seed Corporation, Beej Bhavan, Sector-10A, Gandhinagar, Gujarat.
11 th July, 2012	Dr. R.A. Serasiya, Director	Gujarat State Seed Certification Agency, Beej Pramanan Bhavan (GSSCA), Near Shyamal row House, Vibhag-5 Bus Stand, Opp. Gokul Row House, Satellite, Ahmedabad-380015, Gujarat.
12 th July, 2012	Mr. Jasani, Technical Officer	
13 th July, 2012	Dr. (Mrs.) Lata Chaudhary Head, Department of Plant Breeding and Genetics	Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur-313001, Rajasthan.
14 th July, 2012	Dr. Sonani, Research Scientist	Model Farm, AAU, Vadodara-390020, Gujarat.
24 th July, 2012	Dr. J.A. Patel, Research Scientist (Seed Tech.)	Regional Research Station, Anand Agricultural University, Anand-388110, Gujarat.
24 th July, 2012	Mr. Jasani, Technical Officer	Gujarat State Seed Certification Agency, Beej Pramanan Bhavan (GSSCA), Near Shyamal row House, Vibhag-5 Bus Stand, Opp. Gokul Row House, Satellite, Ahmedabad-380015, Gujarat.
25 th July, 2012	Mr. Vishwa Bhusan Regional Programme Manager	Gramin Vikas Trust (GVT), Chakaliya Road, Dahod-389120, Gujarat.
26 th July, 2012	Mr. Rajiv Khanna Regional Programme Manager	Gramin Vikas Trust, Indore Road, Jhabua, Madhya Pradesh.
	Mr. Rajendra Jaiswal Chief Executive Officer	Prakriti Foundation, Banswara Road, Jhalod, District Dahod, Gujarat.
	Dr. S.M. Khanorkar Research Scientist (Maize)	Main Maize Research Station, Anand Agricultural University, Godhra-389001, Gujarat.
30 th July, 2012	Dr. A.M. Shaikh Vice Chancellor	Anand Agricultural University, Anand-388110, Gujarat.
	Mr. Jasani, Technical Officer	Gujarat State Seed Certification Agency, Beej Pramanan Bhavan, Near Shyamal row House, Vibhag-5 Bus Stand, Opp. Gokul Row House, Satellite, Ahmedabad-380015, Gujarat.
	1. Mr. Rami and 2. Mr. R.F. Patel	Gujarat State Seed Corporation, Beej Bhavan, Sector-10A, Gandhinagar, Gujarat.

Table 4 . Details of the persons met related to the maize seed production during 2013.

Date	Name with designation	Address
21 st Feb 2013	1. Dr. A.M. Shaikh, Vice Chancellor 2. Dr. K.B. Kathiria, Director of Research	Anand Agricultural University, Anand-388110, Gujarat.
24 th Feb 2013	Dr. B.R. Shah, Director of Agriculture	Krishi Bhavan, Sectoe-10A, CH Road, Gandinagar, Gujarat.
25 th Feb 2013	Mr. D.U. Vaghela, Manager Marketing	Gujarat State Seed Corporation (GSSC), Beej Bhavan, Sector-10A, Gandhinagar, Gujarat.
28 th Feb 2013	Mr. Rochak Bhardwaj Regional Programme Manager	Gramin Vikas Trust, Chakaliya Road, Dahod-389120, Gujarat.
01 st Mar 2013	Dr. I.S. Tomar, Programme Coordinator	KVK, RVSKVV, Jhabua, Madhya Pradesh.
11 th -12 th Mar 2013	Mr. Jasani, Technical Officer	Gujarat State Seed Certification Agency, Beej Pramanan Bhavan, Near Shyamal row House, Vibhag-5 Bus Stand, Opp. Gokul Row House, Satellite, Ahmedabad-380015, Gujarat.
14 th Mar 2013	1. Mr. Yashpal Mahavat, Director 2. Mr. Jain and Mr. Rao Seed Certification Officers	Rajasthan State Seed and Organic Production Certification Agency (RSSOPC), Pant Krishi Bhawan, Janpath, Jaipur-302005, Rajasthan.
15 th Mar 2013	Dr. N.K. Sharma Senior Manager (Production)	Rajasthan State Seed Corporation (RSSC), Pant Krishi Bhawan, Janpath, Jaipur-302005, Rajasthan.
19 th Mar 2013	Dr. (Mrs.) Mridula Billore. Senior Scientist (Plant Breeding)	College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya, 3F, Krishi Nagar, Indore GPO, Indore – 452001.
20 th Mar 2013	Mr. Abhaya Jain, Seed Certification Officer	Veterinary Campus, MOG Lines, Indore-452009, Madhya Pradesh.
15 th Apr 2013	1. Dr. G.S. Ameta Zonal Research Director 2. Dr. Devendra Saini Senior scientist	Zonal Research Station, Maharana Pratap University of Agriculture and Technology (MPUAT), Limbdi Road, Banswara, Rajasthan.
	3. Mr. Garasia Seed Processing Plant Manager	Rajasthan State Seed Corporation (RSSC), Seed processing Plant, Dahod Road, Banswara, Rajasthan.
17 th Apr 2013	Mr. Rochak Bhardwaj Regional Programme Manager	Gramin Vikas Trust, Chakaliya Road, Dahod-389120, Gujarat.
	Mr. Rajiv Khanna Regional Programme Manager	Gramin Vikas Trust, Indore Road, Jhabua, Madhya Pradesh.
20 th Jun 2013	Prof. John R. Witcombe	Bangor University, UK met in Kathmandu.
04 th Jul 2013	Mr. D.U. Vaghela, Manager Marketing	Gujarat State Seed Corporation (GSSC), Beej Bhavan, Sector-10A, Gandhinagar, Gujarat.
	Mr. Jasani, Technical Officer	Gujarat State Seed Certification Agency, Beej Pramanan Bhavan, Near Shyamal row House, Vibhag-5 Bus Stand, Opp. Gokul Row House, Satellite, Ahmedabad-380015, Gujarat.
10 th Jul 2013	Mr. Rajendra Jaiswal Chief Executive Officer	Main Maize Research Station, Anand Agricultural University, Godhra-389001, Gujarat.
	Ms. Rekha Solanki Programme Manager	ANANDI, Opposite State bank of India, Chabutara Sheri. Devgadhi Baria-389380, Dahod, Gujarat.
11 th Jul 2013	Dr. S.M. Khanorkar Research Scientist (Maize)	Prakriti Foundation, Banswara Road, Jhalod, District Dahod, Gujarat.
12 th Jul 2013	Dr. J.A. Patel, Research Scientist (Seed Tech.)	Regional Research Station, Anand Agricultural University, Anand-388110, Gujarat.

DEVELOPMENT OF MAIZE VARIETY GUJARAT MAIZE-6

Prior to the development of Gujarat Maize-6, only Gujarat Maize-1 and Ganga Safed-2 of 85-90 days maturity duration were available which met the requirement of resource poor farmers only partially. To meet their needs and provide a wider choice, Gujarat maize-6 (GM-6) was released. The actual release proposal of GM-6 submitted by Main Maize Research Station, Gujarat Agricultural University, Godhra is appended as *Annexure-II* with this report. Prof. J.R. Witcombe from CAZS is named as one of the breeders. The main features of GM-6 are:

- The time to 50% silking averages 44 days and it matures within 80 days.
- It gives 18% more grain yield than GM-1 when compared at experimental sites.
- It has better tolerance to major diseases and pests.
- It matures within 90 days after sowing and so escapes terminal drought.
- Suitable for the areas where second crop is taken after the harvest of maize.
- The per day productivity of GM-6 is 31 kg/ha/day which is higher than GM-1 (27 kg/ha/day).

GM-6 has also been recommended for cultivation in the adjoining states of Madhya Pradesh and Rajasthan in white maize growing districts such as Jhabua and Banswara, respectively. GM-6 recommended and included in the package of practice as documented in their bulletin by JNKVV, Indore and a booklet by Krishi Vigyan Kendra (KVK) of JNKVV, University, Jhabua, MP. The information on recommendation of GM-6 in Rajasthan was available from Zonal Director of Research, MPUAT, Banswara (see below). The varieties recommended for these nine districts have already been given in Table 1.

The actual success of a variety/composite/hybrid depends upon the area covered by that variety. Thus the production of quality seed and its availability to cultivators is a basic factor in determining the spread of a variety. The seed act in India governs seed production and certification. In each state of the country the State Seed Certification Agency (SSCA) is responsible for regulating quality seed production. In Gujarat it is Gujarat State Seed Certification Agency (GSSCA) which has its headquarters in Ahmadabad, in MP it is Madhya Pradesh Seed Certification Agency (MPSSCA) with its head office at Bhopal and regional office at Indore and in Rajasthan it is Rajasthan State Seed and Organic Production Certification Agency (RSSOPCA) with its head quarters at Jaipur. Only these agencies are responsible for certification of foundation and certified seed of any crop.

AGENCIES RESPONSIBLE FOR VARIOUS STAGES OF SEED PRODUCTION

Different agencies are responsible for the various stages of seed production (Table 5).

Table 5. Agencies responsible for the seed production of different seed stages.

Seed stage	Agency responsible	Certification agency.	Usage of the seed stage
Nucleus	Concerned agency/organization who developed that variety	None. Done by breeder	For breeder seed production
Breeder	Concerned agency/organization who developed that variety	Team formed by the respective coordinator of the crop of national crop programme in ICAR.	For foundation seed production
Foundation	Any individual/ organization wishes to produce seed by adopting the procedures laid by the legal body i.e. SSCA.	SSCA officials	For certified seed production
Certified	Any individual/organization wishes to produce seed by adopting the procedures laid by the legal body i.e. SSCA.	SSCA officials	For supply to the farmers directly/ through dealers or to retailers.
Truthful	Concerned agency/organization who produced that variety	Agency has to give TL level tag ensuring the quality of seed.	For supply to the farmers directly/ through dealers or through retailers.

SEED PRODUCTION

GUJARAT

1. ANAND AGRICULTURAL UNIVERSITY

a. MAIN MAIZE RESEARCH STATION, GODHRA

In Gujarat state, by law, the Main Maize Research Station (MMRS), Godhra, Anand Agricultural University (AAU), Anand (earlier under Gujarat Agricultural University) is solely responsible for the recommendation for release of maize variety/composite/hybrid in Gujarat state to the State Variety Release Committee (SVRC). No other agency can recommend any variety to SVRC other than the concerned state agricultural university. The maize varieties/composites recommended by MMRS and their details are given in the table 6 in this report (See also *Annexure IV*).

MMRS, Godhra has registered five maize varieties/composites with the PPV and FRP (Protection of Plant Varieties and Farmers Rights Protection) and are given Table 6.

As stated above, the MMRS is only responsible organization for the maize nucleus and breeder seed production of maize varieties released by MMRS in Gujarat state. The nucleus, breeder and truthful seed production programme of GM-6 undertaken by MMRS increased substantially from 1999 onwards and given Table 7.

In addition, Anand Agricultural University has also produced the GM-6 seed of different stages at its Regional Research Station, Anand which works under the Seed Technology Departments of AAU. The information provided by Nodal Officer and Research Scientist, Regional Research Station, Anand Agricultural university, Anand.

Table 6. Maize varieties/composites registered with PPV and FRP, source Research Scientist (Maize), MMRS, Godhra (Annexure-IV).

Variety name	Pedigree	Major features	Year of release	Adoption Areas	Notification number, PPV and FRP registration
GM-2	(4119x4123)xDRM-6	Flint, Yellow, Early	1995	All Gujarat	7-2/95-50-SD IV REG/2007/336
GM-3	(Composite-1xWRF-9HS)	Flint, White, Early, Winter/Rabi season	1999	All Gujarat	S.O.937(E)07-09-2002.
GM-4	(LGC-40xWRF-15HS)	Flint, White, Early	2000	All Gujarat	36-K,6,30-5-2001/REG/2007/339.
GM-6	CS-2, Sweta, GM-1, Mahikanchan, Navin, CM-3	Flint, White, Extra early	2002	All Gujarat	S.O.383 (E)12-3-2003 REG/2007/338.
Narmada Moti	(GC-40xEH-2922HS)	Flint, White Earliness	2002	Across India except NEH	S.O.937 (E04-09-2003) REG/ 2007/340.

Table 7. Maize GM-6 seed production programme by MMRS, Godhra, source Research Scientist (Maize), MMRS, Godhra.

Year	Quantity produced (t)					Total of N, B and TL seed @	Seed supplied to whom
	Nucleus	Breeder	Foundation	Truthful	Total		
1999	0.00	0.16		0.00	0.16	0.16	Different NGOs in Gujarat, Rajasthan and M. P., Gujarat State Seed Corporation, Gandhinagar.
2000	0.00	0.00		0.00	0.00	0	
2001	0.01	0.00		0.86	0.87	0.87	
2002	0.02	0.25		2.96	3.23	3.23	
2003	0.04	0.38		1.83	2.25	2.25	
2004	0.01	1.50		2.00	3.51	3.51	
2005	0.01	1.83		0.16	2.00	2	
2006	0.02	1.71		3.96	5.68	5.69	
2007	0.01	3.70		0.40	4.11	4.11	
2008	0.01	1.40		5.95	7.36	7.36	
2009	1.10	1.10		0.00	2.20	2.2	
2010	0.00	3.50		0.00	3.50	3.5	
2011	1.20	4.80		0.00	6.00	6	
2012	0	5.36	0.57	3.41	9.34	8.77	
2013*	0.40	4.6	0.20	1.10	6.30	6.10	
Total	2.83	30.2	0.77	22.7	56.51	55.74	

*= Extrapolated on the basis of average of previous three years.

@= Amount of seed where certification is not required

Table 8. Maize varieties/composites developed by Main Maize Research Station, AAU, Godhra and their beneficial impact on farmers.

Varieties/ Hybrid/ composite	Year of Release	Season	Grain type and maturity	Adaptation (District)	Area	Acreage under variety after release (M ha)	Benefited to farmers (M Rupees) 20% gained
GM-2	1995	Kharif rain fed	Yellow flint Earliness	Sabarkantha and Banaskantha		1.403	7856.8
GM-3	1999	Winter/ Rabi	White flint, Earliness	Panchmahals, Dahod, Kheda and Vadodara		0.858	4462.0
GM-4	2000	<i>Kharif</i> rain fed	White flint Earliness	Panchmahals, Dahod, Kheda and Vadodara		0.215	1118.0
GM-6	2002	<i>Kharif</i> rain fed	White flint Extra Earliness	Panchmahals, Dahod, Kheda and Vadodara; Banswara (Rajasthan) and Jhabua and Dhar (M. P.)		2.000	10401.0
Narmada Moti	2002	<i>Kharif</i> rain fed	White flint Earliness Wide adaptability	Panchmahals, Dahod, Kheda and Vadodara		0.500	2600.0
HQPM-1 Hybrid	2011	<i>Kharif</i> rain fed and <i>Rabi</i>	Yellow semi flint Medium	Panchmahals, Dahod, Kheda, Vadodara and Sabarkantha		Endorsed by 42 nd State Seed sub Committee, Gandhinagar.	
GAWMH-2	2012	<i>Kharif</i> rain fed	White flint Earliness	Panchmahals, Dahod, Kheda, and Vadodara		To be submitted in 43 rd State Seed sub Committee, Gandhinagar.	

(Source: Research Scientist (Maize), MMRS, AAU, Godhra by e-mail.)

From the above table received from the scientist, it is evident that the maize variety GM-6 occupied the highest acreage with maximum benefit to the farmers. Though GM-6 was released in 2002 as compared to GM-2 in 1995 even than that has been grown in largest area in Gujarat. This variety was released in 2002 in Gujarat (later recommended in MP and Rajasthan) and since then this has been cultivated in an approximate area of two million hectares. The area and seed production are still going on. The scientist has also reported the benefit to the farmers cultivating GM-6 to the tune of Rs.10401 million rupees (approximating to £104 million) assuming 20% benefits over the period from its release.

No information was supplied with the estimate of benefits by the Research Scientist (Maize). Hence, another assessment is made here. It is more reasonable to assume a 30% increase in yield because this is the increase in yield of GM-6 over the local varieties in the release proposal. This is a better estimate than the 20% increase used in Table 8 that is based on an increase over the check variety GM-1 that is little grown by farmers. It is a reasonable estimate that a cumulative 2 million ha of GM-6 has been grown (see page 33 below). If we assume average yields of 1 t per hectare then the increased grain yield from growing GM-6 is 0.6 million tonnes. At 2013 prices this equates to £96 million (at Rs. 1,600 per tonne) which is close to the estimate of the Research Scientist (Maize). This is a simple calculation and not a financial analysis. Lower maize prices in previous years could reduce the benefit to around £50 million which is still a substantial amount.

b. REGIONAL RESEARCH STATION, ANAND

Table 9. Maize GM-6 seed production programme by Regional Research Station, AAU, Anand.

Year	Seed of different stages produced by RRS, AAU, Anand (t)				Total	B and TL seed @
	Breeder (B)	Foundation (F)	Certified (C)	Truthful (T)		
2006	3.0	4.4	0.0	0.0	7.4	3
2007	2.0	23.3	5.8	16.0	47.1	18
2008	0.2	21.0	0.0	16.0	37.2	16.2
2009	0.0	0.8	0.0	0.0	0.8	0
2010	14.3	7.0	4.0	29.8	55.1	44.1
2011	9.8	16.8	0.0	6.0	32.6	15.8
2012	12.9	7.80	18.0	4.60	43.3	17.80
2013*	12.3	10.50	7.3	13.50	43.6	25.80
Total	54.50	91.6	35.1	85.9	267.1	140.4

*= Extrapolated on the basis of average of previous three years.

@= Amount of seed which do not require certification by GSSCA.

Source: Nodal Officer (Seed) and Research Scientist, RRS, AAU, Anand (*Annexure-V*).

Table 10. Total seed production by Anand Agricultural University over years.

AAU Section	Stages of seed production							Total of N, B and TL seed @	Source (Table No. of this report)
	Nucleus	Breeder	Foundation	Certified	Truthful	Total			
MMRS, Godhra	2.83	30.2	0.757	0.00	22.70	56.500	55.70	7	
RRS, Anand	0.00	54.5	91.6	35.1	85.9	267.10	140.40	9	
Total	2.48	84.7	92.17	35.1	108.6	323.6	196.10		

@= Amount of seed where certification is not required means that do not include foundation seed.

GUJARAT STATE SEED CERTIFICATION AGENCY (GSSCA), AHMEDABAD.

Table 11. Maize varieties foundation and certified seed certification by GSSCA 2003 to 2013.

Year	Variety	Foundation		Certified		Total	
		Area registered (ha)	Production (t)	Area registered (ha)	Production (t)	Area registered (ha)	Production (t)
2002	GM-2	8	5.85	0	0	8	5.85
	CM400xCM300	2.7	0.67	0	0	2.7	0.67
	Ganga Safed-2	0	0	10.8	16.2	10.8	16.2
	Total	10.7	6.52	10.8	16.2	21.5	22.72
2003	GM-2	8.6	3.495	9.2	7.86	17.8	11.355
	GM-4	20.4	4.4	0	0	20.4	4.4
	Narmada Moti	8.8	3.815	0	0	8.8	3.815
	GM-3	3.6	6.28	0	0	3.6	6.28
	GM-6	20	4.535	0	0	20	4.535
	Total	61.4	22.525	9.2	7.86	70.6	30.385
2004	GM-2	2	0.88	0	0	2	0.88
	GM-4	8.2	3.76	0	0	8.2	3.76
	GM-6	0	0	16	2.3	16	2.3
	Ganga Safed-2	0	0	2.8	1.74	2.8	1.74
	Total	10.2	4.64	18.8	4.04	29	8.68
2005	GM-6	32.88	39.92	220.8	13.7	253.68	53.62
	GM-4	18.48	10.116	144.8	71.2	163.28	81.316
	Narmada Moti	4.16	5.79	12.4	2	16.56	7.79
	Ganga Safed-2	0	0	22	11.299	22	11.299
	Total	55.52	55.826	400	98.199	455.52	154.025
2006	GM-2	2.4	2.4	37.2	15.245	39.6	17.645
	GM-4	3.2	0.26	73.2	81.328	76.4	81.588
	GM-6	14	17.46	311.4	156.805	325.4	174.265
	Narmada Moti	0	0	91.6	34.56	91.6	34.56
	Total	19.6	20.12	513.4	287.938	533	308.058
2007	GM-4	20	6.8	49.6	35.932	69.6	42.732
	GM-6	53	81.91	529.2	813.99	582.2	895.9
	Narmada Moti	16.8	4.96	0	0	16.8	4.96
	Ganga Safed-2	0	0	40	21.5	40	21.5
	Total	89.8	93.67	618.8	871.422	708.6	965.092
2008	GM-6	15	25.55	32.4	0	47.4	25.55
	Narmada Moti	4	2.4	0	0	4	2.4
	Ganga Safed-2	0	0	14	17.745	14	17.745
	Total	19	27.95	46.4	17.745	65.4	45.695
2009	GM-6	20.8	14.368	0	0	20.8	14.368
	Total	20.8	14.368	0	0	20.8	14.368
2010	Narmada Moti	1	1.68	0	0	1	1.68
	GM-4	12	4.48	0	0	12	4.48
	GM-6	169.1	69.433	73.6	23.739	242.7	93.172
	Total	182.1	75.593	73.6	23.739	255.7	99.332
2011	GM-6	19	20.1	203.4	382.4	222.4	402.5
	Total	19	20.1	203.4	382.4	222.4	402.5
2012	GM-6	58.4	35.6	58.8	72.2	117.2	107.8
	Shaktiman-2	0.0	0.0	2.0	0.1	2.0	0.1
	CML-176	0.4	0.1	0.0	0.0	0.4	0.1
	CML-186	0.2	0.1	0.0	0.0	0.2	0.1
	CML-161	0.4	0.6	0.0	0.0	0.4	0.6
	Total	59.4	36.3	60.8	72.3	120.2	108.6
2013*	GM-6	82.2	41.7	111.9	159.41	194.1	201.2

*= Extrapolated on the basis of average of previous three years. Source: Extracted from the reports of GSSCA, Ahmedabad (Annexure-VI).

GSSCA is the sole authority to certify the foundation and certified stages of seed produced by any agency. The below information on the certification of maize seed by GSSCA was available from 2002-03 onwards (Table 11 above). The certification of foundation and certified GM-6 seed certification started from 2003-04 only.

Table 12. Details of variety wise total maize foundation and certified seed certification by GSSCA, Ahmedabad, Gujarat (2002 to 2013).

Variety	Foundation		Certified		Total	
	Area (ha.)	Production (t)	Area (ha.)	Production (t)	Area (ha.)	Production (t)
GM-2	21.0	12.6	46.4	23.1	67.4	35.7
GM-3	3.6	6.3	0.0	0.0	3.6	6.3
GM-4	86.3	31.3	267.6	188.5	353.9	219.8
GM-6	484.3	350.6	1557.5	1624.6	2041.9	1975.2
Ganga Safed-2	0.0	0.0	89.6	68.5	89.6	68.5
Narmada Moti	35.1	19.2	104.0	36.6	139.1	55.8
Shaktiman-2	0.0	0.0	2.7	0.1	2.7	0.1
CM400xCM300	2.7	0.7	0.0	0.0	2.7	0.7
CML-161	0.5	0.8	0.0	0.0	0.5	0.8
CML-176	0.5	0.1	0.0	0.0	0.5	0.1
CML-186	0.3	0.1	0.0	0.0	0.3	0.1
Total	634.4	421.7	2067.8	1941.3	2702.2	2363.1

Source: Information from GSSCA, Ahmedabad.

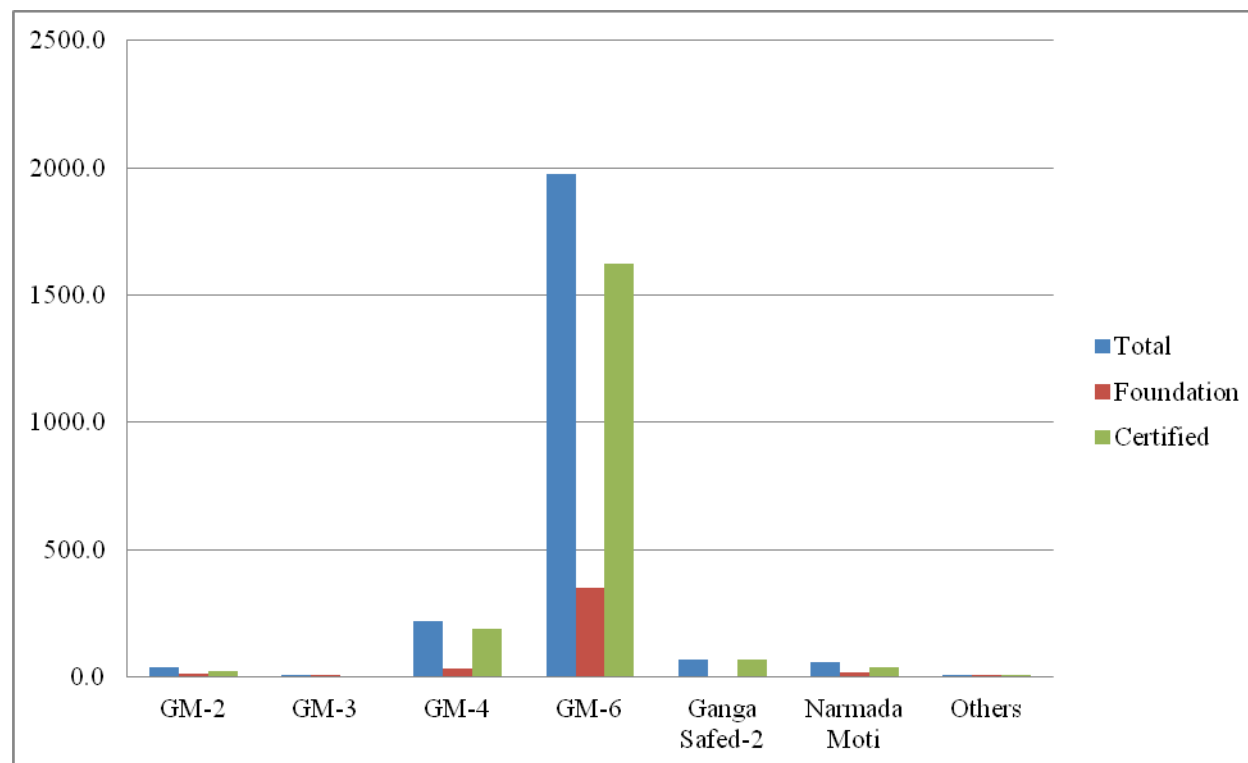


Figure 1. Total maize foundation and certified seed (t) certified by GSSCA, Ahmedabad, Gujarat (2002 to 2013).

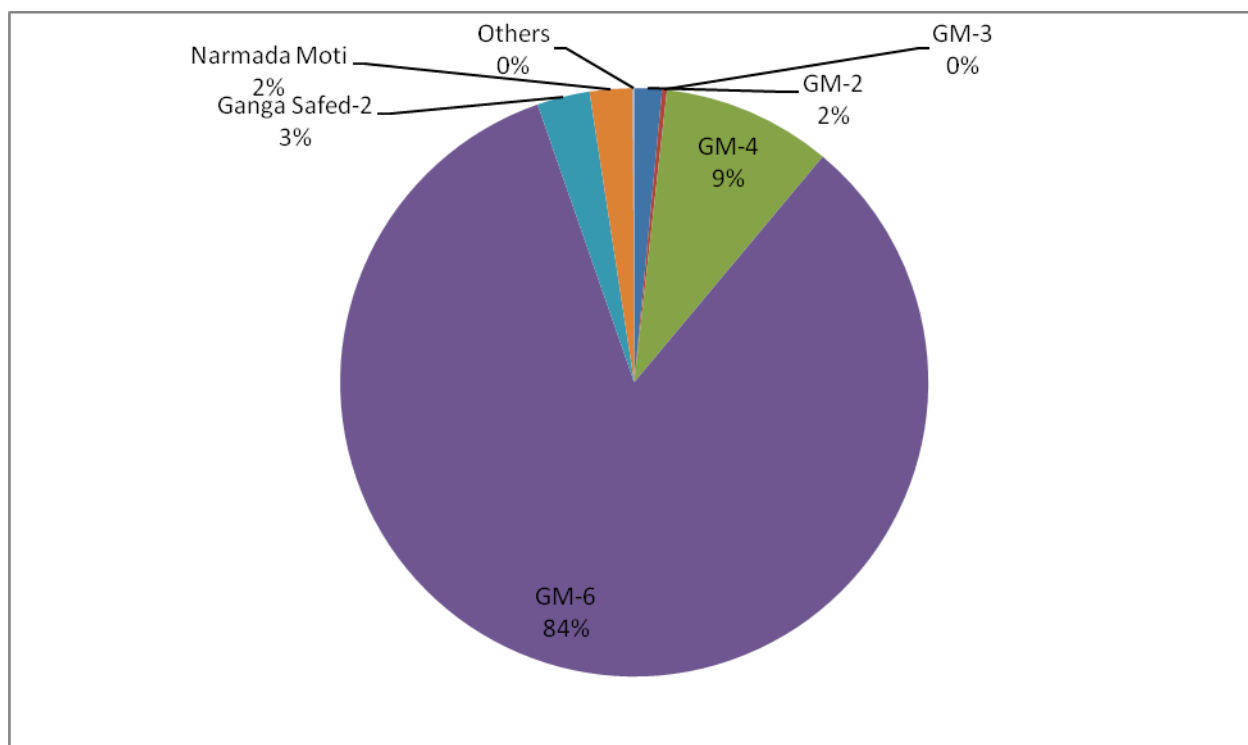


Figure 2. Total seed certification by GSSCA, Ahmedabad, Gujarat (2003-2013) by variety (%).

Table 13. Details of maize GM-6 variety foundation and certified seed certification by GSSCA, Ahmedabad, Gujarat, (2003 to 2013).

Variety	Foundation		Certified		Total	
	Area (ha.)	Production (t)	Area (ha.)	Production (t)	Area (ha.)	Production (t)
2003	20.0	4.5	0.0	0.0	20.0	4.5
2004	0.0	0.0	16.0	2.3	16.0	2.3
2005	32.9	39.9	220.8	13.7	253.7	53.6
2006	14.0	17.5	311.4	156.8	325.4	174.3
2007	53.0	81.9	529.2	814.0	582.2	895.9
2008	15.0	25.6	32.4	0.0	47.4	25.6
2009	20.8	14.4	0.0	0.0	20.8	14.4
2010	169.1	69.4	73.6	23.7	242.7	93.2
2011	19.0	20.1	203.4	382.4	222.4	402.5
2012	58.4	35.6	58.8	72.2	117.2	107.8
2013*	82.2	41.7	111.9	159.4	194.1	201.2
Total	484.3	350.6	1557.5	1624.6	2041.9	1975.2

*= Extrapolated on the basis of average of previous three years.

From Tables 12 and 13 and Figs 1 and 2, it is clearly evident that GM-6 foundation and certified seed production certification by GSSCA is 84% in both the stages of the total foundation and certified seed of all the maize varieties. This signifies the adoption and popularity of GM-6 over other varieties amongst farmers. In other words, it is the maize GM-6 variety that has found the favour of the cultivators and there by the seed producers rules the maize cultivation in marginally poor areas and tribal farmers of white maize growing regions.

Table 14. Total area and production of maize GM-6 foundation and certified seed seed certified by GSSCA from 2003 to 2013 Gjarat, India.

Year	Area registered (ha)	Production (t)
2003	20.0	4.54
2004	16.0	2.30
2005	253.7	53.62
2006	325.4	174.27
2007	582.2	895.90
2008	47.4	25.55
2009	20.8	14.37
2010	242.7	93.17
2011	222.4	402.50
2012	117.2	107.80
2013*	160.8	201.14
Total	2008.6	1975.16

*= Extrapolated on the basis of average of previous three years.

Source: GSSCA, Ahmedabad. See page 2 of *Annexure-VI*.

2. GUJARAT STATE SEED CORPORATION, GANDHINAGAR.

Table 15. Maize foundation seed produced by GSSC (including GM-4 during 2008-2011).

Year	Season	Variety	Stage	Area (ha)	Production (t)
2008	Post rainy	GM-6	F	133.95	144.24
2009	Post rainy	GM-6	F	4.05	0.43
	Rainy season	GM-6	F	2.03	0.79
2010	Post rainy	GM-6	F	13.35	15.74
	Post Rainy	GM-4	F	12.15	4.47
2011	Summer	GM-6	F	6.07	5.2
2012	Summer	GM-6	F	4	4.1
2013*	Summer	GM-6	F	7.81	8.35
Total				183.41	183.32
Total GM-6				171.26	178.85

*= Extrapolated on the basis of average of previous three years.

Table 16. Certified GM-6 seed marketed by Gujarat State Seed Corporation, Gandhinagar.

#	Year	District wise sale (t)						Total (t)
		Banas kantha	Kheda	Vadodara	Panchmahals (including Dahod)	Gandhinagar	Vyara	
1	2007	0	0	0.004	23.25	144.74	0.53	168.52
2	2008	0	0	0.056	50.41	300.31	0.24	351.02
3	2009	9.7	11.2	11.2	8.91	271.51	3.7	316.22
4	2010	0	0	0.24	0.97	0	0	1.21
5	2011	NA	NA	NA	15.75	NA	NA	15.75
6	2012	0	0	0	66.5	36.56	0	103.06
7	2013*	0	0	0.08	27.74	12.19	0	40.01
	Total	9.7	11.2	11.58	193.53	765.31	4.47	995.79

*= Extrapolated on the basis of average of previous three years.

Source: Gujarat State Seed Corporation, Gandhinagar (Page 1, *Annexure-VI*).

In Table 15, the foundation seed produced (178.5t) by GSSC from 2008 to 2013 is given which includes GM-4 (4.47t) also which was produced in 2010 only. Whereas in Table 16, the certified seed produced was 955.79t by GSSC up to 2013. The total foundation and certified seed produced and marketed by GSSC up to 2013 was 1174.63t.

Table 17. Total GM-6 foundation and certified seed production and marketing (t) by GSSC, Gandhinagar, Gujarat.

Year	Foundation	Certified	Total
2007	0	168.52	168.52
2008	144.24	351.02	495.26
2009	1.22	316.22	317.44
2010	15.74	1.21	16.95
2011	5.2	15.75	20.95
2012	4.1	103.06	107.16
2013*	8.35	40.01	48.35
Total	178.85	995.79	1174.63

*= Extrapolated on the basis of average of previous three years.

3. COLLECTIVES FOR INTEGRATED LIVELIHOOD INITIATIVES (CiNi), AHMEDABAD

CiNi is an organization promoted by Sir Ratan Tata Trust (SRTT) that is implementing the *Khariif* Maize Stabilization (KMS) project in Western India, particularly in Dahod, Panchmahals districts of Gujarat, Jhabua in MP and Banswara and Dungarpur in Rajasthan. The main activity of CINI in its KMS project was seed production of popular varieties namely GM-6 and JVM-421. It may be worthwhile to mention that JVM-421 is another variety of white maize bred through the process of Participatory Plant Breeding in the same project in which the GM-6 was recommended by JNKVV. The information on maize seed production made available is given below:

Table 18. Maize seed production by CINI under *Khariif* Maize Stabilization (KMS) project.

Organization	Year	Season	Variety	Stage of production	Area (ha)	Production (t)
N.M. Sadguru	2009	<i>Rabi</i>	GM-6	Certified	4	3
	2010	<i>Rabi</i>	GM-6	Certified	160	120
	2011	<i>Rabi</i>	GM-6	Certified	80	90
	2011	<i>Khariif</i>	GM-6	Certified	40	40
Utthan	2009	<i>Rabi</i>	GM-6	Certified	4	2.8
	2010	<i>Rabi</i>	GM-6	Certified	20	11.2
	2010	<i>Khariif</i>	GM-6	Certified	20	8
Prikriti Foun.	2011	<i>Rabi</i>	GM-6	Certified	20	6
GVT, Dahod	2010	<i>Rabi</i>	GM-6	Certified	20	9
CiNi Project	2013*	<i>Rabi</i>	GM-6	Certified	80	94.7
Total					448	384.7
Total JVM-421 seed supplied to farmers by MP government. 20						

*= Extrapolated on the basis of average of previous three years (2009 to 2011).

The organizations that were involved in CINI project were actively working in Gujarat, MP and Rajasthan and supplied the maize seed to the farmers.

4. PRIKRITI FOUNDATION, JHALOD, DAHOD

Prikriti Foundation is an NGO with its head quarters at Jhalod in Dahod district of Gujarat. Prikriti Foundation is undertaking various agricultural developmental activities in various states of the country. It is also undertaking the seed production programme of Maize crop since 2002-03. The seed production programme started from 2002-03 onwards and from 2005-06 onwards only variety GM-6 was produced that too in increasing order and the details are given in the table below. The seed produced was supplied to the farmers for general cultivation under different projects implemented at many places. The seed produced as said above excludes the seed produced under CINI project which is reported elsewhere. The variety wise details and stage of production are given in the table below:

Table 19. Maize seed production undertaken by Prikriti Foundation, Dahod, Gujarat.

Year	Season	Variety	Stage of production	Area (ha)	Production (t)
2003	<i>Kharif</i>	GM-3	Certified	2.0	3
2004	<i>Kharif</i>	GM-4	Certified	1.60	2
2005	<i>Kharif</i>	GM-6	Truthful	32.0	64
2006	<i>Kharif</i>	GM-6	Truthful	32.0	64
2007	<i>Kharif</i>	GM-6	Certified	7.5	16
2009	<i>Kharif</i>	GM-6	Truthful	42.5	87
2010	<i>Kharif</i>	GM-6	Certified	15.0	33
2011	<i>Kharif</i>	GM-6	Truthful	46.4	100
2012	<i>Kharif</i>	GM-6	Truthful	82.0	182
2013*	<i>Kharif</i>	GM-6	Truthful	43.0	94
	<i>Kharif</i>	GM-6	Truthful	5.0	11
Total GM-3					4
Total GM-4					5
Total GM-6 Certified					60
Total GM-6 Truthful					591

*= Extrapolated on the basis of average of previous three years.(2010-2012)

Since the information for 2013 is yet to come, hence the figures have been extrapolated on the basis of average of preceding three years. It is clear from the above table that a total of 591 t of truthful GM-6 maize seed was supplied by Prakriti Foundation to its project area farmers in Gujarat and Rajasthan states.

5. GRAMIN VIKAS TRUST, DAHOD.

GVT, Dahod has been implementing an ICAR project called National Agricultural Innovation Project (NAIP). As an activity of this project, GVT was involved in the maize GM-6 seed production for meeting the demand of its project area farmers. Prior to NAIP, GVT produced GM-6 seed in a rainfed farming project in western India. The information made available from the reports of consultants and the GVT office, Dahod indicated that during 2000 onwards till 2013 162.7t truthful seed was produced and supplied to the project farmers. GVT has also been an intermediary for supplying the GM-6 seed after procuring from AAU to the neighboring states of MP and Rajasthan. The seed produced as stated above excludes the seed produced under CINI project which is reported elsewhere. The details are given in the table below:

Table20. Maize GM-6 truthful seed production undertaken by Gramin Vikas Trust, Dahod, Gujarat.

Year	Production (t)	Year	Production(t)
2000	0.5	2006	21.8
2001	1.1	2007	20.5
2002	1.9	2010	21.5
2003	15.7	2011	22.3
2004	27.6	2013*	14.6
2005	15.2		
Total			162.7

*= Extrapolated on the basis of average of previous two years (2010 and 2011).

6. ANANDI FOUNDATION, DEVGADH BARIA, DAHOD.

Table 21. Maize GM-6 seed production by Anandi Foundation, Devgadh Baria, Dahod, Gujarat.

Year	Season	Variety	Stage of production	Area (ha)	Production (t)
2009	Kharif	GM-6	Certified	2.46	1.60
2010	Kharif	GM-6	Foundation	2.95	2.15
	Kharif	GM-6	Certified	3.93	3.75
2011	Kharif	GM-6	Foundation	3.28	1.58
	Kharif	GM-6	Certified	6.84	10.37
2013*	Kharif	GM-6	Foundation	3.00	1.20
	Kharif	GM-6	Certified	4.00	4.70
Total		C=5.00	F=20.35	26.46	25.35

*= Extrapolated on the basis of average of previous three years (2009-2011).

B. MADHYA PRADESH

Three districts in Western Madhya Pradesh namely Badwani, Jhabua and Ratlam mainly cultivate white maize in an area of 0.19 Mh producing 0.28 Mt with an average productivity of 1506 kg/ha. In Jhabua district alone the area covered by maize is 0.11 Mh producing 0.16 Mt of maize grain with an average productivity of 1423 kg/ha. In these three district GM-6 was recommended in 2005 and later another variety JVM-421 was released in 2007 from participatory plant breeding programme run in collaboration with GVT by JNKVV, Indore as given below from the source:

1. RAJMATA VIJAYARAJE SCINDIA KRISHI VISHWA VIDHYALAY, INDORE.

Together we win

Table-1 : Varietal scenario in Jhabua

S.No.	Crops	Varieties released by JNKVV	Before inception of the project	After completion of the project
1	Maize	Chandan Makka-1, 2 and 3, Jawahar Makka 8, 12 and 216	JM 8, GM 6, NLD and Local*	Gujarat maize 6 and Indore Vikas Maize 421
2	Upland rice	Poorva, Jawahar Rice (JR) 75 and JR3-45	Local, and Kalinga 3	Ashoka 228, Ashoka 200F and GR 8
3	Chickpea	Desi- Gwalior 2, JG 62, Ujjain 21, Ujjain 24, JG 5, JG 315, JG 74, JG 218, JG 322, JGG 1, JG 130, JG 11, JG 16, JG 412 and JG 63 Kabuli- JGK 1	Ujjain 21, JG 218 and Local* ICCV2	Jawahar Gram 226, JG 412, Indore Gram 370, 379, 593, JG 130, JG 16 and ICCV 88202 KAK 2 and JGK 1
4	Blackgram	Gwalior 2, Khargone 3, JU 2 and JU 3	Local* and Type 9	JU 86, Indore Vikas Urid 486, 466 and 8810
5	Niger	Ootakmand, JNC 1 and JNC 6	Local*	JNC 1, Indore Vikas Niger 10 and NRS 96-1
6	Horsegram	None	Local*, Birsa Kulthi-1	AK 46, 42, 21, 1 and Indore Vikas Horsegram 2

* Seeds are purchased from local mandi (Market), hence, genetic and physical purity always lack.

Copied from the source

The recommendation of GM-6 in Jhabua Hill AEZ was made on the basis of the following criteria taken from the source:

Preference of genotypes as per matrix ranking

Genotype	Farmers' opinion
Indore Vikas Maize 421 (IVM 421)	Tall, bold seeds, good cob size, high yield, filling to the tip, sweet to taste, good cooking quality, high premium and relatively late (the only negative remark)
Gujarat Maize 6 (GM-6)	Tall plants contributing to increased fodder quantity, early maturity, good taste and better cooking quality than local and high yield with high market value.
Indore Vikas Maize 2 (IVM 2)	Early, tall, bold seeds and high yields, most preferred among upcoming test entries.
GDRM 186-1	Early maturity, bold shiny seeds with good yield levels, not much preferred during sensory evaluation, relatively shorter than local
GDRM 190	Early, bold seeds and relatively poor yields, not that sweet and tasty as GM 6 and IVM 421.

The final outcome of that project is given below from the source:

FINAL OUTCOME OF THE PROJECT

Crop	Varieties officially released	Varieties identified by the UVRC for its release by the SVRC	Promising genotypes in pipeline	Remarks
Maize	Jawahar Vikas Maize 421	-	Indore Vikas Maize-2	<ul style="list-style-type: none"> Gujarat Maize 6 recommended for the AEZ Random mating populations viz., Indore Vikas Maize 3, 4, 5, and 6 are in hand for further testing in participatory mode
Upland rice	-	-	Indore Rice MT-1 (Early) and Indore Rice MT-4 (Late)	<ul style="list-style-type: none"> Ashoka 228 and Ashoka 200F recommended for the Jhabua Hill Zone of M.P.
Black gram	Jawahar Urid -86	-	Indore Vikas Urid 486, Indore Vikas Urid 466, Indore Vikas Urid 466-9 and Indore Vikas Urid 8810	<ul style="list-style-type: none"> Released JU-86 by the State Varietal Release Committee in September 2004 for Malwa, Nimar and Jhabua Hill Zone.
Chickpea	Jawahar Gram-412, Jawahar Gram 226	-	Indore Gram 593	<ul style="list-style-type: none"> Extra early (IPC x 08) and few elite wilt resistant derivatives of cross Dahod Yellow x ICCV 2 are in hand for further testing in participatory mode
Horsegram	-	Indore Vikas Horsegram 2	Indore Vikas Horsegram 4	<ul style="list-style-type: none"> AK-42 recommended for Jhabua Hill Zone, IVH-1 with short tendril habit suitable for inter cropping developed.
Niger	-	Indore Vikas Niger-10	Indore Vikas Niger-2	<ul style="list-style-type: none"> Jawahar Niger Composite -1 recommended for cultivation in Jhabua Hill Zone, Extra early maturing (65 days), Indore Vikas Niger -2 developed

MADHYA PRADESH STATE SEED CERTIFICATION AGENCY, INDORE.

There is no record of any GM-6 seed production in the state of MP where as MPSSCA certified the JVM-421 seed production programme. The details of maize seed certified by MPSSC is given below:

Table 22. Information on area registered and certified quantity of maize seed in Indore division, MP by MPSSCA

Year	Season	Variety	Registered area in ha.	Certified quantity (t).
2008	<i>Kharif</i>	Pratap	1.75	1.10
2011	<i>Kharif</i>	Pusa-4 and Narmada Moti	2.00	-
2012	<i>Kharif</i>	JVM-421 and Narmada Moti	3.00	-
2008	<i>Rabi</i>	JVM-421	3.00	0.17
2009	<i>Rabi</i>	JVM-421	7.00	1.49
2010	<i>Rabi</i>	JVM-421	9.00	11.90
2012	<i>Rabi</i>	JVM-421	2.00	
Total	Total		27.75	54.56

It is interesting to note that seed of the variety developed through participatory plant breeding programme JVM-421 has been produced. This is a variety developed in MP in the same project in which GM-6 was developed in Gujarat (Annexure-III). It may not be out of place to mention that the seed of GM-6 produced in Gujarat was supplied in Jhabua district by various agencies like GVT, Anandi Foundation.

In addition to this, CiNi has also undertaken the seed production of JVM-421 and given in Table 15. This may

C. RAJASTHAN

In Rajasthan maize is cultivated in an area of 1.14 mh producing 2.05 Mt with an average productivity of 1798 kg/ha. Banswara and Dungarpur districts of Rajasthan bordering Gujarat are mainly growing white maize. These two tribal districts cultivate maize approximately in an area of 0.22 Mh and contributing 0.32 Mt in the production basket with an average productivity of 1545 kg/ha. The variety GM-6 was included in the package of practices by MPUAT, Banswara in the year 2004 as evidenced in the following information provided by Zonal Director of Research, Agricultural Research station, MPUAT, Banswara.

1. MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BANSWARA.

AGRICULTURE RESEARCH STATION: BANSWARA

Production Recommendations during last Ten Years (2000-01 to 2010-11)

Kharif 2007

- Weed control in maize under rainfed condition where inclusion of intercrop (maize with soybean 2:2 row ratio) having treated with Pendimethalin @ 1.5 kg a.i./ha followed by one hand weeding at 30 DAS found superior grain yield and B:C ratio then other farmer practices.

Kharif 2006

- Integrated nutrient management for cotton.
 - Effect of K application on fibre quality and yield of cotton.
 - Efficiency of different NCU formulations for transplanted paddy.
- Evaluation of bio-inoculants and organic manures on upland paddy.

Kharif 2005

- Paddy variety, Ashoka-200F.
- Proso millet variety, PR-18.
- Groundnut varieties, TJ-37A, DH-86, Pratap Moongfali-1, GG-7.
- Sorghum varieties, CSV-17, Pratap Jawar-1430, SPH-837.

Kharif 2004

- White seeded maize composite, GM-6.
- For sweet cob maize composite, Madhuri.
- Foxtail millet variety, Pratap Kangni-1.
- Proso millet variety, K-1.
- Soybean variety, Pratap Soya-1.
- Spray of (0.2%) thio-urea at grain filling stage of rainfed maize.
- In maize-wheat cropping sequence seed treatment of maize with Azotobactor, PSB alongwith FYM 10 t/ha and 75 % of recommended N and P.
- Six release of Trichogramma eggs (1.5 lac/ha) at 10 days interval from 30 DAS for the control cotton boll worms.
- Spray of profenophos 50 EC or Chloropyriphos 25 EC @ lit/ha at 20-25 DAS for control of soybean insect pests.

Kharif 2003

- Seed treatment with 6-8 g/kg trichoderma to check root rot of soybean. Release of trichogramma eggs @ 1.5 lac/ha 6 times at 10 days interval to control boll worm of cotton.
- Release of trichogramma eggs @ 1.5 lac/ha 6 times 7 days interval to control fruit stem borer of Bhindi.
- Spray of 750 ml/ha pendimethalin just after sowing followed by interculture operations after 30 days to control weeds in Ajwain.

Kharif 2002

- Cotton hybrid H-8.
- Proso millet variety K-1 with full package.
- Maize hybrid, PEHM-1 & PEHM-2.
- Intercropping of maize in soybean in the row ratio of 2:4.
- Use of Acephate 75 sp against paddy pests @ 500 gm/ha.
- Revision of fertilizer dose in irrigated & rainfed maize.
- Chemical weed control in sua.
- Chemical management of cotton boll worms through N.P.V. 450 LE/ha followed by Endosulfan and N.L.E.
- Use of Acephate 75 sp against pod borer complex in arhar @ 500 gm/ha.

Provided by Zonal Director of Research
Agriculture Research Station
MPUAT, Banswara, Rajasthan.
on 15.04.2013 in person.

2. RAJASTHAN STATE SEED CORPORATION, JAIPUR

Although, GM-6 was included in the package of practice in the year 2004 but no seed production programme was taken as evidenced in the records of RSSCA. No doubt a sizable amount of maize seed of different varieties/hybrids has been marketed by RSSC. The amount of maize seed marketed by RSSC is given in Table 23.

Table 23. Maize seed produced and marketed by RSSC during 2006 to 2011.

Year	Foundation		Certified	
	Area (ha)	Production (t)	Area (ha)	Production (t)
2006	15.2	8.1	131.8	43.6
2007	39	17.8	85	15.6
2008	36	19.1	121	107.6
2009	36.4	9.53	370.1	255.65
2010	41	4.7	168	137.7
2011	62	14.2	104	8.8
Total	229.6	73.43	979.9	568.95

The regional office of RSSC at Banswara was also contacted about the maize seed production programme undertaken in the area of its jurisdiction. Surprisingly, GM-6 seed production programme did not figure in his records.

The maize scientist and Zonal Director at Zonal Research Station of Maharana Pratap University of Agriculture and Technology (MPUAT) at Banswara were approached to know if they have undertaken any seed production programme of maize. There was no seed production programme of GM-6 undertaken by MPUAT as the farmers were getting the GM-6 maize seed supply from the neighboring state of Gujarat.

3. RAJASTHAN STATE SEED AND ORGANIC PRODUCE CERTIFICATION AGENCY, JAIPUR

It was also very interesting to see that there was no seed production programme of GM-6 undertaken in Rajasthan state after its incorporation in the package of practices by MPUAT. On the other hand other maize varieties/hybrids were produced continuously over the period GM-6 was recommended (Table 24). It is clear that there was no GM-6 seed certification programme in Rajasthan.

Table 24. Details of foundation seed and certified seed of maize varieties certified by RSSOPCA, Jaipur.

Year	Variety	Foundation		Certified		Total	
		Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)
2004	Navjot	4	17.08	7.6	93.51	11.6	110.59
	Arawali	0	0	2	9.84	2	9.84
	PEHM-1	0	0	3.1	42.86	3.1	42.86
	M. Dhawal	0	0	1	0.12	1	0.12
	GS-2	0	0	1.2	6.52	1.2	6.52
	PEHM-2*	0	0	11.6	90.33	11.6	90.33
	CM-137*	3	3.91	0	0	3	3.91
	E-7166*	1	1.02	0	0	1	1.02
	EM-364*	0.6	0.22	0	0	0.6	0.22
2005	Arawali	0	0	16.4	10.23	16.4	10.23
	M. Dhawal	1.2	0	0	0	1.2	0
	GS-2	0	0	16.4	17.28	16.4	17.28
	PEHM-2	6.4	0	82.6	79.59	89	79.59
	CM-137	0.8	0.92	0	0	0.8	0.92
	M. Kanchan	0.4	0.4	0	0	0.4	0.4
	Agethi-76	0.4	0.81	84.8	123.2	85.2	124.01
2006	Navjot	6	56.29	99.6	142.27	105.6	198.56
	Arawali	0.4	0	0	0	0.4	0
	M. Kanchan	0	0	4.8	6.29	4.8	6.29
	Agethi-76	0.4	0.14	0	0	0.4	0.14
	Pratap-M-3	4	3.91	0	0	4	3.91
2007	Arawali	4	1.3	0	0	4	1.3
	Arawali-1	8	6.3	0	0	8	6.3
	MP-3	0	0	70	25.4	70	25.4
	Navjot	10	11.5	206	288.3	216	299.8
2008	Navjot	0	0	103.4	168.34	103.4	168.34
	Arawali*	0	0	5.4	4.37	5.4	4.37
	Arawali-M-1	6	4.44	14.6	4.52	20.6	8.96
	PM-3	6	3.11	0	0	6	3.11
	PM-5	6	11.86	0	0	6	11.86
2009	Navjot	0	0	346	418.4	346	418.4
	Arawali-1	5	0.7	0	0	5	0.7
	PM-3	10	8.8	0	0	10	8.8
	Pratap-5	5	0.5	59	18.5	64	19
2010	Arawali-1	20	4.7	21	9.7	41	14.4
	PM-3	0	0	113	131.5	113	131.5
	PM-5	11	3.2	27	3.6	38	6.8
	Total	119.6	141.11	1296.5	1694.67	1416.1	1835.78

Source: Extracted from RSSCA annual reports of different years.

*=includes *Rabi* production also.

CONCLUSIONS

From the above information it is evident that the seed production programme of GM-6 was taken in Gujarat state only. The certified as well as truthfully labeled seed was produced by various organizations for supply to the farmers mainly of Gujarat and also to the farmers of MP and Rajasthan. NGOs like GVT, Prikriti Foundation, N.M. Sadguru Foundation and CINI also supplied to farmers in neighboring areas of MP and Rajasthan bordering Gujarat. Seed production in its various categories are summarized below.

NON CERTIFIED SEED PRODUCTION

Seed production not certified by GSSC was considerable (Table 25). Non-certified seed is the nucleus, breeder and truthfully labeled (TL) categories. The nucleus seed was mainly used by MMRS, Godhra and RRS, Anand to produce breeder seed. The most important category is TL seed that is supplied to the farmers for general cultivation.

Table 25. Nucleus (N), breeder (B) and truthfully labeled (TL) seed production 1999 to 2012.

Year	Main Maize Research Station, AAU, Godhra				Regional Research Station, AAU, Anand			Prikriti Foundation	G V T	Total (N, B and TL)
	N	B	TL	Total	B	TL	Total	TL	TL	
1999	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0	0.2
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.535
2001	0.0	0.0	0.9	0.9	0.0	0.0	0.0	0.0	1.1	2.03
2002	0.0	0.3	3.0	3.2	0.0	0.0	0.0	0.0	1.9	5.105
2003	0.0	0.4	1.8	2.3	0.0	0.0	0.0	0.0	15.7	17.962
2004	0.0	1.5	2.0	3.5	0.0	0.0	0.0	0.0	27.6	31.135
2005	0.0	1.8	0.2	2.0	0.0	0.0	0.0	64.0	15.2	81.2
2006	0.0	1.7	4.0	5.7	3.0	0.0	3.0	64.0	21.8	94.465
2007	0.0	3.7	0.4	4.1	2.0	16.0	18.0	0.0	20.5	42.55
2008	0.0	1.4	6.0	7.4	0.2	16.0	16.2	0.0	0	23.6
2009	1.1	1.1	0.0	2.2	0.0	0.0	0.0	87.0	0	89.2
2010	0.0	3.5	0.0	3.5	14.3	29.8	44.1	0.0	21.5	69.1
2011	1.2	4.8	0.0	6.0	9.8	6.0	15.8	100.0	22.3	144.1
2012	0.0	5.4	3.4	8.8	12.9	4.6	17.5	182.0	0	208.3
2013*	0.4	4.6	1.1	6.1	12.3	13.5	25.8	94.0	14.6	140.5
Total	2.8	30.2	22.7	55.7	54.5	85.9	140.4	591.0	162.7	950.0
Source	T-7				T-9			T-19	T-20	
T=Table No.	N= Nucleus	B= Breeder	TL=Truthfully labeled		*=Extrapolated (average of previous three years).					

*= Extrapolated on the basis of average of previous three years.

CERTIFIED SEED PRODUCTION

Table 26. Foundation and certified seed production programme according to GSSCA and responding organizations, and estimates by difference for other organizations.

Year	F and C seed certified by GSSCA (t)	F and C produced by various organisations (t)	Estimates of F and C seed produced by other agencies (t).
2003	4.5	0	4.5
2004	2.3	0	2.3
2005	53.6	0	53.6
2006	174.3	4.4	17.8
2007	895.9	213.6	17.8
2008	25.6	516.2	17.8
2009	14.4	325.6	17.8
2010	93.2	215.1	17.8
2011	402.5	185.8	17.8
2012	107.8	133.6	17.9
2013*	201.1	177.9	17.9
Total	1975.2	1772.2	203.0

TOTAL SEED PRODUCTION

Table 27. Total GM-6 seed production in all categories by various organizations.

Year	Anand Agricultural University					GSSC (F+C)	CiNi	Prakriti Foundation			GVT	Anandi	Others	Total
	MMRS	RRS	MMRS	RRS	Total AAU			TL	C	Total	TL	F+C	Estimated F+C	
	N,B,TL	B, TL	F	F+C										
1999	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5
2001	0.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	2.0
2002	3.2	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	5.1
2003	2.3	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	15.7	0.0	4.5	22.5
2004	3.5	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	27.6	0.0	2.3	33.4
2005	2.0	0.0	0.0	0.0	2.0	0.0	0.0	64.0	0.0	64.0	15.1	0.0	53.6	134.8
2006	5.7	3.0	0.0	4.4	13.1	0.0	0.0	64.0	0.0	64.0	21.8	0.0	17.9	116.8
2007	4.1	18.0	0.0	29.1	51.2	168.5	0.0	0.0	16.0	16.0	20.5	0.0	17.9	274.1
2008	7.4	16.2	0.0	21.0	44.6	495.3	0.0	0.0	0.0	0.0	0.0	0.0	17.9	557.8
2009	2.2	0.0	0.0	0.8	3.0	317.4	5.8	87.0	0.0	87.0	0.0	1.6	17.9	432.7
2010	3.5	44.1	0.0	11.0	58.6	17.0	148.2	0.0	33.0	33.0	21.5	5.9	17.9	302.1
2011	6.0	15.8	0.0	16.8	38.6	21.0	136.0	100.0	0.0	100.0	22.3	12.0	17.9	347.8
2012	8.8	17.5	0.6	25.8	52.6	107.2	0.0	182.0	0.0	182.0	0.0	0.0	17.9	359.7
2013*	6.1	25.8	0.2	17.9	50.0	48.4	94.7	94.0	11.0	105.0	14.6	6.0	17.9	336.6
Total	55.7	140.4	0.8	126.8	323.7	1174.6	384.7	591.0	60.0	651.0	162.7	25.4	203.0	2925.7
Source	T-25		T-7	T-9		T-17	T-18	T-25	T-19		T-25	T-21	T-26	

*= Extrapolated on the basis of average of previous three years.

From Tables 23 to 25 we can visualize that a total amount of GM-6 seed produced since more than one decade is 2925.7 t.

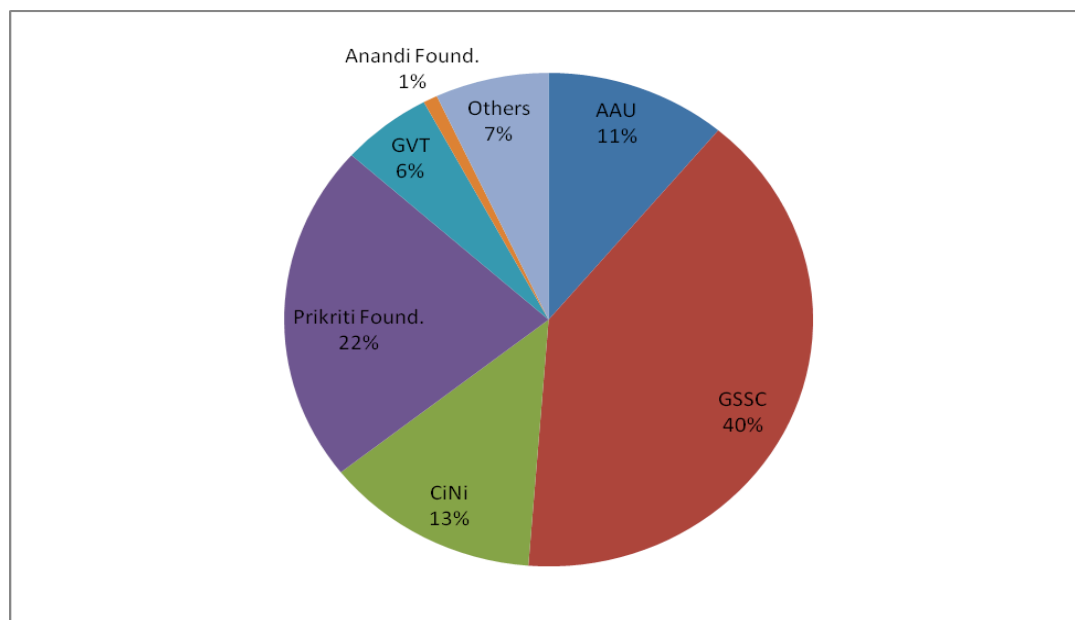


Figure 3. Organization wise percent of total GM-6 seed of all stages produced (t) including other organization.

From Figure 3 it is clear that it is the Gujarat state Seed Corporation that supplied most seed, followed by NGOs and others. The contribution of Anand Agricultural University to GM-6 production was 11 per cent.

The production by organization by type of seed is shown in Figure 4.

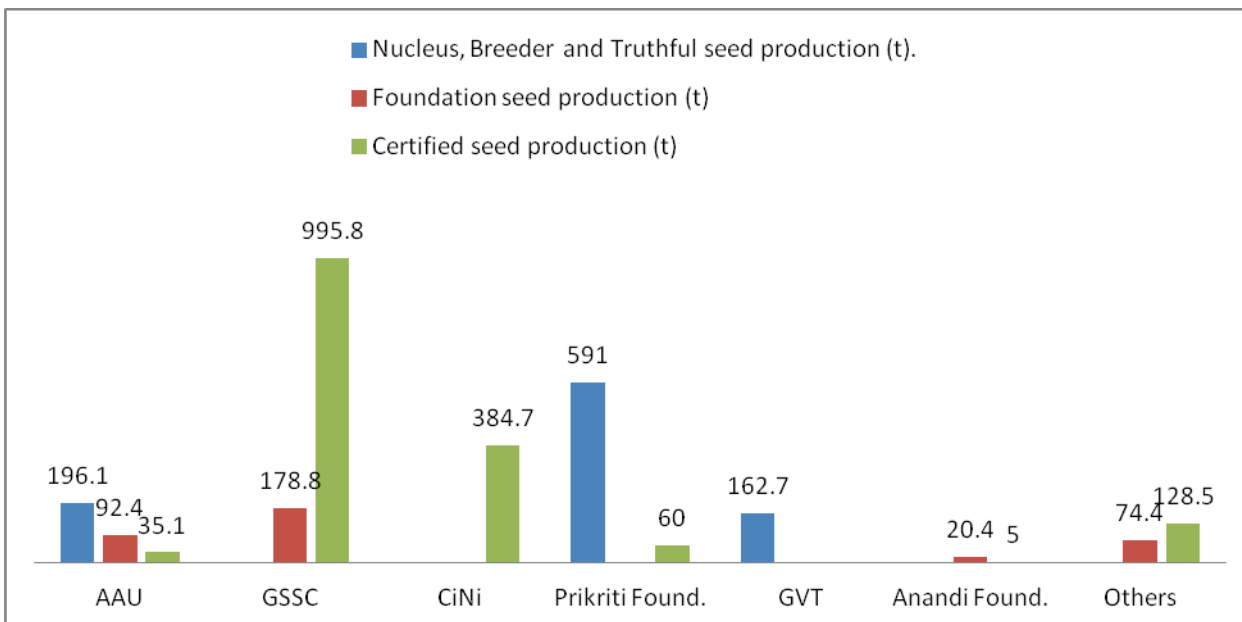


Figure 4. Total, amount of all stages of GM-6 seed produced by different organizations during 1999-2013.

Table 28 (A, B, C and D). Overall organization-wise data for GM-6 seed production including nucleus, breeder and truthfully labeled seed produced from 1999 to 2013.

A. Total quantity of foundation and certified seed production by different agencies summarised from Table 27.			
Total quantity of GM-6 foundation seed production certified by GSSCA = 350.7 t.			
Total quantity of GM-6 certified seed production certified by GSSCA = 1624.5 t.			
Organization	Certified foundation (F) seed produced (t)	Certified (C) seed production (t)	Total F and C certified seed production (t)
MMRS	0.8	0	0.8
RRS	91.7	35.1	126.8
GSSC	178.8	995.8	1174.6
CiNi	0.0	384.7	384.7
Prikriti F	0.0	60.0	60.0
Anandi F	5.0	20.4	25.4
Others*	74.4	128.5	202.9
Total	350.7	1624.5	1975.2

B. Other than certified GM-6 seed (nucleus, breeder and truthfully labelled seed produced by different organizations) produced by different organization (t) summarised from Tables 7, 9 and 18 to 21.				
Organization	Nucleus seed production	Breeder seed production	Truthfully labelled seed production	Total other than certified seed
MMRS	2.8	30.2	22.7	55.7
RRS	0.0	54.5	85.9	140.4
Prikriti	0.0	0.0	591.0	591.0
GVT	0.0	0.0	162.7	162.7
Total	2.8	84.7	757.9	950.0

C. Cumulative production of certified and non certified seed production summarised from Tables 7, 9 and 18 to 21.							
Main Season	Total TL seed production of GM-6 (t)	Cumulative TL seed production of GM-6 (t)	Total F+C seed production of GM-6 (t)	Cumulative F+C seed production of GM-6 (t)	Total seed production of all categories of GM-6 (t)	Cumulative total seed production of GM-6 (%)	
1999	0.16				0.16	0.16	0.16
2000	0.16				0.16	0.16	0.16
2001	2.0	2.0	0	0.0	2.0	2.0	
2002	5.1	7.1	0	0.0	5.1	7.1	
2003	18.0	25.1	4.5	4.5	22.5	29.6	
2004	31.1	56.2	2.3	6.8	33.4	63.0	
2005	81.2	137.4	53.6	60.4	134.8	197.8	
2006	94.5	231.9	174.3	234.7	116.8	314.6	
2007	42.6	274.4	895.9	1130.6	274.1	588.6	
2008	23.6	298.0	25.6	1156.2	557.8	1146.4	
2009	89.2	387.2	14.4	1170.6	432.7	1579.1	
2010	69.1	456.3	93.2	1263.8	302.1	1881.2	
2011	144.1	600.4	402.5	1666.3	347.8	2229.0	
2012	208.3	808.7	107.8	1774.1	359.7	2588.7	
2013*	140.5	949.2	201.1	1975.2	336.6	2925.3	

*=Based on the extrapolated values.

On the basis of the information generated in table 28C for cumulative NBTL (TL), Foundation and Certified (F+C) and total of all categories seed production of maize GM-6 can be depicted in the graphical form as under:

Table D. Annual and cumulative certified seed production of GM-6 in relation to total certified maize production

Year	All maize varieties seed production (t)		GM-6 variety seed production (t)		Per cent production (t)	
	By year	Cumulative	By year	Cumulative	By year	Cumulative
2002	22.7	22.7	0.0	0.0	0.0	0.0
2003	30.4	53.1	4.5	4.5	14.9	8.5
2004	8.7	61.8	2.3	6.8	26.5	11.1
2005	154.0	215.8	53.6	60.5	34.8	28.0
2006	308.1	523.9	174.3	234.7	56.6	44.8
2007	965.1	1489.0	895.9	1130.6	92.8	75.9
2008	45.7	1534.7	25.6	1156.2	55.9	75.3
2009	14.4	1549.0	14.4	1170.5	100.0	75.6
2010	99.3	1648.3	93.2	1263.7	93.8	76.7
2011	402.5	2050.8	402.5	1666.2	100.0	81.2
2012	108.6	2159.4	107.8	1774.0	99.3	82.2
2013	203.4	2362.8	201.1	1975.1	98.9	83.6

The cumulative seed production of all varieties of maize and proportion of GM-6 cumulative seed production is also shown in the following figure:

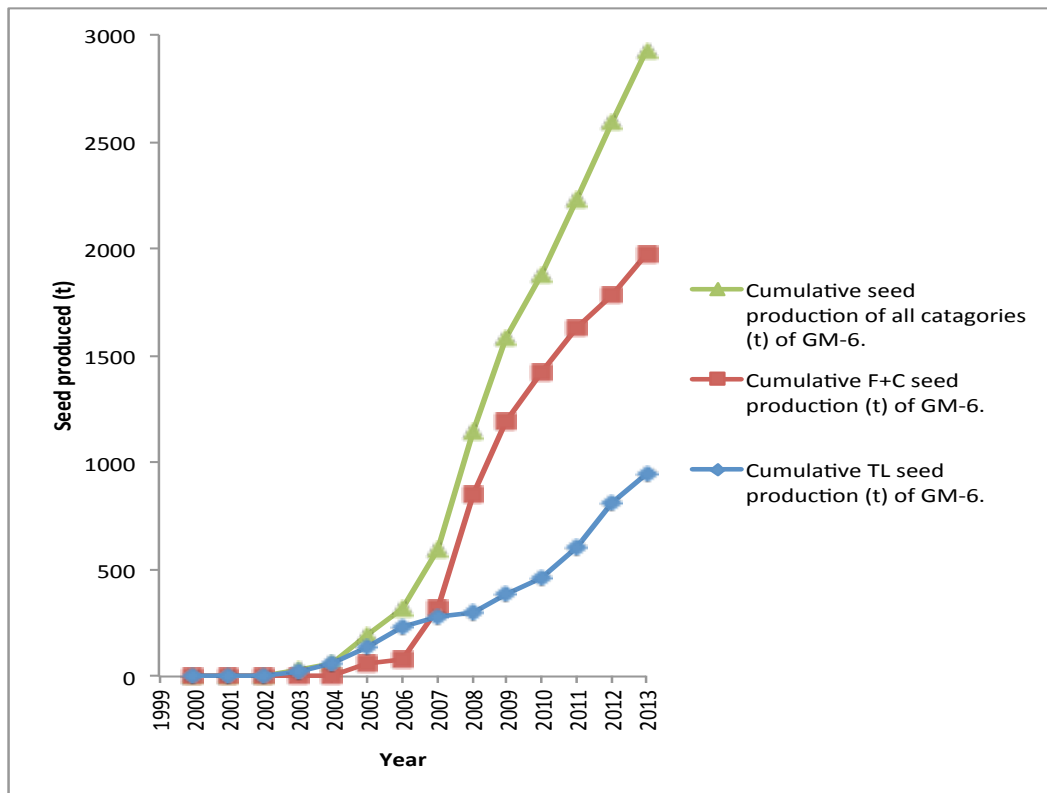


Figure 5. Cumulative seed production TL, F+C and all categories of maize GM-6.

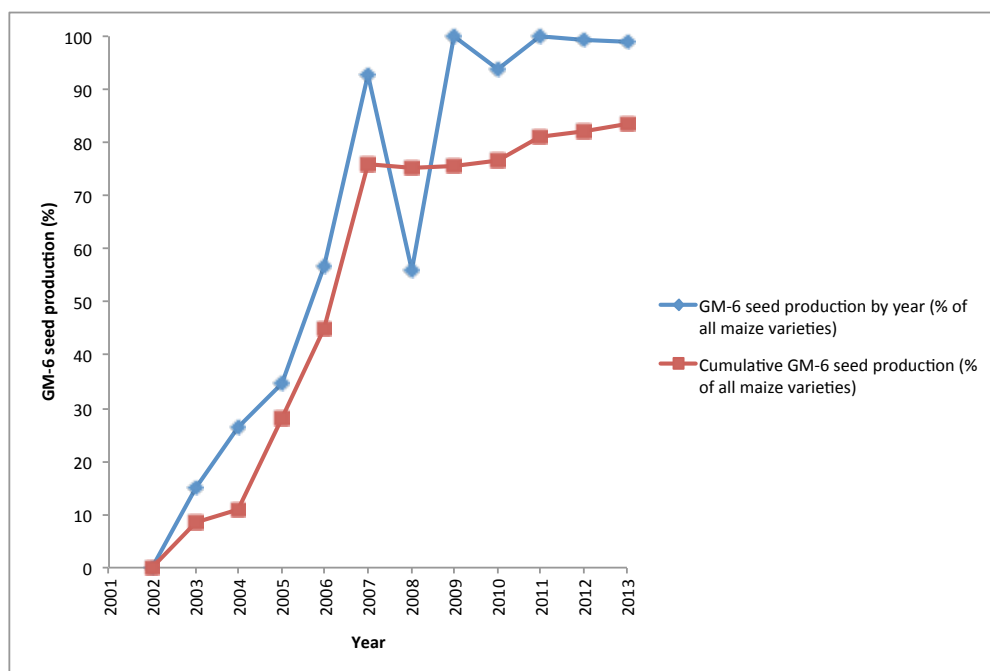


Figure 6. Per cent GM-6 cumulative seed production as proportion total maize seed production and year.

TOTAL AREA COVERED BY MAIZE VARIETY GM-6

Total quantity of maize GM-6 seed which was available for sowing = 2925 t.

Estimation of total area covered by GM-6 after its release as per records of seed produced:

Seed rate for sowing as per recommendation by MMRS; 20 kg per hectare.

One ton will cover an area of 50 hectares.

Table 29. Total area covered by different seed stages of maize variety GM-6.

Category of seed	Quantity (t)	Area covered (ha)
Nucleus	2.8	140
Breeder	84.7	4235
Foundation	366.0	18300
Certified	1609.1	80455
Truthfully labelled	949.4	47470
Total	2925.0	150600

This is the area covered by the seed which is known from the official records of the agencies mentioned. However, all the seed used for maize cultivation by the farmers is not certified. In addition to farmer-to-farmer exchange of seed, there are many large farmers who regularly produce and sell maize seed. Some of them are contract seed growers for the state seed corporation, private companies or cooperatives. A part of the seed produced, which is not acquired by the seed producing agency, is sold to other farmers. There are a number of other cases where farmers buy the foundation or certified seed, either from the state seed

corporation or a research station, and produce second-generation seed. It is important to note that these seed farmers are not registered, and their seed is therefore sold without a brand name, proper record or formal tag. But neighboring farmers regard them as an important source of reliable seed, thus indicating that some quality standards are maintained.

In addition, 7% of the certified seed was produced by unnamed organizations that are in the private-sector. It is expected that all or most of these organizations also produced TL seed. The total seed (certified and truthful) known to have been produced and supplied up to and including 2013 was sufficient to sow about 150,600 ha at a seed rate of 20 kg ha⁻¹. The maize scientist from the Main Maize Research Station, Godhra reported during the survey in 2012 that the area covered by GM-6 after its release (Table 8), by taking into account GM-6 grown from farm-saved seed, has been two million hectares. This would provide a benefit of million equal to £104 million in increased yields.

To achieve 2 M ha an additional 1.85 M ha of maize has to be sown from farm-saved seed. This needs about 4% of the harvest to be sown as seed in subsequent years (amounting to 40 kg of saved seed per ha with an average yield of 1 t per ha). Yadavendra et al., (2005) found that an average of 3% of harvested seed of GM-6 was sown, based on a survey in 2004 of 121 farmers in 18 villages across Gujarat, Madhya Pradesh and Rajasthan. Moreover, farmers distributed an additional 6% of the harvest of GM-6 to relatives, friends and neighbors by sale and barter. These results when extrapolated to the total seed supply more than account for an additional 1.85 M ha without needing to consider any private-sector TL seed production.

The estimates of adoption using assumptions on the use of farm-saved seed are subject to large errors as a small difference in the assumption on how much of the harvest is used as seed has a large effect. However, given the increasing rate of seed production of certified and TL seed of GM-6 and the substantial area that must be under GM-6, it is certain that if 2 M ha had not been achieved by 2013 this amount will be reached within only two or three years even with rates of farm-saved seed considerably below those found in the 2004 survey.

References

- Billore M., 2008.2008. Together We Win. College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Indore, MP.
- Witcombe J.R., Joshi, A.R. and Goyal, S.N. 2003. Participatory Plant breeding in maize: A case study from Gujarat, India, *Euphytica* 130:413-422
- Yadavendra, J.P., Patel, V.P. and Witcombe, J.R., 2005. The impact of new maize and rice varieties on the livelihoods of poor farmers in marginal agricultural areas of western India. In Livelihoods Summit, Udaipur, Rajasthan, India, 27th-30th September, 2005, Department for International Development (DFID) and Indian Farm Forestry Development (IFFDC).