Agricultural Education and Research in the Jurisdiction of RVSKVV, Gwalior (M. P.)

(JNKVV period till establishment of RVSKVV)

1964-2008

Volume - III

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
Gwalior - 474002 (M.P.)

Agricultural Education and Research in the Jurisdiction of RVSKVV, Gwalior (M.P.)

(JNKVV period till establishment of RVSKVV)

1964-2008

Volume III

Suresh Singh Tomar
G. S. Bhardwaj
A. K. Singh
V. S. Tomar

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
Gwalior - 474 002 (M.P.)

Correct Citation	:	Agricultural Education and Research in the Jurisdiction of RVSKVV, Gwalior (JNKVV period till establishment of RVSKVV (1964-2008) Volume III
Compiled and Edited by	:	Dr. Suresh Singh Tomar Dr. G. S. Bhardwaj Prof. A. K. Singh Prof. V. S. Tomar
Technical Assistance	:	Dr. S. S. Bhadauria Dr. Neeraj Hada Dr. Shobhana Gupta
Consultancy	:	Dr. P. R. Rajput
Year of Publication	:	2013
Published by	:	Directorate of Extension Services RVSKVV, Gwalior - 474 002 (M.P.) INDIA

Prof. A.K. Singh
Vice Chancellor

Rajmata Vijayaraje Schindia
Krishi Vishwa Vidyalaya
Race Course Road, Gwalior-474002 (M.P.)
Ph.: 0751-2467673(O), 2467685 (R)
Fax: 0751-2464141
Email: vcrvsaugwa@mp.gov.in

PREFACE

Indian agriculture must continuously remain ever responsive to cater the ever growing and diversified needs of the huge population, farmer community and other stake holders involved in the entire production to consumption chain. The researchers are expected to visualize alternate agriculture based scenarios so that the success of doing better than the best is achieved at the expected pace. It is also desirable to knit the threads of dynamic interaction between agriculture and industry that will eventually lead to a self sustained farmer at its base.

Since its inception, RVSKVV, Gwalior has been making efforts incessantly to keep pace with the country's march towards sustainable agriculture ensuring that small and marginal rainfed farmers are not left out from the process of technology transfer. I feel it is high time to have a thorough investigation of the glorious past of agricultural achievements in the area under the jurisdiction of the University. A small but timely attempt has been made by the University in the form of this book.

This book is a continuation of Volumes I & II, in which the history and achievements of agricultural education and research in the jurisdiction of RVSKVV till 1964 were presented. Now, the work of JNKVV (1964-2008) until the establishment of RVSKVV in 2008 has been documented in the present volume. It is hoped that the publication would prove as a source of valuable information.

The efforts of Dr. S.S. Tomar, Director Extension Services and his team need to the commended and complimented for their meticulous planning and efforts put in for bringing out these publications well in time.

(A. K. Singh)

ACKNOWLEDGEMENT

With special pleasure, we acknowledge the contribution of Prof. A.K. Singh, Hon'ble Vice Chancellor, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior for his cordial support, encouragement and exemplary guidance from time to time in compiling and giving a final shape to this publication.

We would like to express special thanks of gratitude to Dr. G.P. Verma, Retd. Director Research Services, JNKVV, Jabalpur, Dr. O.P. Verma, Retd., Dean, College of Agriculture, Gwalior and Dr. P.R. Rajput, Retd. Prof. (Agronomy), GBPUAT, Pantnagar for providing information base and valuable guidance in gathering the information required for this volume.

It is also our duty to record thankfulness to Dr. A.S. Tiwari, Ex. Vice Chancellor, JNKVV, Jabalpur for his guidance and valuable suggestions in finalization and bringing out this issue.

We would like to place on record our gratitude for the contribution and encouragement provided by the Dr. B.S. Baghel, Dean Faculty of Agriculture, Dr. H.S. Yadav, Director Research Services, Dr. Y.M. Kool, Director, Planning and Farm Development, Dr. R.L. Rajput, Director Instruction, Dr. N.S. Tomar, Dean, College of Agriculture, Gwalior, Dr. V.S. Gautam, Dean College of Agriculture, Sehore, Dr. A.M. Rajput, Dean, College of Agriculture, Indore, Dr. P.P. Shastri, Dean, College of Agriculture, Khandwa, Dr. H. Patidar, Dean, College of Horticulture Mandsaur, Sh. H.S. Mehar, Registrar, Smt. Rajani Shukla, Comptroller, RVSKVV, Gwalior and Deans and Directors of JNKVV, Jabalpur.

We gratefully acknowledge the contribution made by Incharge Research Projects, team of scientistand Heads of Departments who have generated important research data which have been compiled in this Publication.

We are also thankful to Dr. U.P.S. Bhadauria, JDE, Dr. S.S. Tomar, ADR, PCs of all KVKs, Dr. Pankaj Shah, Dr. Shilpi Verma, Dr. G.S. Chundawat, Dr. S.K. Sharma, Dr. C.D. Hirve, Dr. S.S. Kushwah and Dr. R.P. Yadav for the information provided by them in their respective fields.

We are thankful to Incharge Academic, Librarians of Colleges, Officer Incharge and other staff members of Information and Communication Centre, Directorate of Extension Services, Faculty members of RVSKVV, Gwalior and Officers of Agriculture Department of Madhya Pradesh Government for providing valuable information for preparation of this manuscript.

Informetion given in the publication is located on verbal/telephonic/uesitten communication from different in service retired officers of the universities & other concerned. We thank almighty and all who had directly or indirectly helped in providing information without which this assignment would not be possible.

EDITORS

प्रो. विजय सिंह तोमर
कुलपति
Prof. Vijay Singh Tomar
Vice Chancellor

जवाहरलाल नेहरू कृषि विश्वविद्यालय
कृषि नगर, आधारताल, जबलपुर ४८२ ००४ (म.प्र.)
Jawaharlal Nehru Krishi Vishwa Vidyalaya
Krishi Nagar, Adhartal, Jabalpur 482 004 (M.P.)
Ph.: 0761-2681706 (O), 2681809 (R); Fax: 2681389
E-mail: vst.vcjnkvv@gmail.com

FOREWORD

In a country like India, where about 70% of the population is earning their livelihood from agriculture, technological changes have been the basis for increasing agricultural productivity and promoting agricultural development. Agricultural research and science have taken on the role of developing solutions to farming challenges in a much bigger way than ever before during the last half of 20th century. The research on improved technologies has undeniably been successful in developing many innovative technologies under diverse agro-ecological situations. However, with the changing agricultural scenario, researchers and scientists are increasingly realizing the need for promotion of promising innovative thoughts and actions which would contribute significantly towards the sustainable development of agriculture.

This publication, along with its last two volumes, is, perhaps, the first of its kind, which has been devoted in documentation of the history and achievements of agricultural education and research in Madhya Pradesh with special reference to the area of jurisdiction of RVSKVV, Gwalior (JNKVV period till establishment of RVSKVV) over a long period of time. It is firmly believed that it would certainly encourage the researchers, planners and policy makers to look back into the wisdom of past and incorporate the same in the future research / development agenda.

The present publication and the previous volumes have been brought out in a record time with the help of dedicated and enthusiastic team of scientists from Directorate of Extension Services and support of Ex-Professors of the College of Agriculture, Gwalior under the dynamic leadership of Dr. S.S. Tomar.

I wish them a great success in their future endeavors.

(V.S. Tomar)
Vice Chancellor

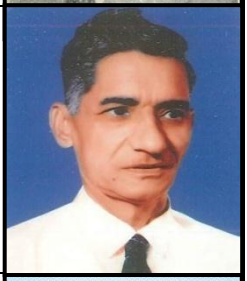
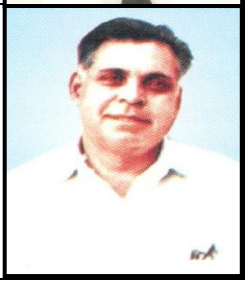
CONTENT

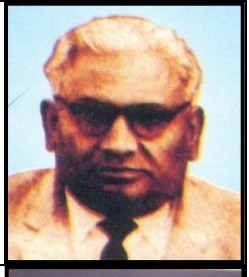
I. Infrastructure and Achievements of Education

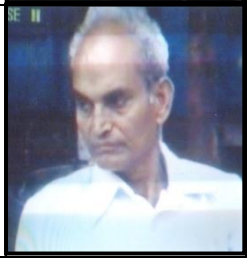
College of Agriculture, Gwalior

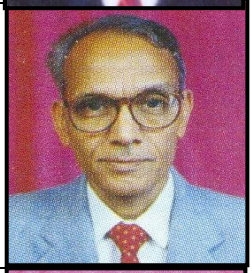
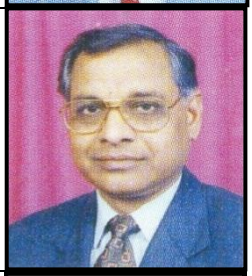
The College of Agriculture, Gwalior was established in the year 1950. The College has an intake capacity of 60 students, with an additional 12 payment seats and 10 per cent seats for NRIs and foreign nationals for the undergraduate degree programme. Masters degree is available in Agronomy, Extension Eduction, Entomology, Horticulture, Plant Pathology, Plant Breeding & Genetics and Soil Science & Agricultural Chemistry. The College has a total land area of 64.8 ha including 13.5 under roads and buildings, 8 ha under pasture, 6.9 ha under fruits and forest plantations and 36.4 ha cultivated land. A major portion (30.0 ha) of cultivated land is irrigated.

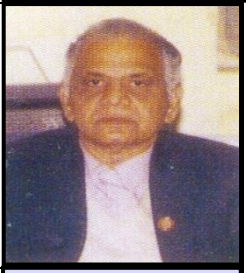
(1) Principals/ Associate Deans/ Deans of College of Agriculture, Gwalior

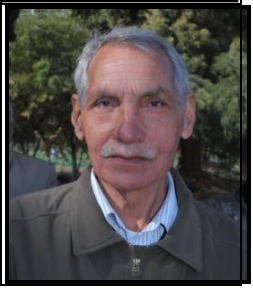
S. No.	Name	Duration		Photograph
		From	To	
1.	Prof. S. K. Singh Gour	May 1964	May 1966	
2.	Dr. R. S. Bhatt	June 1966	August 1967	
3.	Prof. H. P. Dwivedi	August 1967	January 1968	
4.	Dr. O. P. Dhama	January 1968	July 1969	

5.	Dr. S. N. Dubey	July 1969	May 1971	
6.	Prof. S. K. Singh Gour	May 1971	May 1975	
7.	Dr. A. C. Jain	May 1975	April 1976	
8.	Dr. M. L. Purohit	April 1976	August 1978	
9.	Dr. D. Singh	September 1978	June 1979	

10.	Dr. B. P. Tiwari	June 1979	September 1979	
11.	Dr. M. P. Singh	September 1979	July 1981	
12.	Dr. V. P. Shukla	July 1981	October 1985	
13.	Dr. D. Singh	October 1985	August 1987	
14.	Dr. U. S. Mishra	August 1987	February 1988	

15.	Dr. D. Singh	February 1988	September 1988	
16.	Dr. M. K. Mishra	October 1988	May 1989	
17.	Dr A. S. Tiwari	May 1989	April 1993	
18.	Dr. R. K. Gupta	April 1993	July 1993	
19.	Dr. M. K. Mishra	July 1993	November 1994	

20.	Dr. S. V. Dhamdhere	December 1994	August 1995	
21.	Dr. J. S. Raghu	August 1995	May 2002	
22.	Dr. K. N. Bansal	May 2002	June 2002	
23.	Dr. O. P. Verma	June 2002	October 2005	
24.	Dr. S. S. Jakhmola	November 2005	March 2006	

25.	Dr. P. C. Jain	April 2006	May 2006	
26.	Dr. S. S. Jakhmola	June 2006	December 2006	
27.	Dr. V. S. Kushwah	January 2007	January 2007	
28.	Dr. H. S. Kushwah	February 2007	July 2008	
29	Dr. K. P. S. Malik	August 2008	Jan. 2009	

(2) Staff Position

Year	Principal/ Assoc. Dean/ Dean	Professor/ Associate Professor	Assistant Professor	Lecturer	Demonstrator	Physical Instructor	Hostel Warden	Librarian	Total
1964-65	1	6	4	22	2	1	2	1	39
1965-66	1	7	4	22	2	1	2	1	40
1966-67	1	6	-	29	2	1	2	1	42
1967-68	1	6	-	29	2	1	2	1	42
1968-69	1	5	-	31	2	1	2	1	43
1969-70	1	5	-	31	2	1	2	1	43
1970-71	1	4	33	-	1	1	2	1	43
1971-72	1	4	33	-	1	1	2	1	43
1972-73	1	4	33	-	1	1	2	1	43
1973-74	1	4	33	-	1	1	2	1	43
1974-75	1	4	33	-	1	1	2	1	43
1975-76	1	4	33	-	1	1	2	1	43
1976-77	1	5	33	-	1	1	2	1	44
1977-78	1	5	33	-	1	1	2	1	44
1978-79	1	5	33	-	1	1	2	1	44
1979-80	1	7	25	-	2	1	2	1	39
1980-81	1	7	25	-	2	1	2	1	39
1981-82	1	7	25	-	2	1	2	1	39
1982-83	1	7	25	-	2	1	2	1	39
1983-84	1	7	25	-	2	1	3	1	40
1984-85	1	7	25	-	2	1	3	1	40
1985-86	1	7	25	-	2	1	3	1	40

Year	Principal/ Assoc. Dean/ Dean	Professor/ Associate Professor	Assistant Professor	Lecturer	Demonstrator	Physical Instructor	Hostel Warden	Librarian	Total
1986-87	1	7	25	-	2	1	3	1	40
1987-88	1	7	25	-	2	1	3	1	40
1988-89	1	7	25	-	2	1	3	1	40
1989-90	1	7	25	-	2	1	3	1	40
1990-91	1	7	25	-	2	1	3	1	40
1991-92	1	7	25	-	2	1	3	1	40
1992-93	1	7	25	-	2	1	3	1	40
1993-94	1	7	25	-	2	1	3	1	40
1994-95	1	7	25	-	2	1	3	1	40
1995-96	1	7	25	-	2	1	3	1	40
1996-97	1	7	25	-	2	1	3	1	40
1997-98	1	7	25	-	2	1	3	1	40
1998-99	1	7	25	-	2	1	3	1	40
999-2000	1	7	25	-	2	1	3	1	40
2000-01	1	7	25	-	2	1	3	1	40
2001-02	1	7	25	-	2	1	3	1	40
2002-03	1	7	25	-	2	1	3	1	40
2003-04	1	7	25	-	2	1	3	1	40
2004-05	1	7	25	-	2	1	3	1	40
2005-06	1	7	25	-	2	1	3	1	40
2006-07	1	7	25	-	2	1	3	1	40
2007-08	1	7	25	-	2	1	3	1	40

(3) Number of Students enrolled in UG/ PG programme and completed their degree

S. No.	Year	UG		PG	
		Enrolled	Passed	Enrolled	Passed
1	1964-65	85	72	35	33
2	1965-66	64	56	21	30
3	1966-67	50	48	18	15
4	1967-68	10	77	19	18
5	1968-69	45	56	09	16
6	1969-70	42	28	06	11
7	1970-71	60	04	-	06
8	1971-72	80	42	-	04
9	1972-73	61	31	09	05
10	1973-74	58	45	11	04
11	1974-75	64	55	17	06
12	1975-76	80	52	22	08
13	1976-77	82	48	25	12
14	1977-78	85	53	23	13
15	1978-79	87	56	26	14
16	1979-80	85	51	25	12
17	1980-81	87	54	26	15
18	1981-82	85	42	24	14
19	1982-83	86	60	25	18
20	1983-84	78	62	28	16
21	1984-85	80	65	25	14
22	1985-86	82	64	24	15
23	1986-87	85	66	26	14
24	1987-88	77	58	22	12
25	1988-89	80	63	25	13
26	1989-90	75	78	24	18

S. No.	Year	UG		PG	
		Enrolled	Passed	Enrolled	Passed
27	1990-91	82	75	25	14
28	1991-92	83	73	28	15
29	1992-93	85	65	25	11
30	1993-94	79	67	23	10
31	1994-95	80	68	25	13
32	1995-96	80	69	29	18
33	1996-97	82	65	26	14
34	1997-98	80	69	29	18
35	1998-99	80	65	27	14
36	1999-2000	92	56	30	14
37	2000-01	71	58	29	15
38	2001-02	78	45	30	12
39	2002-03	91	66	32	18
40	2003-04	93	38	33	36
41	2004-05	67	45	59	21
42	2005-06	83	71	64	34
43	2006-07	77	51	57	60
44	2007-08	81	70	61	45

(4) Merit list of B. Sc. (Ag.) Students

S. No.	Name of Student	Year	Medal/ Position
1	Pramod Vakil	1965	Gold Medal
2	Asharam Pal	1966	Gold Medal
3	Gurudatt Singh	1967	Gold Medal
4	V.R. Subhramanium	1969	Gold Medal
5	P.S. Raghuwanshi	1971	Gold Medal
6	Ashok Kumar	1972	Gold Medal
7	Bhupendra Prasad	1973	Gold Medal

S. No.	Name of Student	Year	Medal/ Position
8	Shyam Sunder	1974	Gold Medal
9	Shiv Dutt Pateriya	1974	Gold Medal
10	H.C.S. Tomar	1974-75	Gold Medal
11	Dilip Singh Kushwah	1979-80	Gold Medal
12	R.K. Sharma	1981-82	Gold Medal
13	R.N. Rathore	1982-83	Gold Medal
14	N. S. Tomar	1983-84	Gold Medal
15	S.P.S. Sengar	1983-84	Gold Medal
16	A.K. Dixit	1984-85	Gold Medal
17	P.C. Patidar	1985-86	Gold Medal
18	Rajendra Pushpad	1986-87	Gold Medal
19	M.C. Gupta	1987-88	Gold Medal
20	Shailendra Kushwah	1990-91	Gold Medal
21	Amrendra Singh	1994-95	Gold Medal
22	Vivek Pachori	1998-99	Gold Medal
23	Anil Kumar	1999-2000	Gold Medal

(5) Merit list of M. Sc. (Ag) students

S. No.	Name of Student	Year	Medal/ Position
Agronomy			
1	S.K. Maheshwary	1964	Gold Medal
2	R.M. Mundi	1965	Gold Medal
3	V.K. Shrivastav	1966	Gold Medal
4	B.L. Chhippa	1981-82	Gold Medal
5	R.N. Sharma	1982-83	Gold Medal
6	S.P.S. Sengar	1985-86	Gold Medal
7	S.S Tiwari	1987-88	Gold Medal
8	Atul Deole	1992-93	Gold Medal
9	Shailendra Kushwah	1993-94	Gold Medal

S. No.	Name of Student	Year	Medal/ Position
10	Amrendra Singh	1997-98	Gold Medal
Horticulture			
1	Vijay Kumar Agrawal	1992-93	Ist Position
Botany			
1	D.S. Rawat	1964	Ist Position
2	M.M. Shrivastav	1965	Ist Position
3	E.T. Thomas	1966	Ist Position
4	Rakesh Bhatnagar	1967	Ist Position
5	B.K. Mishra	1968	Ist Position
6	Jaya Singh	1969	Ist Position
Extension			
1	K.P. Govil	1964	Ist Position
2	T.N. Sharma	1965	Ist Position
3	G.M. Vakil	1966	Ist Position
4	C.L. Chaudhary	1967	Ist Position
Entomology			
1	S.S. Jakhmola	1964	Ist Position
2	Surendra Kumar	1965	Ist Position
3	B.V. Deshpanday	1966	Ist Position
4	C.P.S. Sengar	1967	Ist Position
5	M.L. Sharma	1984	Ist Position
Plant Pathology			
1	Manohar Havava	1964	Ist Position
2	B.S. Kiri	1965	Ist Position
3	R. Keshwal	1966	Ist Position
Agricultural Chemistry & Soil Science			
1	S.S. Yadav	1964	Ist Position
2	O.P. Verma	1965	Ist Position
3	M.N. Jha	1966	Ist Position

S. No.	Name of Student	Year	Medal/ Position
4	G.C. Tyagi	1967	Ist Position
5	O.P. Joshi	1968	Ist Position
6	Arun Gupta	1984-85	Ist Position
7	A.S. Yadav	1988-89	Ist Position
8	D.C. Gupta	1988-89	Ist Position

(6) Post Matric Scholarship (UG & PG)

S. No.	Year	SC	ST	OBC
1	1964-65	2	2	2
2	1965-66	2	2	2
3	1966-67	2	1	2
4	1967-68	2	1	1
5	1968-69	2	2	1
6	1969-70	1	1	-
7	1970-71	2	1	-
8	1971-72	2	2	1
9	1972-73	2	2	2
10	1973-74	2	2	2
11	1974-75	2	3	2
12	1975-76	6	2	3
13	1976-77	4	3	2
14	1977-78	3	5	5
15	1978-79	4	3	2
16	1979-80	6	6	8
17	1980-81	10	9	11
18	1981-82	12	9	10
19	1982-83	13	10	8
20	1983-84	15	12	12

S. No.	Year	SC	ST	OBC
21	1984-85	12	15	15
22	1985-86	20	18	13
23	1986-87	17	13	11
24	1987-88	15	16	17
25	1988-89	14	13	10
26	1989-90	17	12	9
27	1990-91	21	18	17
28	1991-92	18	20	23
29	1992-93	26	18	23
30	1993-94	29	26	22
31	1994-95	24	22	28
32	1995-96	21	20	42
33	1996-97	29	38	43
34	1997-98	31	43	60
35	1998-99	36	48	85
36	1999-2000	38	43	48
37	2000-01	42	47	24
38	2001-02	54	31	48
39	2002-03	58	44	66
40	2003-04	85	92	58
41	2004-05	93	101	70
42	2005-06	90	77	72
43	2006-07	106	99	85
44	2007-08	89	94	84

(7) National Talent Scholarship (UG)

S. No.	Year	No. of Student
1	1964-65	20
2	1965-66	17
3	1966-67	18
4	1967-68	16
5	1968-69	9
6	1969-70	6
7	1970-71	10
8	1971-72	12
9	1972-73	13
10	1973-74	9
11	1974-75	11
12	1975-76	14
13	1976-77	17
14	1977-78	11
15	1978-79	13
16	1979-80	12
17	1980-81	14
18	1981-82	20
19	1982-83	22
20	1983-84	19
21	1984-85	17
22	1985-86	11
23	1986-87	15
24	1987-88	17
25	1988-89	13
26	1989-90	14
27	1990-91	17
28	1991-92	18

S. No.	Year	No. of Student
29	1992-93	11
30	1993-94	16
31	1994-95	14
32	1995-96	10
33	1996-97	9
34	1997-98	9
35	1998-99	15
36	1999-2000	12
37	2000-01	14
38	2001-02	8
39	2002-03	12
40	2003-04	11
41	2004-05	9
42	2005-06	9
43	2006-07	16
44	2007-08	17

(8) National Service Scheme

National Service Scheme (NSS) unit in Agriculture College was started on December 1st, 1975 in order to impart the practical training of social service and coseqently the personality development.

The activities to be taken in N. S. S. are based on the needs of rural and urban society. They are grouped as Regular and Specific. The college unit has organised the activities such as Health Camp in Village Bandholi, Polio Drive in Gwalior Trade Fair and Railway Station locality, tree plantation, observance of N. S. S. Day etc., are some of the regular activities of the unit. Dr. Subhash Sharma was N.S.S. officer in 1991 and other management committee members were Sh. Vishnu Dutt Sharma and Sh. Sudhir Singh Bhadauria.

(9) Vivekanand Study Circle

Looking to the increasing negative influence of western life style on the minds of students, a character building programme of spiritual and

cultural nature was started in 1997 in the college. In the Golden Jubilee Year this has been duly registered under M. P. society registration act 1973 (No. 40) on 07.08.2000 as a project on Human Resource Development and Value Based Education. It has a executive committee with its saving bank account in JNKVV, Extension counter UCO Bank in college premises. The aim of Vivekanand Study Circle is to acquint the students with the Man Making and Human Services message of Swami Vivekananda. The circle has been organising a regular class on each Friday to induct the moral and spiritual values in student community. It has published Hindi Version of the book *Student Power - its use and abuse*. It has also started publishing a bulletin Tonic to energise the students and teachers with the elevating ideas of Swami Vivekananda and other scientific and humanistic values. Late Krishna Kumar Trivedi Memorial Teacher – Taught Excellence Fund has also been started to take up all type of teacher – student welfare activities in college. The university is being requested to accept and absorb it as a separate department on Human Resource Development and Value Based Education.

Dr. S.C Sharma, Dr. S.S. Tomar, Dr. R.S. Verma, Dr. N.S. Bhadoria and Dr. Asha Arora were the founder members of V.S.C.

Dr. S.L. Mehta, DDG (Education) ICAR, Inaugurating Vivekanand statue at College of Agricultue, Gwalior at the time of Golden Jubilee celebration on 11.11.2000

(10) National Cadet Corps (NCC) Unit

A company of NCC 8 M. P. Battalian was started in July 1959 in the College of Agriculture, Gwalior. At present this unit is directed under 15 M. P. Battalian in which about 40 new students are registered every year. These students are given training of soldiers for a period of 3 years. During this period, they are awarded "B" and "C" certificates on the basis of their performance. These student soldiers are trained in drill and army weapons. They are also trained in social services and other related subjects. The students take part in different camps organized by NCC unit, in which they learn discipline, national unity and brotherhood among students.

This NCC unit of the college was started in the leadership of Lt. M. S. Jadhav, NCC Officer. The NCC unit was successfully directed by Lt. R. S. Pachouri in 1963, Lt. D. V. S. Chouhan in 1966-67, Major Dwarika Singh in 1967-68 and Capt. S. S. Dixit in 1978. At present NCC unit is being directed by Capt. H. S. Bhadouria, NCC Officer since April, 1987. Since the inception of this unit upto year 2000, about 1600 cadets have been trained in NCC. Every year about 10-12 and 5-8 NCC students are awarded "B" and "C" certificates, respectively. Every year about 20 NCC cadets take part in National & Adventurous camps for example, National Unity Camp, All India Track, and Mountainiaring, Rock Climing, Army Attachment etc. In addition, NCC cadets also take part in social services such as blood donation, adult education, tree plantation, campus cleaning etc. In the year 1993, the NCC unit of this college was awarded Trophy by Former Governor Shrimati Sarala Greval for blood donation by maximum NCC cadets.

Dr. V. S. Kushwah, Dean, CoA, Gwalior giving "C" certificates to NCC Cadets on Republic Day (2007)

(11) Participation of Students in Sports and Games

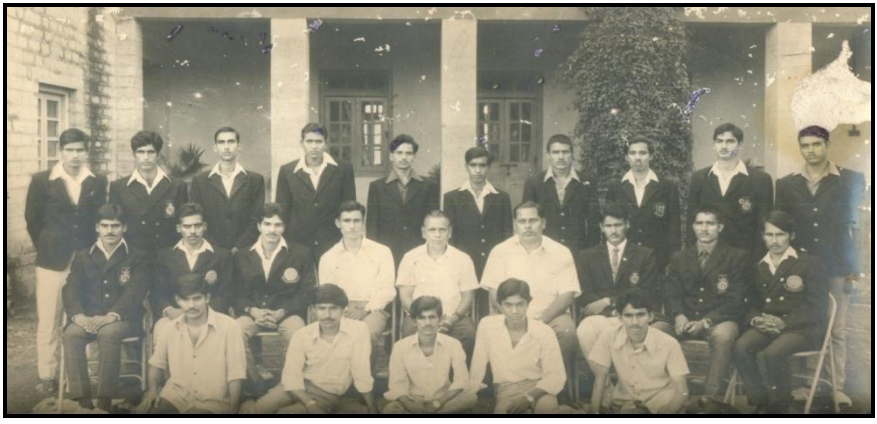
The busy academic calendar has not restricted students to participate in various sports and games to inculcate values of self worth, self-confidence and self-reliance. These lead to developing sentiments of kindness, self-reflection and self-improvement.

All Rounder & Best Player

1. Mr. H. Khan - Represented Vikram University in Hockey 1964
2. Mr. T. A. Khan - Best Hockey Player 1977 District Player, West Zone
3. Mr. V. D. Sirse - All Rounder & Best Hockey Goal Keeper
4. Mr. Madhav Singh- Best Volley Ball Player, Represented District
5. Mr. A. M. Bose - Best T. T. and Badminton, Represented District.
6. Mr. N. S. Tomar- Best Hockey & Foot Ball 1983, Represented West Zone
7. Mr. R. B. Sharma- Best Kabaddi & Wt Lifting,1982-83
8. Mr. I. S. Tomar - Best Bowler in Cricket 1983
9. Mr. K. P. Sharma - All Rounder and Best Foot Ball Player
10. Mr. B. M. Sharma- Best Kabaddi Player, Represented District and All India Agricultural Universities Meet, Hissar,1999
11. Mr. Vijay Sharma- Best Bolly Ball Player, Represented All India Agricultural Universities Meet, Hissar,1999
12. Dr. M. R. Jadhav- Represented University and National in Hockey and officiating in District Hockey Association
13. Mr. J. K. Gupta - Represented All India Agricultural Universities Meet in Athletic 100 m run in 1999-2000
14. Mr. R. P. Kashyap- Represented All India Agricultural Universities Meet in Javelin Throw in 1999-2000

College of Agriculture, Gwalior

A Group of Foot-ball, Kabaddi, Volley-ball, T. T. & Badminton, Participated in Inter College Tournament of JNKVV, 1972-73



Left to Right :

Sitting in front : R. K. Jain, S. Pathak (JNKVV, Hockey), S. S. Bhadoria, A. M. Bose, V. K. Patil.

Sitting on Chair : S. D. Pateria, Surendra Singh Bhadouria, R. N. Singh Gurjar, S. W. Sapre (PTI), Dr. S. K. Singh Gaur (Asso. Dean), Dr. D. Singh (Sport Adviser), Dhirendra Singh Bhadouria (Captain Athletics), A. S. Tomar (Captain Volly-ball), K. K. Singh Bhadouria (Captain Football).

Standing row : R. B. S. Tomar, P. L. Zaddo, J. S. Tomar, V. N. S. Tomar, S. S. Tomar, R. S. Rajput (JNKVV, Hockey), R. B. S. Tomar, R. S. Kushwah, M. S. Tomar, H. C. S. Tomar.

(12) Library Details

Year	Books	Thesis	Journals
1964-65	44	115	18
1965-66	48	65	64
1966-67	279	250	15
1967-68	509	65	13
1968-69	721	30	13
1969-70	329	-	-
1970-71	600	-	-

Year	Books	Thesis	Journals
1971-72	194	14	37
1972-73	183	2	40
1973-74	385	6	24
1974-75	267	15	16
1975-76	351	7	21
1976-77	659	7	37
1977-78	2249	20	23
1978-79	329	12	18
1979-80	435	14	22
1980-81	2957	20	30
1981-82	1358	24	34
1982-83	547	17	29
1983-84	897	15	22
1984-85	493	34	19
1985-86	557	32	21
1986-87	415	40	16
1987-88	1389	16	12
1988-89	546	26	14
1989-90	861	25	36
1990-91	05	27	0
1991-92	1242	10	0
1992-93	1705	22	0
1993-94	650	27	20
1994-95	1838	7	29
1995-96	-	7	22
1996-97	645	19	19
1997-98	-	22	25
1998-99	267	17	33
1999-2000	481	17	24
2000-01	115	29	26

Year	Books	Thesis	Journals
2001-02	1442	44	24
2002-03	1210	22	22
2003-04	306	4	0
2004-05	422	24	12
2005-06	725	43	12
2006-07	287	40	0
2007-08	673	30	0

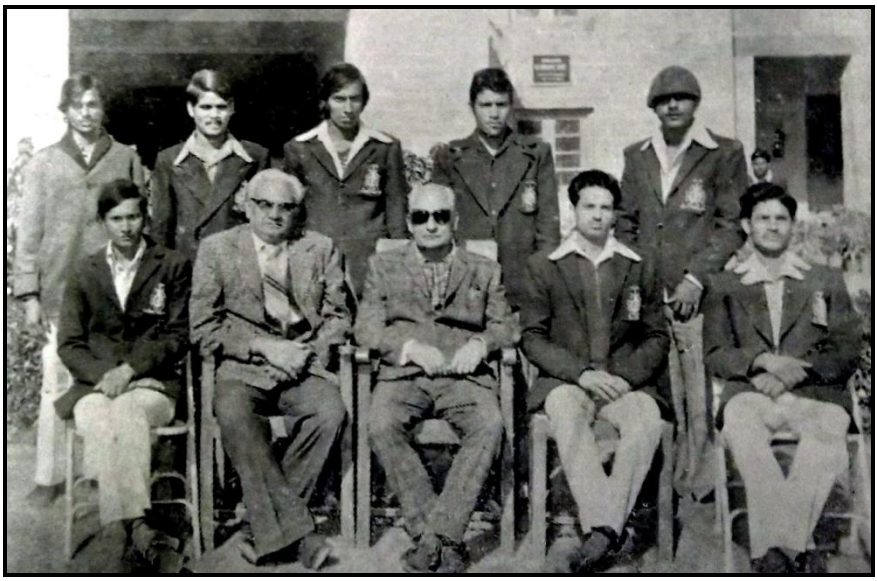
Library books

Detail	Year	Total books
Book Bank-SC/ST	1993-2007	3598
Book Bank-OBC	1995	898
Book Bank-General	1965-2007	10158
	Total	14654

(13) Student Union

Year	President	Vice-president	General Secretary
1964-65	S. K. Sharma	R. K. S. Kushwah	S. S. Bhadoria
1965-66	R. K. Mishra	S. N. Sharma	D. S. Bhadoria
1966-67	S. C. Sharma	R. S. Kushwah	D. P. Sharma
1967-68	Kamal Singh	S. P. S. Tomar	V. N. S. Bhadoria
1976-77	Suresh Singh Tomar	Rajkumar Rajput	Lakhan Singh Rajput
1991-92	Vijay Agarwal	S.S. Kushwah	Anil Tiwari

Silver Jubilee Celebration - Student Union 1976-77

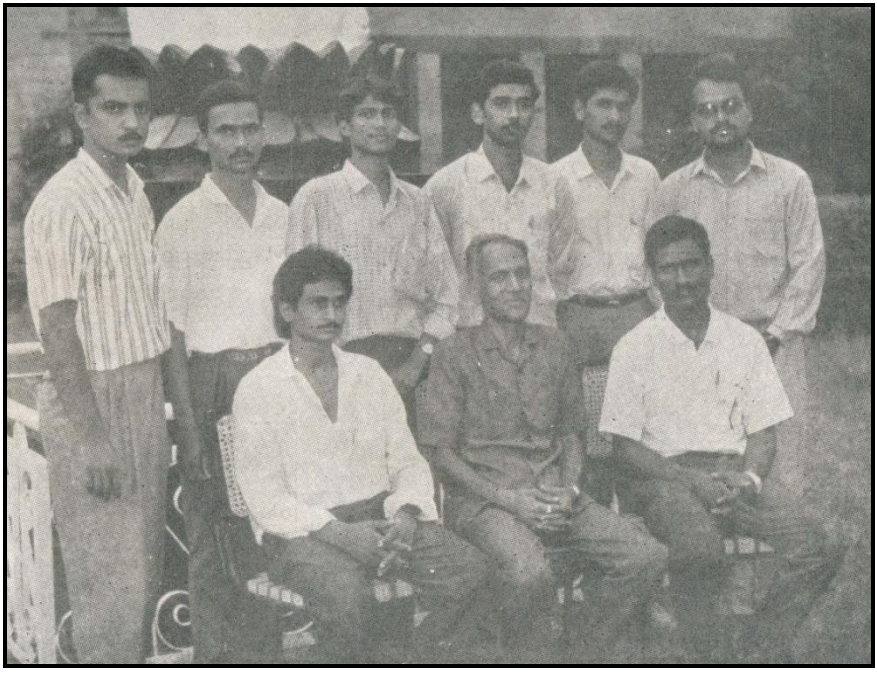


On Chair : Shri L. S. Rajput (Secretary), Dr. M. L. Purohit (Dean), Shri M. L. Dubey (State Minister, Agriculture, M. P.), Shri S. S. Tomar (President), Shri R. K. Rajput (Vice-President)

Standing : Shri P. N. Sharma, Shri M. L. Jain (Joint Secretary), Shri P. K. Koashal (Literary Secretary), Shri R. S. Tomar (Cultural Secretary), Shri V. D. Sirase (Sport Secretary)

College of Agriculture, Gwalior

Student Union 1991-92



Sitting : Shri Vijay Agrawal (President), Dr. A. S. Tiwari (Dean), Shri Shailendra Singh Kushwah (Vice-president).

Standing : Shri Sudhir Singh Bhadauria, Shri Amrendra Singh Chauhan, Shri Ramkesh Yadav (Joint Secretary), Shri Anil Tiwari (Secretary), Shri Hariom Tiwari, Shri Vivek Trivedi.

Eminent Visitors

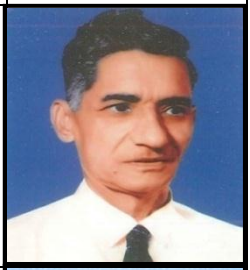
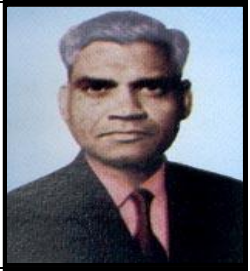
1964	Dr. S. S. Bhandarkar, Vice-Chancellor, Jiwaji University, Gwalior
1964	Dr. R. L. Gupta; Vice-Chancellor, J.N.K.V.V., Jabalpur
1966	Smt. Vijaya Laxmi Pandit, Member of Parliament.
1969	Shri Lafuri, Progressive Farmer of Gwalior district.
1977	Dr. M. S. Swaminathan, Eminent Scientist
1977	Sh. Tej Lal Tembe, State Minister
1977	Sh. M. L. Dubey; State Agriculture Minister, Madhya Pradesh
1977	Dr. D. P. Motiramani; Director Research, JNKVV, Jabalpur
1977	Sh. Rajendra Singh, State Minister, Madhya Pradesh
1977	Sh. H. B. Joshi; I.G. Police, Govt. of Madhya Pradesh
1977	Sh. Lahiri; Commissioner, Wheat Production
1977	Sh. Vallal, Commissioner, Chambal Division
1977	Sh. G. N. Tandon; Vice Chancellor; Jiwaji University, Gwalior
1981	Professor S. V. Arya; Vice Chancellor, JNKVV, Jabalpur
1981	Dr. K. K. Tiwari;Vice Chancellor, Jiwaji University, Gwalior
1981	Dr. R. K. S. Rajput; Director, Water Management, Rahuri
1986	Dr. C. B. S. Rajput; Dean, Institute of Agric. Sciences, B.H.U., Varanasi
1988	Dr. P. R. Verma; Emeritus Scientist, Saskatchewan, Canada
1988	Dr. Olesan; Emeritus Scientist, Sweden
1989	Dr. R. K. Downey; Emeritus Scientist, Saskatchewan, Canada
1992	Dr. Balram Jakhad; Central Agriculture Minister
1992	Shrimant Madhav Rao Scindia; Member of Parliament
1992	Sh. Bhagwan Singh Yadav; M.L.A. & Chairman, Apex Bank
1992	Sh. Hari Singh Narwaria; M.L.A.
1994	Dr. P. R. Kumar; Director, N.R.C.R.M., Bharatpur

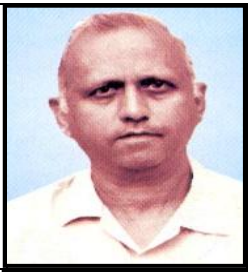
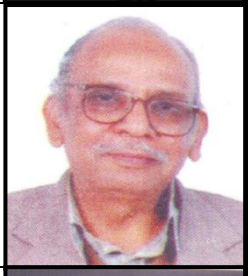
1995	Dr. K. S. Johar; Vice Chancellor, JNKVV, Jabalpur
1995	Dr. K.K. Singh; Jiwaji University, Gwalior
1996	Dr. R. R. Das; Vice Chancellor; Jiwaji University, Gwalior
2000	Dr. Y. L. Nene; A.D.G.; ICRISAT, Hyderabad
2000	Dr. S. L Mehta, Dy. D. G. (Educ.); I.C.A.R.
2000	Dr. Anand Swaroop Tiwari; Vice Chancellor, JNKVV, Gwalior
2000	Sh. Narendra Singh; M.L.A.
2000	Sh. Sumit Bose, Collector, Gwalior
2000	Dr. A. Subba Rao; Indian Institute of Soil Science, Bhopal
2000	Dr. Deepak Pental; Director, South Campus & Centre for Genetic Manipulation of Crop Plants; Delhi University, Delhi
2000	Dr. S. E. Pawar; Emeritus Scientist, B.A.R.C., Mumbai
2000	Dr. Akshay Pradhan; Delhi University, Delhi
2000	Dr. Punjab Singh; Vice Chancellor, JNKVV, Jabalpur
2001	Dr. G. B. Singh; Vice Chancellor, JNKVV, Jabalpur
2006	Dr. A. K. Gogoi; Director, N.R.C. Weed Science, Jabalpur
2006	Dr. D. P. Singh; Vice Chancellor, JNKVV, Jabalpur
2006	Dr. V. S. Tomar; D.F.A., JNKVV, Jabalpur
2007	Dr. J. S. Raghu, D.E.S., JNKVV, Jabalpur
2007	Dr. S. K. Rao, Director Farm, JNKVV, Jabalpur
2007	Dr. G. Kallo; Vice Chancellor, JNKVV, Jabalpur
2007	Sh. B. S. Rana; Member of Board, JNKVV, Jabalpur

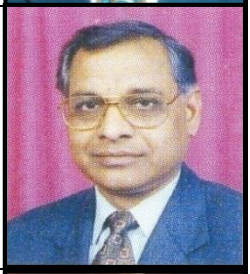
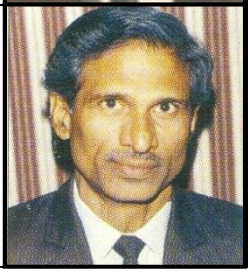
RAK College of Agriculture, Sehore

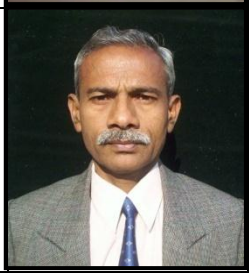
The foundation of College of Agriculture, Sehore was laid down by the first Food and Agriculture Minister of India, Late Shri Rafi Ahmad Kidwai on August 01, 1952. At that time, this college was up to intermediate level. On July 17, 1955, Union Minister for Food and Agriculture, Shri Ajit Prasad Jain laid foundation of Rafi Ahmad Kidwai Undergraduate College and Agricultural Research Institute. Initially, the college was affiliated to Vikram University, Ujjain. In the year 1964, after establishment of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, this college was one of the constituent colleges of JNKVV, Jabalpur.

(1) Principals/ Associate Deans/ Deans of College of Agriculture, Sehore

S. No.	Name	Duration		Photograph
		From	To	
1.	Shri H.P. Dwivedi	July 01, 1963	December 06, 1966	
2.	Dr. B.P. Tiwari	December 07, 1966	February 03, 1970	
3.	Dr. R.R. Rawat	February 04, 1970	June 20, 1972	
4.	Dr. R.P. Jyotishi	June 21, 1972	May 15, 1976	

5.	Dr. V.P. Shukla	May 16, 1976	July 22, 1978	
6.	Dr. S.N. Dubey	July 23, 1978	October 10, 1979	
7.	Dr. L.K. Joshi	October 11, 1979	October 31, 1984	
8.	Dr. R.A. Khan	November 01, 1984	December 31, 1984	
9.	Dr. Dwarka Singh	January 01, 1985	October 17, 1985	

10.	Dr. D.P. Nema	October 18, 1985	May 29, 1989	
11.	Dr. P.K.R. Nair.	June 01, 1989	July 31, 1993	
12.	Dr. R.K. Gupta	August 01, 1993	July 01, 1995	
13.	Dr. S.K. Dubey	July 02, 1995	July 26, 1996	
14.	Dr. V.S. Tomar	July 27, 1996	December 30, 2001	

15.	Dr. S.C. Agrawal	December 01, 2001	October 31, 2002	
16.	Dr. S.K. Srivastav	November 01, 2002	March 03, 2009	

(2) Staff Position

Year	Professor	Associate Professor	Assistant Professor/ Lecturer
1964-65	03	-	23
1965-66	03	-	23
1966-67	03	-	23
1967-68	03	-	23
1968-69	03	-	23
1969-70	03	-	23
1970-71	03	-	23
1971-72	03	-	23
1972-73	03	-	23
1973-74	03	-	23
1974-75	03	-	23
1975-76	03	-	23
1976-77	03	-	23
1977-78	03	-	23
1978-79	03	-	23
1979-80	05	-	49

Year	Professor	Associate Professor	Assistant Professor/ Lecturer
1980-81	05	-	49
1981-82	05	-	49
1982-83	05	-	49
1983-84	05	-	49
1984-85	05	-	49
1985-86	05	-	49
1986-87	05	-	49
1987-88	05	-	49
1988-89	05	-	49
1989-90	05	-	49
1990-91	05	-	49
1991-92	05	-	49
1992-93	05	-	49
1993-94	05	-	49
1994-95	05	-	49
1995-96	05	-	49
1996-97	05	-	49
1997-98	05	-	49
1998-99	05	-	49
1999-00	05	-	49
2000-01	05	-	49
2001-02	05	-	49
2002-03	-	08	28
2003-04	-	10	26
2004-05	01	13	22
2005-06	01	12	22
2006-07	01	12	22
2007-08	01	11	21

(3) Number of students admitted in Graduation and Post Graduation programmes and completed their degrees (year wise)

Year	Graduate		Post Graduate	
	Admitted	Completed	Admitted	Completed
1964-65	68	36	20	16
1965-66	47	67	16	20
1966-67	50	-	12	15
1967-68	33	32	07	-
1968-69	46	41	19	16
1969-70	56	39	18	17
1970-71	53	46	17	14
1971-72	48	38	20	13
1972-73	61	42	12	09
1973-74	56	38	15	12
1974-75	68	43	18	14
1975-76	72	52	14	10
1976-77	64	61	12	08
1977-78	80	57	15	13
1978-79	66	63	12	10
1979-80	54	53	13	07
1980-81	60	67	09	12
1981-82	61	36	14	12
1982-83	75	57	13	11
1983-84	82	39	12	10
1984-85	44	57	33	27
1985-86	51	70	29	24
1986-87	53	74	20	23
1987-88	-	39	34	31
1988-89	15	41	19	24
1989-90	57	49	-	17
1990-91	66	81	22	05
1991-92	75	05	31	17
1992-93	95	43	11	27
1993-94	86	32	08	09

1994-95	85	61	32	10
1995-96	61	39	26	15
1996-97	84	20	25	21
1997-98	71	29	26	24
1998-99	83	39	22	21
1999-00	84	45	28	22
2000-01	99	40	21	18
2001-02	86	47	24	19
2002-03	94	39	22	20
2003-04	98	55	25	21
2004-05	97	82	3	25
2005-06	111	62	39	29
2006-07	99	67	38	31
2007-08	92	64	37	62

(4) List of Medal/ Award winner students:

(i) Shri Hanuant Rao Prabhakar received NSS National Yuva Award 2000 in field of national development and social service.

(ii) Shri Khamdeo Kanate received NSS National Award 2006-07.

Hanumant Rao Prabhakar receiving the National Yuva Award 2000 from Central Minister Ku. Uma Bharti

(5) Foreign Education/ Visits of staff Members

(i) Dr. R.P. Agrawal, Professor Farm Management for higher education at Illinoise University, USA (1965).
(ii) Dr. V.P. Shukla, Professor, Ag. Extension for higher education at Cornel University, USA (1965).
(iii) Dr. U.S. Mishra, Professor, Entomology for higher education at IARI, New Delhi (1966).
(iv) Dr. R.D. Wankhede, Lecturer, for higher education at Illinoise University, USA (1966).
(v) Dr. S.C. Gupta, Soil Scientist (Chickpea microbiology), attended III European grain Legume Conference at Valladolid, Spain, wef 14.11.1998 to 19.09.1998 and presented a research paper in the conference.
(vi) Dr. S.C. Gupta, Soil Scientist (Chickpea microbiology), visited Research Institute for Soil Science and Agricultural Chemistry, Budapest, Hungary under bilateral exchange programme of Indian national science Academy and Hungarian Academy of Sciences. Wef 10.07.2003 to 10.10.2003. and undertaken joint research work.

(6) Chief Guests/ Visitors of important programme in the college

(i) Dr. Agr. Theodor Bergmannr- A German Agricultural Economist at the University, Stuttgart Hohenhen (1964).
(i) Dr. R.L. Gupta, Dean, Agriculture, JNKVV (1964).
(ii) Dr. W.D. Buddeimeir- USAID Advisor (1967).
(iii) Dr. L.S. Negi- Vice Chancellor, JNKVV (1969).
(iv) Dr. R.C. Shivelkar-Director Ext. JNKVV (1972).
(v) Dr. J.S. Kanwar-Dy. Director General, ICAR (1973).
(vi) Dr. Elwood F. Olber- Chief of party, USAID (1978).
(vii) Mr. O.O. Mowrey- USAID (1978).
(viii) Dr. J.R. Jackob-Co-ordinator All India Soybean Project. (1979).
(ix) Dr. B.L. Brooks- Marketing Advisor (1979).
(x) Dr. Thorne- USAID Advisor (1979).
(xi) Dr. Marshaln, Me Glammary-Weed Specialist (1980).
(xii) Dr. Malsura- Agronomy Advisor, UPAU (1980).
(xiii) Shri S.V. Arya, Dean Ag. Eng, JNKVV (1984).

(7) Outstanding Scholar of College

Year	B.Sc. (Ag.)	M.Sc. (Ag.)
1965	Mr. A.W. Khan	Mr. K.S. Pillai, Mr. N.S. Verma, Mr. B.M. Kushwaha, Mr. P.V. Pandit and Mr. B.L. Jain
1966	Mr. M.L. Nigam and Mr. D.P. Mahere	Mr. S.C. Deshmukh, Mr. J.M. Belashki, Mr. B.S. Rajput and Mr. Shivsanker
1967	Mr. G.L. Katiya and Mr. B.P. Chimaniya	Mr. R.B. Arwar, Mr. S.D. Saxena and Mr. Madhukar Choudhary

(8) Starting of new courses / Degree programmes

Year	Starting of new courses/ Degree programmes	
	Graduate	**Post Graduate**
1985-86	Four Year B.Sc. (Ag) Course	M.Sc. (Ag.) in Genetics & Plant Breeding and Plant Pathology

(9) Library details

Year	Number of Books	Number of Journals	Number of Theses
1964-65	231	100	13
1965-66	660	110	18
1966-67	399	110	12
1967-68	650	105	13
1968-69	707	89	13
1969-70	234	85	12
1970-71	299	134	10
1971-72	411	130	Nil
1972-73	417	127	Nil
1973-74	396	100	Nil
1974-75	346	97	02
1975-76	620	90	05
1976-77	1273	65	10
1977-78	594	80	12
1978-79	929	75	05
1979-80	1260	104	02
1980-81	3552	98	10

1981-82	1079	82	10
1982-83	871	80	06
1983-84	555	107	20
1984-85	622	103	12
1985-86	430	98	12
1986-87	325	87	20
1987-88	389	85	08
1988-89	358	80	14
1989-90	315	85	14
1990-91	569	50	26
1991-92	168	40	12
1992-93	284	60	12
1993-94	319	60	03
1994-95	Nil	50	11
1995-96	304	65	07
1996-97	504	55	06
1997-98	28	50	21
1998-99	Nil	35	14
1999-00	Nil	35	10
2000-01	220	40	13
2001-02	Nil	25	17
2002-03	112	28	15
2003-04	51	25	19
2004-05	237	28	17
2005-06	461	20	24
2006-07	65	25	21
2007-08	529	Nil	19

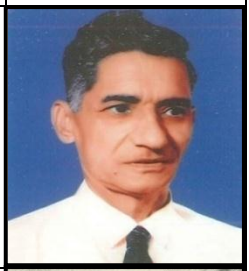
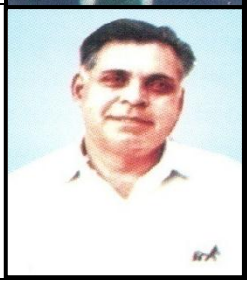
(10) Student union

Year	President	Vice-president	General Secretary
1964-65	-	-	V.J.M. Rao
1965-66	-	-	A.K. Tiwari
1966-67	-	-	S.C. Mehta,
1967-68	-	-	Shyam Lal Agrawal
1968-69	Hari Singh	J.S. Yadav	J.S. Raghu
1979-80	Om Prakash Depuria	Salim Malik	Trilochan Singh
1980-81	K.S. Thakur	-	D.P. Sharma
1981-82	R.N. Sharma	-	V.K. Verma

College of Agriculture, Indore

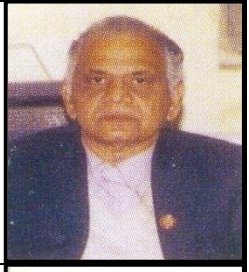
Indore, situated in the heart of Malwa, enjoys the status of an "educational and industrial Capital of Madhya Pradesh". To initiate and strengthen agricultural research and development in Malwa and Nimar regions, the Institute of Plant Industry came into existence in the year 1924. Later on, in the year 1959, the Government College of Agriculture was established with the merger of the erstwhile Institute of Plant Industry (IPI). It was a prestigious campus of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, since 1964.

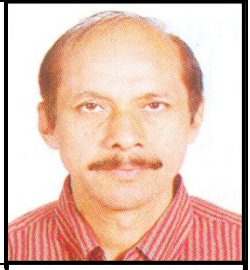
(1) Principals/ Associate Deans/ Deans of College of Agriculture, Indore

S. No.	Principals	Duration		Photograph
		From	To	
1.	Shri H.P. Dwivedi	August 1965	June 1966	
2.	Shri S.K. Singh Gour	June 1966	May 1971	
3.	Shri M.P. Singh	June 1971	June 1974	
4.	Dr. O.P. Dahama	June 1974	June 1975	

5.	Dr. M.M. Rai	June 1975	July 1975	
6.	Dr. D.K. Tiwari	July 1975	January 1976	
7.	Dr. M.M. Rai	January 1976	April 1976	
8.	Dr. L.K. Joshi	April 1976	October 1979	
9.	Shri S.K. Singh Gour	October 1979	May 1982	

10.	Dr. V.N. Shroff	May 1982	July 1982	
11.	Dr. G.P. Verma	July 1982	October 1985	
12.	Dr. V.N. Shroff	November 1985	August 1987	
13.	Dr. D. Singh	August 1987	January 1988	
14.	Dr. V.N. Shroff	February 1988	January 1995	

15.	Dr. R.N. Saran	February 1995	July 1996	
16.	Dr. B.L. Mishra	July 1996	December 1996	
17.	Dr. R.N. Saran	December 1996	June 1998	
18.	Dr. O.P. Verma	June 1998	May 2002	
19.	Dr. J.S. Raghu	June 2002	November 14, 2005	

20.	Dr. S.S. Tomar	November 17, 2005	April 23, 2007	
21.	Dr. S.L. Naik	April 23, 2007	July 21, 2008	
22.	Dr. R.A. Sharma	July 21, 2008	September 18, 2008	

(2) Staff Position

Year	Principal/ Assoc. Dean/ Dean	Professors	Associate Professors	Assistant Professors	Demonstrators	Physical Instructor	Librarian	Total
1964	1	-	2	31	1	-	1	36
1965	1	-	2	31	1	-	1	36
1966	1	-	2	31	1	-	1	36
1967	1	-	2	31	1	-	1	36
1968	1	-	2	31	1	-	1	36
1969	1	-	2	31	1	-	1	36
1970	1	-	2	31	1	-	1	36

Year	Principal/ Assoc. Dean/ Dean	Professors	Associate Professors	Assistant Professors	Demonstrators	Physical Instructor	Librarian	Total
1971	1	-	2	31	1	-	1	36
1972	1	-	2	31	1	-	1	36
1973	1	-	4	28	1	1	1	36
1974	1	-	4	28	1	1	1	36
1975	1	-	4	28	1	1	1	36
1976	1	-	4	28	1	1	1	36
1977	1	-	4	28	1	1	1	36
1978	1	-	4	28	1	1	1	36
1979	1	1	3	26	1	1	1	34
1980	1	1	3	26	1	1	1	34
1981	1	1	3	27	-	1	1	34
1982	1	1	3	27	-	1	1	34
1983	1	1	3	27	-	1	1	34
1984	1	1	3	27	-	1	1	34
1985	1	1	3	27	-	1	1	34
1986	1	1	3	27	-	1	1	34
1987	1	1	3	27	-	1	1	34
1988	1	1	3	27	-	1	1	34
1989	1	1	3	27	-	1	1	34
1990	1	1	3	27	-	1	1	34
1991	1	1	3	27	-	1	1	34
1992	1	1	3	27	-	1	1	34
1993	1	1	3	27	-	1	1	34
1994	1	1	3	27	-	1	1	34
1995	-	-	26	6	1	1	1	35

Year	Principal/ Assoc. Dean/ Dean	Professors	Associate Professors	Assistant Professors	Demonstrators	Physical Instructor	Librarian	Total
1996	-	1	26	6	1	1	1	36
1997	-	-	23	5	1	1	1	31
1998	-	-	21	5	1	1	1	29
1999	-	-	21	5	1	1	1	29
2000	-	1	23	4	-	-	1	29
2001	-	2	19	4	-	-	1	26
2002	1	9	13	2	-	-	1	26
2003	1	11	10	2	-	-	1	25
2004	1	10	12	2	-	-	1	25
2005	1	10	9	-	-	-	-	20
2006	1	7	7	2	-	-	-	17
2007	-	6	7	2	-	-	-	15
2008	-	5	8	2	-	-	-	10

(3) Starting of new courses/ degree programmes

Department	Year of starting	Post Graduate
Agronomy	1969	M. Sc. (Ag) Agronomy
Pl. Breeding	1971	M. Sc. (Ag) Pl. Breeding & Genetics
Entomology	1980	M. Sc. (Ag) Entomology
Ag. Economics & F.M.	1983	M. Sc. (Ag) Ag. Economics & F.M.
Pl. Pathology	1985	M. Sc. (Ag) Pl. Pathology

Horticulture	1994	M. Sc. (Ag) Horticulture
Extension Education	2004	M. Sc. (Ag) Extension Education

(4) Number of students admitted in Graduation and Post Graduation programmes and completed their degrees

Year	B. Sc. (Ag)	
	Admitted	Passed
1964-65	71	55
1965-66	82	58
1966-67	64	41
1967-68	64	45
1968-69	50	46
1969-70	54	51
1970-71	63	58
1971-72	68	61
1972-73	52	42
1973-74	65	57
1974-75	68	61
1975-76	77	64
1976-77	60	50
1977-78	73	60
1978-79	69	65
1979-80	67	63
1980-81	69	58

Year	B. Sc. (Ag)	
	Admitted	Passed
1981-82	74	65
1982-83	81	77
1983-84	82	78
1984-85	65	63
1985-86	80	86
1986-87	80	80
1987-88	65	64
1988-89	67	63
1989-90	55	53
1990-91	76	70
1991-92	78	76
1992-93	81	75
1993-94	87	80
1994-95	77	47
1995-96	71	45
1996-97	79	48
1997-98	70	55

Year	B. Sc. (Ag)	
	Admitted	Passed
1998-99	90	47
1999-00	77	56
2000-01	104	36
2001-02	83	81
2002-03	89	67

Year	B. Sc. (Ag)	
	Admitted	Passed
2003-04	80	65
2004-05	88	75
2005-06	94	74
2006-07	94	67
2007-08	95	77

Year	M. Sc. (Ag) (A-Admitted, P-Passed)									
	Plant Pathology		Entom-ology		Agricultural Economics & F.M.		Horti-culture		Extension Education	
	A	P	A	P	A	P	A	P	A	P
1983-84	-	-	8	8	4	4	-	-	-	-
1984-85	-	-	10	9	4	4	-	-	-	-
1985-86	1	1	11	9	4	4	-	-	-	-
1986-87	1	1	9	7	4	4	-	-	-	-
1987-88	2	2	6	4	4	4	-	-	-	-
1988-89	1	1	6	3	4	4	-	-	-	-
1989-90	1	1	11	11	4	4	-	-	-	-
1990-91	3	3	4	3	4	4	-	-	-	-
1991-92	6	1	8	3	9	9	-	-	-	-
1992-93	4	1	3	3	4	4	-	-	-	-
1993-94	4	1	5	2	4	4	-	-	-	-
1994-95	4	1	4	3	3	3	2	2	-	-
1995-96	6	5	6	3	6	6	2	1	-	-
1996-97	5	4	4	2	4	4	2	2	-	-
1997-98	5	4	5	3	4	4	3	3	-	-
1998-99	5	3	4	3	5	5	2	2	-	-
1999-2000	6	4	4	4	5	5	2	2	-	-

Year	M. Sc. (Ag) (A-Admitted, P-Passed)									
	Plant Pathology		Entom-ology		Agricultural Economics & F.M.		Horti-culture		Extension Education	
	A	P	A	P	A	P	A	P	A	P
2000-01	3	2	4	3	5	5	4	3	-	-
2001-02	4	3	5	5	4	4	4	4	-	-
2002-03	4	4	6	6	4	4	4	4	-	-
2003-04	5	5	9	7	4	4	4	3	-	-
2004-05	8	7	8	8	7	7	4	4	8	5
2005-06	10	9	8	8	10	10	8	8	8	7
2006-07	8	8	4	4	9	9	9	8	7	7
2007-08	8	8	8	8	9	9	8	8	8	8

(5) List of Medal/ Awards winner students

S. No.	Name of student	Year of award	Degree Prog.	Name of awards
1	Shri Vithal Soni	1965	B. Sc. (Ag.)	• Shri S. P. Hada Gold Medal
2	Shri Kishor Sopekar	1978-79	B. Sc. (Ag.)	• VV Gold medal • Silver Jubilee Gold Medal • Govind Prasad Gold Medal • ASP Gold Medal
3	Ku. Usha Joshi	1978-79	M. Sc. (Soil Sci. & Agril Chem)	• Rai Sahib Satya Pal Handa Gold Medal
4	Shri Arvind Kulkarni	1985-86	M. Sc. (Ag)	• VV Gold Medal • O.P. Dahama Gold Medal

S. No.	Name of student	Year of award	Degree Prog.	Name of awards
5	Shri Anil Kotasthani	1985-86	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal
6	Shri Nikhilesh Pandey	1987-88	B. Sc. (Ag)	• Silver Jubilee Commemoration Silver Medal • ASP Gold Medal • Dr. L.K. Joshi Gold Medal
7	Anand Nigoskar	1988-89	B. Sc. (Ag)	• VV Gold Medal • Silver Jubilee Gold Medal • Govind Prasad Gold Medal • ASP Gold Medal • Dr. L.K. Joshi Gold Medal
8	Anil Kumar Nagar	1980-81	M. Sc. (Ag)	• VV Gold Medal
9	Deepak Sahgal	1982-83	B. Sc. (Ag)	• VV Gold medal • Silver Jubilee Commemoration Rotary Gold Medal • Govind Prasad Gold Medal • ASP Gold Medal
10	K. C. Supekar	1978-79	B. Sc. (Ag)	• VV Gold Medal • Silver Jubilee Commemoration Rotary Gold Medal • ASP Gold Medal

S. No.	Name of student	Year of award	Degree Prog.	Name of awards
11	Ravindra T. Khedekar	1978-79	M. Sc. (Ag)	• VV Gold Medal
12	Usha Joshi	1978-79	M. Sc. (Ag)	• Rai Sahib Satya Pal Handa Gold Medal (for girl student only)
13	Prakash Poddar	1988-89	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal
14	Shaji John	1989-90	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal • Dr. A.C. Jain & Dr. K.G. Neema Silver Medal
15	Kamal Kumar Jain	1991-92	M. Sc. (Ag)	• VV Gold Medal • Shamji Bhai Harsivan Mehta Silver Medal • Dr. A.C. Jain & Dr. K.G. Neema Silver Medal
16	Prakash Vishwakarma	1992-93	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal
17	Bhavesh Kumar Joshi	1994-95	M. Sc. (Ag)	• VV Gold Medal
18	Amol Pandit	1994-95	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal • Dr. A.C. Jain & Dr. K.G. Neema Silver Medal

S. No.	Name of student	Year of award	Degree Prog.	Name of awards
19	Smriti Dave	1996-97	M. Sc. (Ag)	• VV Gold Medal • Shamji Bhai Harsivan Mehta Silver Medal • Dr. A.C. Jain & Dr. K.G. Neema Silver Medal • Rai Sahib Satya Pal Handa Gold Medal
20	Sanjay Kumar Singh	1996-97	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal • Dr. A.C. Jain & Dr. K.G. Nema Silver Medal • Rai Sahib Satya Pal Handa Gold Medal
21	Roshan Galani	1996-97	B. Sc. (Ag)	• VV Gold Medal • Silver Jubilee Commemoration Rotary Gold Medal • Govind Prasad Silver Medal • Aspee silver Medal • Dr. L.K. Joshi gold Medal • Lt. Dr. R.L. Gupta Gold Medal
22	Prasanna Kumar Sharma	1997-98	M. Sc. (Ag)	• VV Gold medal • Shamji Bhai Harsivan Mehta Silver Medal

S. No.	Name of student	Year of award	Degree Prog.	Name of awards
23	Suman Prasad	1997-98	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal • Dr. A.C. Jain & Dr. K.G. Neema Silver Medal • Rai Sahib Satya Pal Handa Silver Medal
24	Mukesh Kumar Yadav	1999-00	M. Sc. (Ag)	• Shamji Bhai Harsivan Mehta Silver Medal
25	Rahul Jain	2000-01	B. Sc. (Ag)	• Lt. Dr. R.L. Gupta Gold Medal
26	Ansuman	2001-02	B. Sc. (Ag)	• VV Gold Medal
27	Nishi K. Panday	2005-06	B. Sc. (Ag)	• Lt. Dr. R.L. Gupta Gold Medal

(6) Foreign Education/ Visits of staff members

S. No.	Name of Visitor	Country/Place	Year
1	Dr. N. S. Sisodiya	USA	
2	Dr. H. S. Jethmalani	Illinois	
3	Dr. M. M. Rai	Illinois	
4	Dr. R. K. Gupta	USA	
5	Dr. G. P. Verma	USA, Canada & UK	1983
6	Dr. V. N. Shroff	Vietnam	1987
7	Dr. D. D. Dubey	UK	1992
8	Dr. O. P. Sharma	Pakistan	1993
9	Dr. K. S. Bangar	Bangkok, Thailand	2000
10	Dr. D. H. Ranade	Israel	2001
11	Dr. M. Billore	Philippines	2002

S. No.	Name of Visitor	Country/Place	Year
12	Dr. R. A. Sharma	Prague, Czech Republic & Germany	2003
13	Dr. J. S. Raghu	Prague, Czech Republic & Germany	2003

(7) Chief Guests/ Visitors

Year	Visitors
1964	Mr. C. Subramaniam, Central Agril. Minister
1976	Mr. Shankar Rao Chouhan, Central Agril. Minister
1981	National Krishi Vigyan Mela: Sh. Digvijay Singh iaugurated the mela and Chief guest for closing ceremony was Chief Minister of M.P. Mr. Arjun Singh

(8) Student Union

Year	Post	Name of student
1964-65	President	Subhash Yadav
1966-67	President	Akbar S. Tomar
1974-75	President	Dinesh Sharma
1977-78	President	R.P. Bajpai
1978-79	President	Girish Acharya
1979-80	President	A.K. Sharma
1981-82	President	R.P. Patel

(9) Library Information (Number of Journals/ Thesis/ Books)

Year	Journals	Thesis	SC/ST Books	General books	Book Bank
1964	-	-	-	575	-
1965	1	9	-	175	-
1966	1	4	-	350	-
1967	1	4	-	235	-
1968	1	3	-	200	-

Year	Journals	Thesis	SC/ST Books	General books	Book Bank
1969	1	4	-	228	-
1970	2	1	-	500	-
1971	2	3	-	517	363
1972	2	-	-	427	364
1973	129	1	-	315	-
1974	55	3	-	412	-
1975	59	7	-	490	365
1976	141	10	-	637	360
1977	126	5	-	712	-
1978	211	8	-	869	358
1979	326	11	-	445	336
1980	293	11	-	421	340
1981	141	6	-	1005	380
1982	381	11	-	384	355
1983	138	9	-	75	386
1984	74	78	-	98	330
1985	15	22	-	146	-
1986	-	6	-	412	-
1987	-	11	-	170	-
1988	-	31	-	1332	-
1989	3	13	-	-	-
1990	3	10	-	13	240
1991	4	10	-	702	-

Year	Journals	Thesis	SC/ST Books	General books	Book Bank
1992	56	8	-	152	-
1993	16	8	-	375	-
1994	66	9	638	173	-
1995	91	3	781	03	-
1996	37	19	148	06	-
1997	8	14	-	-	-
1998	11	12	-	214	150
1999	94	27	627	44	-
2000	112	26	-	55	350
2001	34	20	-	460	780
2002	69	21	-	420	-
2003	166	23	-	275	-
2004	209	34	330	1056	-
2005	221	51	-	134	-
2006	176	74	353	446	-
2007	110	47	-	439	-

(10) National Cadet Corps (NCC) Unit

The Directorate of National Cadet Corps (NCC) was established in the year 1948 to conduct the activities of NCC under the Ministry of Defence with the Motto of 'Unity and Discipline'. The three colours of the mono represent Army, Naval and Air wing. The NCC course for the undergraduates in agriculture was started in the year 1960 and was implemented in the College of Agriculture, Indore with One Company of NCC cadets comprising of 100-150 cadets with the following objectives.

- To treat everyone with the same respect and dignity regardless of race, creed, color, ethnic or national origin.

- To provide opportunities for developing bonds of respect, affection and to impart basic skills needed incontemporary life.
- To nurture spiritual, cultural, social, psychological and physical growth in the students.
- To discern students gifts and weaknesses, so as to provide quality education at all levels and sequence of learning.
- To balance students self-direction and freedom with personal responsibility.
- To sensitize students to issues of environment stewardship, social justice and reverence for life.
- To communicate with and cooperate with parents in the academic development of their sons and daughters.

The NCC activities are governed by the 9 M. P. Battalion, NCC, Indore. The activities include, drill, arms training Map reading, field crafts, civil defense, adventurous training, firing, first aid etc. the students also participte by attending different types of camps viz. Annual Training camp, Social Service Camp, All India Summer Training Camp, Advance Leadership Course, Paratroopers Camp, Army Attachment Camp National Integration Camp, Republic Day Camp and Trekking Camp etc.

Name and tenures of past NCC Officers

Maj. S. C. Jain	1964-1977
Lt. G. P. Verma	1978-1996
Capt R. Shinde	1996-2008

The camps were helpful for developing self confidence, leadership and integrity in the students. Two annual camps were necessary for appearing in "C" certificate examination.

(11) National Service Scheme (NSS)

National Service Scheme (NSS) has come into existence for the first time in our institution in the year 1975. A unit of 100 volunteers is being run efficiently and conducting regular and specific activites as per the mandate of NSS.

NSS fully aims at self development of volunteers through social service, feelings of affection, love, integrity, sacrifice, social welfare, self

dependence, cooperation; patriotism is the yardsticks and hallmarks to be reckoned with.

The important activities conducted:

- Theme based one day camps
- Plantation programmes
- Blood donation camps
- Valuable social surveys
- Ten days special rural camps
- Campus beautification and development work
- Theme based awareness rallies
- Education for women and school dropouts

The voluneteers have also attended the university level, state level and nation level camps and obtained remarkable positions in competitions.

A 'Red Ribbon Club' was constituted. Establishment of Red Ribbon Club was a movement started by the Government of India in Schools/ Colleges through which the NSS volunteers created awareness against AIDS.

B. M. College of Agriculture, Khandwa

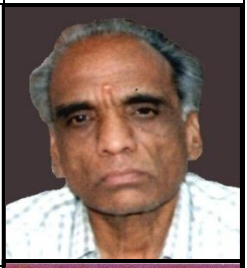
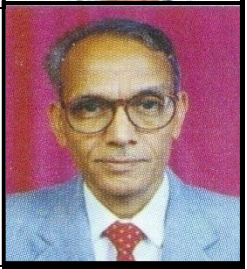
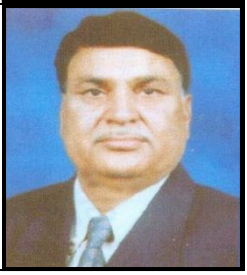
The College of Agriculture Khandwa was established in the name of the former Chief Minister of Madhya Pradesh Shri Bhagavant Rao Mandloi on March 1, 1986 in the Nimar Valley of Madhya Pradesh. The then Hon'ble Chief Minister of Madhya Pradesh Sh. Motilal Vora laid down the foundation stone of B. M. College of Agriculture, Khandwa under the jurisdiction of the JNKVV, Jabalpur. The College came under jurisdiction of RVSKVV, Gwalior on August 19, 2008.

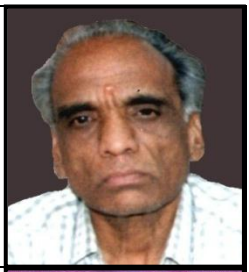
The College offers Under Graduate teaching programme (4 years degree course) of B. Sc. (Ag.). There are 13 departments working in this college: Agronomy, Plant Physiology, Agriculture Statistics & Computer Science, Agriculture Economics & Farm Management, Extension Education & Rural Sociology, Entomology, Food science & Technology, Forestry, Plant Breeding & Genetics, Plant Pathology, Soil Science & Agricultural Chemistry, Horticulture and Agricultural Engineering. The total intake capacity of this college is 56 including payment, ICAR and NRI seats under different categories. Modern teaching aids like computers, LCD projectors and internet facilities are available for staff and students. An independent ARIS Cell functions in the College for

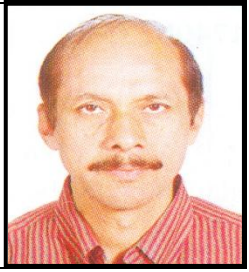
computer teaching and information technology related to Agriculture Science. The College has excellent laboratories in Plant Pathology and Biotechnology subject with huge collection of rare specimens and slides. The College library has 6167 books related to agriculture science. CeRA facility of ICAR in the College library has been initiated for effective learning to students and teaching staff through national and international journals. The hostel facility is available for 52 girl students. Efforts are being made for hostel facilities for boys also.

The College has a total area of 75.05 ha, which includes 8.00 ha under roads and buildings, 6.60 ha under fruits and forest plantations and 43.40 ha under cultivation. Out of the total area a major part 29.0 ha is rainfed and 17.05 ha is permanent fallow.

(1) Principals/ Associate Deans/ Deans of College of Agriculture, Khandwa

S. No.	Name	Duration		Photograph
		From	To	
1.	Dr. K.C. Mandloi	January 12, 1987	January 31, 1988	
2.	Dr. A.S. Tiwari	February 01, 1988	May 20, 1989	
3.	Dr. C.B. Singh	May 21, 1989	November 23, 1997	

4.	Dr. K.C. Mandloi	November 24, 1997	August 31, 2001	
5.	Dr. Y.K. Sharma	September 01, 2001	October 31, 2002	
6.	Dr. R.G. Satpute	November 01, 2002	February 02, 2004	
7.	Dr. A.K. Choudhary	February 03, 2004	July 29, 2005	
8.	Dr. S.S. Tomar	July 30, 2005	November 15, 2005	

9.	Dr. R.A. Sharma	November 16, 2005	July 20, 2008	
10.	Dr. S.L. Naik	July 21, 2008	September 18, 2008	

(2) Staff Position

Year	Professor	Associate Professor	Assistant Professor
1988-89	-	1	5
1989-90	-	1	5
1990-91	-	1	5
1991-92	-	1	6
1992-93	-	1	6
1993-94	-	1	7
1994-95	-	-	6
1995-96	-	-	6
1996-97	-	-	7
1997-98	-	1	8
1998-99	-	1	8
1999-2000	-	1	8
2000-01	-	2	9
2001-02	-	2	9
2002-03	-	2	9

2003-04	-	2	9
2004-05	-	2	9
2005-06	-	1	6
2006-07	-	2	8
2007-08	-	2	6

(3) Number of students admitted in graduation programme and completed their degrees

Year	Students Admitted	Graduation Degree awarded
1988-89	12	-
1989-90	12	-
1990-91	17	-
1991-92	21	9
1992-93	22	1
1993-94	14	2
1994-95	21	8
1995-96	20	3
1996-97	30	6
1997-98	30	8
1998-99	35	12
1999-2000	30	7
2000-01	20	17
2001-02	48	14
2002-03	20	16
2003-04	29	18
2004-05	29	42
2005-06	28	31
2006-07	52	32
2007-08	53	18

(4) University Positions/ Medal winners

Mr. Prabash Bose was honoured with the University Gold Medal in 1993 for his outstanding performance in B.Sc. (Ag) degree programme.

(5) Outstanding Staff of College

(i) Hexanar Awarded 1993 to Dr. P.P. Shastry for outstanding research work in Plant Pathology.

(ii) Sharda Memorial Award 1995 to Dr. P.P. Shastry for Best Research paper published in Indian Journal of Plant Protection.

(iii) Ramdhan Singh Memorial Award 1999 to Dr. K.C. Mandloi for Lifetime Achievement.

(6) Library details

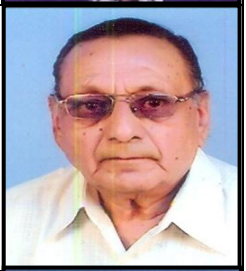
Year	No. of Books	No. of Manuals	No. of Journals
1997	-	-	20
1998	-	-	38
1999	-	-	55
2000	-	-	77
2001	-	-	99
2002	-	-	125
2003	1583	58	145
2004	1807	58	165
2005	1912	58	181
2006	2244	58	201
2007	2423	212	217

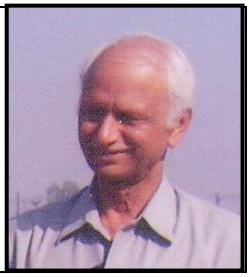
College of Agriculture, Mandsaur

The College of Agriculture, Mandsaur was established on March 28, 1987. The undergraduate programme in agriculture had the intake capacity of 28 students every year, including ICAR, payment and NRI seats.

The College has total area of 74.15 ha including 14.45 ha under roads and buildings, 2.02 ha under pasture, 2.50 ha under fruit plantation and 50.85 has under field experimentation and cultivation. A substantial portion (21.0 ha) of this area is partially irrigated while 17.85 ha is rainfed. The remaining 4.33 ha area is fallow.

(1) Principals/ Associate Deans/ Deans of College of Agriculture, Mandsaur

S. No.	Name	Duration		Photograph
		From	To	
1.	Dr. R.S. Pachouri	February 29, 1988	March 31, 1993	
2.	Dr. S.R.Sharma	March 31, 1993	February 27, 1995	
3.	Dr. K.B. Nigam	February 27, 1995	July 31, 1996	
4.	Dr.C.P.S.Yadav	July 31, 1996	July 31, 2001	

5.	Dr. J.P.Tiwari	July 31, 2001	October 3, 2002	

(2) Staff Position

Year	Professor	Associate Professor	Assistant Professor
1988-89	1	-	15
1989-90	1	-	12
1990-91	1	-	13
1991-92	1	2	10
1992-93	1	2	14
1993-94	1	1	9
1994-95	2	6	10
1995-96	2	6	10
1996-97	1	7	10
1997-98	1	10	4
1998-99	1	12	6
1999-2000	-	11	7
2000-01	1	11	5
2001-02	4	8	7

(3) Number of students admitted in the graduation programme and completed their degree

Year	B. Sc. (Ag.)	
	Admitted	Pass out
1988-89	13*	-
1989-90	-	-
1990-91	22	-
1991-92	25	-
1992-93	-	-
1993-94	31	10
1994-95	23	10
1995-96	12	4**
1996-97	18	15
1997-98	24	8
1998-99	26	8
1999-2000	21	13
2000-01	33	13
2001-02	29	10

* The upgraded students were transferred to other colleges of Agriculture.

** The back students of 1991-92 admitted batch.

(4) Outstanding scholar of the College

1. Shri Himanshu - Job in Foreign Country
2. Shri Manoj Chouhan - Captain of National Kabaddi Team
3. Shri Navin Doshi - Good Position in Chambal Fetilizer Ltd.
4. Shri Vijay Oswal - Good Position in Ruchi Soya
5. Shri Akhilesh Saraf - Good Position in Ruchi Soya
6. Shri Prasan Sharma - Good Position in Ruchi Soya

(5) Foreign Education/ Visit of Staff Members

S. No.	Name of Visitor	Country/ Place
1.	Dr. R. S. Pachouri, Dean, CoA, Mandsaur	Ethiopia

(6) Chief Guest / Visitors

S.No.	Name	Designation	Date
1.	Shri Moti Lal Vora	Chief Minister M.P. Govt.	21st March 1987
2.	Shri Sunder Lal Patwa	Chief Minister M.P. Govt.	18th June 1992
3.	Shri Laxmi Narayan Sharma	Minister of Agriculture, M.P. Govt.	18th June 1992
4.	Shri Kailash Chawla	Minister , Cooperation	-
5.	Dr. K. S. Johar	Vice Chancellor, JNKVV, Jabalpur	-
6.	Shri Mahendra Singh Ji Kalukheda	Minister of Agriculture, M.P. Govt.	22nd February 2003
7.	Dr. G. Kalloo	ADG, Horticulture, ICAR, New Delhi	-
8.	Dr. D.P. Singh	Vice Chancellor, JNKVV, Jabalpur	-
9.	Dr. Balram Jakhad	Governer, M.P. & Chancellor of JNKVV, Jabalpur	21 March 2005
10.	Shri Kailash Chawla	Minister of Commerce and Industries, M.P. Govt.	-
11.	Shri Gopal Bhargav	Mnister of Agriculture and Cooperation	-
12.	Shri Laxminarayan Pandey	Member of Parliament	-
13.	Shri Balkavi Bairagi,	Ex- Member of Parliament	-

14.	Shri Om Prakash Purohit	M.L.A., Mandsaur	-
15.	Dr. D.P. Singh	Vice Chancellor, JNKVV, Jabalpur	-
16.	Dr. V.S. Tomar	DFA, JNKVV, Jabalpur	-
17.	Dr. Y. L. Nene	Ex. Deputy Director General, ICRISAT, Hyderabad	-
18.	Shri Subhash Yadav	Cabinet Minister, M.P. Government	-

(7) Library details

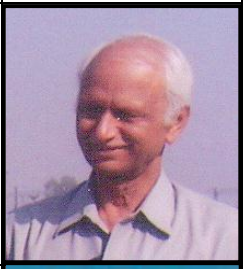
Year	No. of Books	No. of Journals
1988-89	46	01
1989-90	200	-
1990-91	410	01
1991-92	491	01
1992-93	75	02
1993-94	452	-
1994-95	769	-
1995-96	569	-

Year	No. of Books	No. of Journals
1996-97	-	-
1997-98	-	-
1998-99	-	-
1999-2000	-	-
2000-01	50	-
2001-02	179	-

K.N.K. College of Horticulture, Mandsaur

The Collge of Agriculture, Mandsaur was converted into the Kailash Nath Katju. College of Horticulture, Mandsaur on October 4, 2002. This is the only College of Horticulture in Madhya Pradesh. The College imparts education at under graduate and post graduate levels. The programmes offered in this College include B. Sc (Hort.) and M. Sc (Hort.). The total intake capacity of under graduate level is of 56 students in B. Sc. (Hort.) in each year. Masters degree programme is available in 6 departments viz., Fruit Science, Floriculture & Land Scaping, Medicinal and Aromatic Plants, Plantation & Spice Crops, Post Harvest Management and Vegetable Science. In addition to normal seats in UG and PG programmes, payment seats, NRI seats and ICAR seats are also available as per rules. As in other Colleges, good facilities of library, sports and laboratories are also available at this College.

(1) Principals/ Associate Deans/ Deans of College of Horticulture, Mandsaur

S. No.	Name	Duration		Photograph
		From	To	
1.	Dr. J. P Tiwari	October 04, 2002	August 30, 2003	
2.	Dr. P. K. Mishra	August 31, 2003	January 05, 2005	
3.	Dr. B. S. Baghel	January 06, 2005	May 04, 2005	
4.	Dr. P. K. Jain	May 05, 2005	March 03, 2006	

5.	Dr. (Smt.) S. B. Tambi	March 04, 2006	June 18, 2006	
6.	Dr. B. S. Baghel	June 19, 2006	August 20, 2012	

(2) Staff Position

Year	Professor	Associate Professor	Assistant Professor	Demonstrator (T.A.)
2002-03	-	05	09	01
2003-04	01	04	14	01
2004-05	02	10	19	01
2005-06	01	07	24	-
2006-07	01	04	25	-
2007-08	01	04	21	-

(3) Number of students admitted in the graduation and post graduation programmes and completed their degree

Year	B. Sc. (Hort.)		M. Sc. (Hort.)	
	Admitted	Pass out	Admitted	Pass out
2002-03	18	-	-	-
2003-04	52	-	-	-
2004-05	51	-	-	-
2005-06	53	14	-	-
2006-07	51	33	12	-
2007-08	56	30	17	12

(4) List of Medal/ award winner students

Year	UG	PG
2006-07	-	-
2007-08	01	-

(5) Starting of New courses/ Degree programme

S. No.	Year	Degree Programme
1.	B. Sc. (Hort.)	2002
2.	M. Sc. (Hort.)	2006

II. Infrastructure and Achievements of Research

Research Stations

There are five Zonal Agricultural Research Stations, four Regional Agricultural Research Stations and four Special Research Stations in jurisdiction of the University. Details are depicted below:

Research Stations in jurisdiction of the RVSKVV

Research Stations	No.	Location and establishement year
Zonal Agricultural Research Stations	05	Indore (1924), Sehore (1952), Khargone (1964), Morena (1981) and Jhabua (1989)
Regional Agricultural Research Stations	04	Gwalior (1916), Khandwa (1964), Mandsaur (1964) and Ujjain (1989)
Special Research Stations	04	Entkhedi (1962), Joara (1964), Bagwai (1964), and Badwah (1969)

Research Projects

Externally and state funded projects like AICRPs, Plan, Non-Plan, Tribal Sub Plan and Adhoc projects are in operation to solve location specific agricultural constraints and develop technologies for increasing the production, profitability and sustainability of cropping systems. All India Coordinated Research Projects are listed in Table no.: 1.

Table 1. All India Coordinated Research Projects

S.No.	Name of Scheme/ Project	Centre	Year of Start	Project I/C (I*)
1	AIC Cotton Improvement Project	Indore	1967	Dr. K.M. Simlote
2	AICRP on Oilseeds (Groundnut)	Khargone	1967	Sh. V.N. Khot
3	i. AIC Cotton Improvement Project (Sub Centre)	Khandwa	1967	Dr. C.N. Mahadik

S.No.	Name of Scheme/ Project	Centre	Year of Start	Project I/C (I*)
	ii. AIC Cotton Improvement Project (Main Centre)	Khandwa	1982	Dr. K.C. Mandloi
4	AICRP on Sorghum Improvement	Indore	1969	Dr. S.S. Baghel
5	AICRP on Dryland Agriculture	Indore	1969	Dr. G.P. Verma
6	i. AICRP on Soil Salinity & Water Management	Indore	1969	Dr. S.C. Jethmalani
	ii. AICRP on Management of Salt Affected Soils	Indore	2000	Dr. O. P. Sharma
7	AICRP on Cropping System & Research	Indore	1969	Dr. R.M. Dubey
8	AICRP on Sugarcane	Sehore	1970	Dr. S.R. Sharma
9	AICRP on Medicinal & Aromatic Plant (Main Centre)	Mandsaur	1978	Dr. K.B. Nigam
10	AICRP on Dryland Agriculture Research (ORP)	Indore	1980	Er. H.R. Tyagi
11	AICRP on Water Management	Morena	1981	Dr. V.S. Rajput
12	i. AICRP on Pulses	Sehore	1982	Dr. M.S. Lal
	ii. AICRP on Chickpea	Sehore	1995	Dr. S. C. Agrawal

S.No.	Name of Scheme/ Project	Centre	Year of Start	Project I/C (I*)
	iii. AICRP on Chickpea	Sehore	2001	Dr. H.S. Yadav
13	AICRP on Pigeonpea	Khargone	1982	Dr. N.S. Thakur
14	AICRP on Soybean	Sehore	1983	Sh. M. Niymatulla
15	AICRP on Pearl Millets	Gwalior	1986	Dr. G.S. Chauhan
16	AICRP on Oilseed (Safflower)	Indore	1986	Dr. S.R. Sawant
17	AICRP on Arid Legumes (Guar)	Gwalior	1987	Dr. R.B.S. Bhadoria
18	AICRP on Oilseed (Rapeseed & Mustard)	Morena	1987	Dr. S.S. Bhadoria
19	AICRP on Wheat Improvement	Gwalior	1987	Dr. G.P. Singh
20	AICRP on Weed Control	Gwalior	2000	Dr. P.C. Jain
21	AICRP on MULLaRP	Sehore	2001	Dr. K.S. Pawar
22	AICRP on Pigeonpea	Sehore	2001	Dr. A.N. Tikle

* Project Leader, who started / initiated the project for the first time

(Source: Sovenir 6th Convocation, 10 April, 2001, JNKVV, Jabalpur, M.P. and Directorate of Research Services, RVSKVV, Gwalior M.P.)

(1) Crop Improvement

(a) Cotton :

College of Agriculture, Indore received a strong base of research since its inception by transfer of breeding material of cotton from erstwhile Institute of Plant Industry established at Indore in the year 1924. The research work on cotton was strengthened at Zonal Agricultural Research Station, Khandwa and College of Agriculture Indore with All India Cotton Improvement Project in the year 1967.

National Agricultural Technology Project was started in the year 2000 to meet the needs of marginal cultivators of rainfed ecosystem vis-a vis textile industry by promoting production of high quality *G. arboreum* cotton. Characterization and identification of productive and high quality cotton species/genotypes participatory programme was also undertaken.

Research work under Technology Mission on Cotton Mini Mission-I and II was also started in the year 2000 to develop diploid and tetraploid Cotton cultivars with high fibre quality, resistance to drought and biotic stresses and Improvement in seed oil.

Table 2: Important features of Cotton varieties

Variety	Maturity (days)	Yield (q/ha)	Important features
Badnawar 1	180-240	12	Ginning 32%, fibre length 25.6 mm
Maljari	160-170	11	Ginning 36%, fibre length 19.6 mm
Khandwa 1	180-200	11	Ginning 36%, fibre length 25 mm
RB-50 (S)	160-170	9	Resistant to BLB
K 2 (MB)	160-180	10	Ginning 34% MFL 25 mm
K 2	160-170	9	Ginning 34%, MFL 24-25 mm
K 3	150-160	12	Ginning 33%, fibre length 25.6 mm
VIKRAM	150-160	10-12	Ginning 35%, MFL 25 mm

Variety	Maturity (days)	Yield (q/ha)	Important features
J Tapti	150	20-25	Ginning 35%, MFL 24 mm spinnability up to 30 counts
Sarvottam	140-150	18-20	Mean fibre length 22.0-24.0, count 25-30
JK 4	140-150	18-20	Tolerant to boll worm and jassids mean fibre length 25-26 mm, count 30-35

Resistance against stresses

- **i.** To overcome the infestation of bollworm and jassids a tolerant variety JK 4 with wider adaptability was developed.
- **ii.** Variety Khandwa 2 was identified as the important source of resistance for sucking pests with excellent combining ability.
- **iii.** The strain Sarvottam a salinity tolerant variety may intensify the cultivation of cotton in extreme grades of salinity.

Development of hybrid

- **i.** First intra hirsutum commercial hybrid JKHy-1 was developed at Khandwa.
- **ii.** Hybrid suitable for double cropping was the need of the cotton growers in Malwa region and the requirement was fulfilled by the development of extra early duration hybrid JKHy 3.

Table 3: Important features of Cotton hybrids

Hybrid	Yield potential q/ha	Mean fibre length (mm)	Counts
Intra-hirsutum Hybrids			
JKHy-1	25-30 (Irrigated) 20-25 (Rainfed)	27.0-28.0	40
	20-25 (Rainfed)		
JKHy-2	30-35 (Irrigated)	27.0	40-45
JKHy-3 (J. Akash)	30-35 (Irrigated)	25.0-27.0	40-50
JKHy 11	18-24	28.6	80-100

Fibre quality

G. arboreum

- **i.** Jawahar Tapti a high yielding a staple diploid cotton variety with 30 counts is a popular variety of Madhya Pradesh.
- **ii.** Development of variety (Jawahar Tapti, Sarvottam, KWA 23 and 24) with staple length of > 25 mm with good strength and spinnable up to 40s counts with yield levels of 25-30 q/ha.
- **iii.** Several cultures are in the pipeline with staple length ranging between 26-31 mm and strength > 24 g/tex and yields comparable to *G. hirsutum* varieties and hybrids.
- **iv.** Development of superior fine cotton to meet the need of the industry (MFL > 26.0 mm and high strength > 24.0 g/tex) along with fineness in the range of 3.8-4.5 micronaire with yields comparable to tetraploid hybrids.

G. hirsutum

- **i.** Development of MDR genotypes with high yield potential & excellent fibre properties (Length : > 27 mm, 3.8-4.5 micronaire with strength > 24.0 g/tex.)
- **ii.** Development of genotypes tolerant to sucking pests with high yield potential & excellent fibre properties (Length: > 27 mm, 3.5-4.5 micronaire with strength > 24.0 g/tex).
- **iii.** Development of genotypes with high Ginning percentage (> 40%).
- **iv.** Development of Extra Early (< 140 days) genotypes suitable for double cropping.
- **v.** Development of Erect Compact genotypes suitable for drill sowing. This will help to reorient the crop geometry.
- **vi.** **Naked seeded:** Development of Naked seeded *arboreum* genotypes (KWA N-1, 3, 4, 5, 6, 3-1) through introgressed material with high oil content (>22%). KWA N-3 and 4 have identified at national level for excellent fibre properties.
- **vii.** **Wider adaptability:** Identification of location specific genotypes for different agro-climatic situations of M. P. (Soil types and Rainfall pattern).
- **viii.** **Gene pool:** A gene pool involving *hirsutum* 60, G. arboreum 80, *G. herbaceum* 05, Wild Species 5 have been developed.
- **ix.** **Varieties identified by ICAR for fast track release:** In the *arboreum* category four (KWA-24 KWA N-3, KWA N-3, KWA-23 and KWA N-4) out of nine identified cultures by the committee comprises of the members of Cotton Advisory Board,

GOI, the Textile Commission Government of India and the Project Coordinator, AICCIP (29/04/2003) at National level were from University.

x. **Development of cytoplasmic genetic male sterility based hybrid:** It was started at College of Agriculture, Indore with the object to develop CGMS based hybrid (JICH-5 and JICH-6 are in pipeline) and to diversify the sources of R lines. An identified extra long stapled culture in converted into 'A' line at Khandwa.

xi. **Plant type:** Twenty stable cultures with zero monopodia and zero sympodia with bolls borne on the main stem have been developed. Suitable drill sowing with a population from 25000 hills per hectare to 1,00,000 hills per hectare with suitability for mechanical picking. The gene for erect compact plant type has been transferred from the wild species *G. anomalum* to CTI (hirsutum) material.

xii. **Coloured cotton:** First naturally coloured cotton *hirsutum* variety JCC1 of the country released in 1997. Fifteen stable cultures of various shades have been developed and are being maintained with twenty germplasm lines.

xiii. **Development of genotypes with high oil content:** Five selections have been made for high oil content and the generations are being advanced.

Table 4: Genetic sources available with the CoA, Indore

Source species	Trait
G. tomentosum	Fibre strength, pilosity, nectarines, source of male sterility.
G. raimondil	Fibre strength, fibre fineness and resistance to boll worms.
G. australe	Yield, high ginning & drought resistance
G. harknesii	Lustrous fibre quality
G. thurberi	Fibre strength & elongation, wilt resistance and resistance to boll worms
G. braziliense	Fineness
G. anomalum	Fibre length, fineness, yield, resistance to Jassids, boll worms & BLB
G. stocksii	Fibre strength, yield & drought resistance
G. stuartianum	Yield, Gossypol glandless seeds

Source species	Trait
Hirsutum latifolium	Acclimatized race
Hirsutum punctatum	Source for resistance to Bacterial Leaf Blight
Arboreum bangalense	Fibre quality
Arboreum indicum	Locule retention

- **Development of cytoplasmic genetic male sterility based hybrid :** It was started at College of Agriculture, Indore with the objective to develop CGMS based hybrid (JICH-5 and JICH-6 are in pipeline) and to diversify the sources of R lines. An identified extra long stapled culture is converted into 'A' line at Khandwa.
- **Plant type :** Twenty stable cultures with zero monopodia and zero sympodia with bolls borne on the main stem have been developed. Suitable drill sowing with a population from 25000 hills per hectare to 100000 hills per hectare with suitability for mechanical picking. The gene for erect compact plant type has been transferred from the wild species *G. anomalum* to CTI *(hirsutum) material.*
- **Coloured cotton :** First naturally coloured cotton *hirsutum* variety JCC 1 of the country released in 1997. Fifteen stable cultures of various shades have been developed and are being maintained with twenty germplasm lines.
- **Development of genotypes with high oil content :** Five selections have been made for high oil content and the generations are being advanced.

Significant findings of All India Cotton Improvement Project, College of Agriculture, Indore M. P.

Background information

Indore, presently the Sub-centre of All India Cotton Improvement Project (ICAR) and also the Technology Mission on Cotton (Mini Mission – MM I-1.5, MMA-1 and MM I – 2.3 & 2.2) is following the legacy or the erstwhile, Institute of Plant Industry, Indore (1924). The station most successfully functioned as the main centre of the "The Centrally Sponsored Scheme for the Production of Nucleus and Foundation Seed of Cotton". Besides these, Indore was the main centre of time bound ICMF CD & RA sponsored scheme for evolution and

development of higher medium staple varieties and hybrids of cotton (1971-1980). It was under the auspicious of this project that hybrid JKHy-1 and JKHy-11 and variety Khandwa-2 were produced. Indore yet, again, was the obvious upright choice for being the state centre of new project "Promotion of Research and Development Efforts on Hybrids in Selected Crops – Sub Project (6): Cotton".

Following significant contribution by the project (AICCIP, 2008) has been made are as under.

Plant Breeding

Table 5: Varieties and hybrids developed, released and notified

S. No.	Varieties	Pedigree	Year of release
1	Khandwa-1	(CO2 x G.tomentosa) x Indore-2	1967
2	Khandwa-2	Sel from KW-66-2096	1971
3	Vikram	Sel from IC-1036	1981
4	JK-35	CMSH6 x RCH-2	2006

Hybrids

1	JK Hy-1	K-2 (MB) x Reba –b- 50 (s)	1976
2	JkHy-11	K-2 (MB) x ERB–4492(s)	1982
3	JkHy-2	Vikram x Reba –b- 50 (s)	1997

Khandwa 2: (Selection KW-66-2096), released in 1971, a variety descendant of inter-specific G. hirsutum, widely adaptability with high ginning out turn.

JKHy -1 : (K-2 (MB) x Reba b-50(s)), released in 1976, is tolerant to jassid and bollworm complex. This hybrid is still ruling in the Cotton arena of M. P. adjoining Maharashtra and Andhra Pradesh.

JKHy – 2 : (Vikram x Reba b-50(s)), released in 1997, is tolerant to bollworm complex and JKHy-11: (K-2 (MB) x ERB-4492(s)) was released in 1982.

Vikram: (Sel IC-1036), released in 1981, an American cotton variety was developed for its fair degree of tolerance to boll worm, balanced properties of fibre and early yielding attributes suitable for double cropping.

Variety Jawahar Kapas-35 (CMSH 6 x RCH-2) is an American strain developed through crossing of two CMS F_1. Early tolerance to sucking

pest as well as to bollworms with high yield potential (18-20 q/ha) under rainfed condition occupying approx. 2000 hectare in Malwa and adjointing Nimar area of M. P. This variety released in 2006 by state varietal release committe.

Various other promising genotypes like IH-63 (MR), (MECH1 x RCH2) are also American strains which ranked III in central zone and II in south zone during 2000 and retained during 2003-04 & 2004-05 in central zone trials.

IH-06, IH-07 & IH-08 were also included in national trial from 2005-06.

IH-09 has been included in National AICCIP trial during 2006-07.

Work on hybrid production through CMS lines has again been intiated and the JICH-8 (CMS VIK x MR 29-4-1-1) a new intra hirsutum CMS hybrid was included in national trial during 2005. But due to lack of good performance further promotion could not be done.

Twenty CMS A-line are been maintained by their isogenic B-line (Maintainers) with specific markers. It is mainly of harknessii blood. Four fertility restrores are identified and maintained.

Eleven cytotypes of different combinations are being maintained with particular objectives concerning drought resistant and tolerance to different sucking pest as well as bollworms.

Double cross materials- The linkage between restoration of fertility in CMS lines and serious sucking pest susceptibility broken by adopting double cross technique. New restrorers thus indigenously developed utilized for developing new improved cent per cent restorating male (MR-29-4-4-1 (s), 3 Petal Spot Absent (PSA), Simultaneously purification work of double cross restorers (37) with PSA and Petal Spot Present (PSP) is under progress. Twenty secondary selections and (20) retentions are also maintained. Similarly 13 F^3 s of DCR lines and 46 SPS lines are also being maintained).

Maljari

Khandwa-2

Vikram

JK-35

JKH-1

JKH-2

(ii) **Varieties tested and recommended for cultivation**

The varieties Khandwa -2, Vikram and JK-35 are recommended for cultivation. While hybrid JK Hy-1 was the preferable choice of the farmers across the country, under rainfed system, before introduction of Bt cotton.

Impact of material/ Technologies developed by the centre:

varieties/hybrids		
 JK 35  IH 67	Jawahar Tapti Khandwa-2	A desi cotton variety suitable for Jhabua region. American (*Hirsutum*) cotton variety very suitable with IPM technologies.
	Vikram	An American cotton variety suitable for spend-end modern spinning.
	JK-35	A new American cotton early variety that is suitable for double cropping, tolerance to sucking pests as well as bollworm complex.
	IH-67 (MR)	An American cotton variety retained for testing in South & A Central Zone.
	Hybrid JK Hy-1	A hybrid that is still ruling the state as well as adjoining states.

	Hybrid JK Hy-2	A hybrid tolerant to boll worms suitable for blending.
	Hybrid JICH-5	A new CMS hybrid, tolerant to sucking pest suitable for cost reduction of hybrid seed.
(B) Seed processing	Delinting	Improvement in germination to the higher levels merely @ Rs.20/- per ha.
	Seed Treatment	Biofertilizers, Azotobacter, Azospirillum @ Rs.10/- per ha to rationalize chemical fertilizer use reduction by about 20%.
(C) Intercropping	Cotton+ Urd or Soybean	Cotton(vikram)+Urd,and Cotton(vikram) + Soybean (1:3 ratio) was found suitable & recommended
(D) Biomulching	Dhaincha	Dhaincha as suitable biomulch, sown between rows of cotton and its soil incorporation at 25-30 DAS and lopping up in 45 DAS benefits in sustaining soil health besides better & eco-friendly yield.
(E) Seed dressing by pesticide	NTN (Imidachloprid)	Saves at least three early season sprays against Jassid thereby saving nearly 1000/- Besides sustaining environment (Part of IPM technology)
(F) IPM	Complete module	Follow-up of the various attempts in this technology, rigorously and continuously over years on a large village level scale can reduce pesticides use by 20-25%.

AIC Cotton Improvement Project, Khandwa Centre (AICCIP, 2008)

The research work on cotton was strengthened at Zonal Agriculture Research Station, Khandwa and College of Agriculture, Indore with All India Coordinated Cotton Improvement project in the year 1967.

- Cotton varieties with promising features like Badnawar 1, Maljari, Khandwa 1, RB – 50(S), K 2 (MB), K 2, K 3, Vikram, J Tapti, Sarvottam, JK 4 were developed by centre.

- To overcome the infestation of bollworm and jassids a tolerant variety JK 4 with wider adaptability was developed.
- Variety Khandwa 2 was identified as the important source of resistance for sucking pests with excellent combining ability.
- The strain Sarvottam a salinity tolerant variety may intensify the cultivation of cotton in excellent grades of salinity.
- First intra hirsutum commercial hybrid JK Hy – 1 was developed of Khandwa
- First naturally colored cotton hirsutum variety JCC 1 of the country released in 1997.
- The first variety Majri was evolved in 1954 but it was highly tolerant to sucking pests. JK Hy 1 was the first cotton hybrid of Madhya Pradesh released in 1976 which became popular due to its high yield and resistance to pests.

Jawahar - Tapti

Khandwa 2 - Hirsutum

JKHy 2 – Hybrid

KH-11

Recent Achievements

- Variety Jawahar Kapas – 35 (CMSH 6 X RCH-2) released in 2006, early and tolerance to sucking pest as well as to bollworms with high yield potential (18-20 q/ha) under rainfed condition in Malwa and adjoining Nimar area of Madhya Pradesh.
- IH-63, A variety performing well in adoptive trial and further improvement are being taken.
- Twelve cyto types with one reduced stamina column are being maintained for resistant breeding along with twelve new advance lines.
- 21 CMS A lines are being maintained with isogenic maintainer B lines along with 4 fertility restores.
- Application of 75% RDF + 5 t FYM/ha + seed treatment and soil application with PSB gave 20% higher yield over 100% RDF in irrigated condition.
- The foliar application of various micronutrients except Boron 0.1% spraying gave on an average 1.62 q to 2.33 q/ha more yield over control. However, the spraying of 1.0% $MgSO_4$ was recorded slightly letter as compared to all other treatments.
- Dhaincha/ sunhemp/ green gram planted between cotton rows as live mulch and incorporated in the soil after 30 to 35 DAS fairly indicated slight increase in organic carbon % and available NPK.
- The soybean as an intercrop with Bt. Cotton was recorded higher CEY (2420 kg/ha) & found more remunerative with the net return of Rs. 50960/ha and B:C ratio of 4.05 and it was closely followed by Bt. Cotton + Green gram and Bt. Cotton + Urid intercropping system respectively.
- The Bt. Cotton – Okra cropping system recorded consistently higher mean values of crop equivalent yield (12.80 t/ha), net return (Rs. 228634), land use efficiency (85.45%) as well as production use efficiency (40.75 kg/ha/day) and this was closely followed by Bt. Cotton cowpea cropping systems.

All India Co-ordinated Cotton Improvement Project, Morena

The Project was started at the then government Agriculture Farm, Morena on 1 May, 1972 with the following aims:-

- To breed and evolve suitable long staple varieties, capable of giving all picking by the end of November
- To carry out agronomic research to evolve suitable production parameter and to explore the yield potential of newly improved strains.

During 1972-83 (AICCIP, 1983):

The highlights of this project from 1972-1983 are as follows-

- Planting cotton in the first week of May increased seed cotton yield by 15% and 36% over planting in 3rd week of May and 1st week of June respectively.
- Spacing of 60 X 30 cms and a fertilizers dose of 80:40:40 kg/ha of N:P:K: respectively, has given relatively higher yields.
- Paired row planting of cotton is but as compared to solid planting & skip row planting methods.
- Diuron is one of the effective herbicide to maintain the weed density in cotton. Weeds were effectively cotrolled by pre + post emergence application of Diuron @ 0.5 to 0.75 kg/ha.
- The economy in the use of nitrogenous fertilizers could not be obtained with the application of Azotobacter, irrespective of rate, stage of method.
- Under zinc deficient soils, application of zinc sulphate @ 50 kg/ha helped to improve the seed cotton yield by 34%
- Production potential trial results revealed that fertilizer application and plant protection are key factors for improving the productivity of cotton by 46% and 11% respectively
- Methods of irrigation (Flood, furrow, alternate furrow) do not affect the cotton yield significantly.
- Intercropping of cowpea (fodder) and blackgram in paired row planting of cotton helped to improve total monetary returns over no intercropping.
- Variety Bikaneri Narma has proved to be a promising variety in coordinated trails, in details demonstration plot and in adaptive trails on cultivators fields of Chambal Command Area.

During 1985-86 (AICCIP, 1986):

- Out of 12 entries tested the maximum yield was recorded in entry no. CPH 1851 (1802 kg/ha) followed by CPH – 1853 (1652 kg/ha) which were higher than Bikaneri Narma (1338 kg/ha). The ginning out turn (GOT) was also maximum in CPH 1851 (35%).

  The GOT % was 34.8 in entry no. 1853 & fibre length 23.9 mm respectively were recorded in entry no. CPH 1853 as compared to BN which recorded fibre length 22.1 and GOT 33.3%
- Research also showed that date of sowing and nitrogen doses influenced the seed cotton yield significantly. Nitrogen doses

applied @ 60 kg and 120 kg/ha gave the significantly higher yield (752 and 810 kg/ha) than control (557 kg/ha).

- Recommended schedule of Plant protection measures recorded significantly more yield (727 kg/ha) over control (588 kg/ha).
- All the entries tested were found resistant to modulate resistant to bacterial blight except entry no. CPH 1853.
- All the entries tested were found moderately resistant to alternaria blight except entry no. CPH 1854.
- Baristin (0.2%), Dethane M – 45 (0.2%), Dithane Z – 78(0.2%), topsin M – 70 (0.2%) and Derosol (0.05%) were found significantly effective in reducing the incidence of alternaria blight.

During 1986-87 (AICCIP, 1987):

- Entry no. CPH 2032 & 2034 recorded significantly higher yield with 2444 kg/ha and 2362 kg/ha respectively the got % and fibre length of CPH 2032 was 35% and 26.6 mm where as that CPH 2034 was 34.3% and 25.1 mm.
- All the entries tested were found either resistant or moderately resistant to Bacterial blight and resistant to alternaria leaf spot under natural conditions.

(b) Chickpea (Gram) :

Systematic research work on chickpea improvement was started after establishment of All India Coordinated pulses improvement project in 1968 at Jabalpur in Madhya Pradesh, where it remained functioning up to May 1982, later on it was shifted to RAK College of Agriculture, Sehore (AICRPC, 2008) on the recommendation of ICAR expert committee. After trifurcating of project in 1995 this centre is working as main centre of AICRP on chickpea which was further strengthen with a sub centre at Jabalpur in IX plan wef. April 2001.

In the beginning, the major emphasis was on the collection of local land races and their evaluation for immediate use as potential varieties or donors for breeding programs late on it was realized that most of the recommended chickpea varieties suffered due to occurrence of wilt and root rot disease and moisture stress at seed filling stage of the crop hence emphasis was given on the development of early maturing high yielding bold seeded, with multiple disease resistant against major soil borne disease and tolerance to environment stresses like early and terminal drought and high temperature. The improvement work is concentrated on three types of chickpea viz., desi, gulabi and kabuli as these are being cultivated in state with pre-dominance of desi types.

Genetic enhancement in seed yield

The genetic potential of chickpea varieties developed and released before 1970 i.e. Ujjain 21, Ujjain 24 and Gwalior 2 was on an average 1100 kg/ha has been raised to a level of 1800-2000 kg/ha in JG 130 and JG 16 with the incorporation of resistance against *Fusarium* wilt, M R to dry root rot and collar rot, tolerance to Helicoverpa with good nodulation ability, the then 2000-2500 kg/ha in recently released variety JG 63 a multiple disease resistant variety.

Genetic enhancement in resistance against biotic stresses :

(i) Development of variety JG 315, (release 1981) played a major role in foundation of commercial cultivation in central zone with ability to perform in wide range of environment. It is resistant to race 1 and 4 and widely used as donor for resistant to wilt throughout the world.

(ii) JG 62 is highly susceptible to Fusarium wilt but is resistant to race 0 in Spain. Ability of recently release disease resistant varieties viz., JG 11, JG 130, JG 16, JGKI, JG 63 perform well in continuous cropping sequence of soybean chickpea is due to multiple disease resistance.

(iii) JG 74 wilt resistant variety released in 1983 is best for late planting after paddy crop.

Genetic advancement for tolerance to drought

To overcome early and terminal drought, maturity duration has been reduced from 140 days (JG 5) to 112 days (JG 16) 110 days JG 130, JG K1, JG 63,97 days (JG 11). 90 days (MPJG K3) with yield advancement. JG 74 has ability to tolerate draught due to its faster deep root system JG 130 produces more filled pods even in moisture stressed environment. The efforts are also in way to transfer droughts and temperature tolerance in high yielding chickpea genotypes.

Genetic advancement for sequential cropping system

Development of an extra early (100 days) variety TG 412 (2004), good for perching and suitable under soybean potato, chickpea sequential cropping system will be boon for farmers of Malwa plateau. Genetics advancement in nodulating ability after successful identification of high and low nodulating lines from composite seed sample of JG 74, attempts were made to develop high nodulating and yielding varieties of chickpea. JG 130 developed from a three way cross possess high nodulating ability with higher yield.

Genetic advancement in new compact, lodging resistant plant type

A lodging resistant, compact erect, short internode with sturdy stem a new plant type JG-99-14-12-5 has been developed by a three way cross of JGM-1 x (ICC 4929 x ICC 4958) where JG M-1 a mutant of JG 315 with short internode ICC 4929 double podded white flowered and ICC 4958 a drought tolerant parent. It is an early maturing (90-100 days) lodging resistant, double podded short internode, compact, erect growth habit having dark green overlapped large leaflet with waxy appearance persists up to maturity. It has 2-3 primary and 5-6 secondary with bold seed (28-30 g/100 seed weight). Beside lodging resistant this new genotypes could offer a best opportunity in drought prone areas.

Genetic advancement in Gulabi Chickpea

White flowered, pink seeded gulabi chickpea mainly used for parching in grown in restricted parts of Madhya Pradesh. JG 5 first gulabi variety released in 1979 has been replaced by JGG 1 (1999) which is wilt resistant and matures in 120-125 days as compared to previous variety (140 days).

Genetic improvement in Kabuli Chickpea

The demand of kabuli chickpea is increasing day by day due to its high market price. Earlier recommended varieties viz., L 550 and ICCV 2 are medium seeded and low yield. Recently recommended variety KAK 2 fulfils the goal of bold seeded having high yield which farmers are demanding, JGK 1 and early maturing, bold seeded first kabuli variety has been released for cultivation in CZ, MPJG-K3 an early maturing multiple disease resistant variety is under process of release for the state.

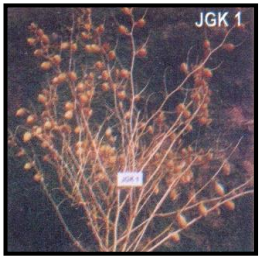
Number of selections and advanced breeding generation which are early bold seeded (> 45g/100 seed) high yielding, multiple disease resistance are also in advance stage of evaluation in coordinated trials and at the final stage of selection to meet the demand of farmers.

Table 6: A journey of Chickpea varieties developed and released for Madhya Pradesh

Period	Varieties developed & released	Target of genetic advancement
Before 1956	Indore 22, Gwalior 2, Pink 2, A-1-8, Ujjain 21 and Ujjain 24	Local adaptability
1960's	-	Recognization & strengthening in Research.
1970's	JG 62, Ujjain 21, Ujjain 24 & JG 1	High yield (1000-1200 kg/ha)
1980's	JG 221, JG 5, JG 315 and JG 74	High yield (1300-1500 kg/ha) & resistance against wilt.
1990's	JG 218, JG 11, JG 322 & JGG 1	Early maturing, bold seeds, high yield (1500-1800 kg/ha) & wilt resistance
2000's	JG 16, JG 130, JG 63, JAK1 9218, JGK 1, JGK 2, JGK 3 and JG 6	Early maturing, bold to extra bold seeds, high yielding (1800-2000 kg/ha) and multiple resistance against fusarium wilt, dry root, collar rot, stunt & drought

JGG-1

JG-130



JGK-1

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme (AICAES, 1971)

Varieties: Gram varieties T 1, G. 2, T. 87, Ujjain 21, Ujjain Green-22, Ujjain Pink-2, Ujjain-24 and Local have been tried for five years at Baroda and Bhind and for six years at Jora.

On an average of five years data at Baroda variety Ujjain-24 gave the highest yield of 1103 kg/ha followed by Local (1058 kg/ha), T. 87 (1039 kg/ha), G. 2 (1029 kg/ha) and T. 1 (1012 kg/ha).

At Jora, the average of six years data indicate that variety G. 2 gave the highest yield of 1435 kg/ha followed by local, T. 87, Ujjain-24 and Ujjain 21.

At Bhind on an average of five years data, local variety gave the highest yield of 1740 kg/ha followed by Ujjain-24, Gwalior-2, T. 8 and Ujjain-21.

Promising three gram varieties i.e. P. 87, Ujjain-24 and G. 2 were again tried in a manurial experiment at Baroda, Jora and Bhind for two years i.e. 1966-68.

Although the differences were not very significant, but variety T. 87 at Baroda, G. 2 and Ujjain-24 at Jora and Ujjain-24 at Bhind were found promising.

During this 1971-72 Rabi season one gram varietal trial was conducted at Chhimka (Bhind). This trial included variety C. 62-404 of West Nimar which is double podded and erect plant type.

In this trial varieties T. 87 and G. 62-404 were found superior to G. 2 and T. 1 varieties.

Three varieties T. 87, G. 2 and G. 62-404 may be taken for general cultivation with advantage.

Fertilizer: Good response to increasing dose of Nitrogen and Phosphate was noticed at Baroda. However, very slight response to the increasing dose of Nitrogen and Phosphate was noticed at Jora. At Bhind there was response to the increasing dose of nitrogen but in the case of phosphates the results were reverse.

(c) Clusterbean (Guar) :

AICRP on Arid Legumes Clusterbean (Guar) was started in April 1987 at CoA, Gwalior, (M.P.). Significant achievements (AICRPAL, 2008) are listed below:

i. Under rainfed situation, variety RGC-936 and Naveen (branched type) proved better under agro- climatic condition of Gird region.
ii. Varieties 5863 selected and developed from local material, had high percentage of gum and possess better yielding capacity.
iii. For effective control of weeds in guar, application of Fluchloralin@1.5 kg a. i. /ha is recommended.
iv. The critical period of weed crop competition in guar is first 15 to 30 days after sowing.
v. First week of July is most appropriate date for guar sowing.
vi. Unbranched and branched variety of guar should be shown at 30 and 45 cm of row spacing respectively.
vii. Under agro-climatic condition of Northern M.P. balanced use of fertilizer viz., 20: 40:20 N:P:K kg/ ha should be adopted.
viii. Among various cropping system, guar with pearl millet at the ratio 3:1 is found most economical.
ix. Wheat crop should be grown after guar crop for the saving of 30 kg nitrogen per hectare.
x. Application of 40 kg S along with 60 kg P_2O_5/ha should be done for getting higher yield of guar under Northern M.P. conditions.
xi. In Guar +Bajra inter–cropping system, interculture after 30 DAS gave effective weed control and increased yield.
xii. Experiment of cropping system with Guar-Wheat crop sequences revealed that 75 per cent recommended fertilizer application was most remunerative and there was a saving of fertilizer of 26 kg P_2O_5 in Guar and 30 Kg nitrogen in Wheat per hectare.
xiii. The effect of varieties spacing and fertilizer experiment showed that among the different cowpea varieties GC-3 was superior to all other varieties.
xiv. A row spacing of 45 cm is better over 30 cm spacing. Among the fertilizer doses, the recommended dose proved superiority.
xv. On the basis of three years result it has been concluded that the application of 60 kg P_2O_5 / ha+ 10 tonnes F.Y.M./ha with Rhizobium gave maximum net return of 31,087 with B:C Ratio 4.56 of guar crop.
xvi. Thio urea spray at vegetative and at flowering stage with seed soaking gave maximum net return Rs.10, 506 with B: C Ration of 2.40 of Cowpea.

xvii. On the basis of study made of long term cropping system in five years, the best crop system is GUAR-GUAR, which gave Rs.17445 net income, and BCR 4.01 followed by Bajra-Guar with Rs.14165 as net income and 3.18 BCR.

xviii. On the basis of two years the variety HG-563 gave the highest yield. As regard the fertility level the higher yield under wider row spacing (45cm) was obtained over closer spacing.

xix. On the basis of three years mean, the maximum grain yield of Clusterbean, net profit and benefit cost ratio was recorded with S2L4 (50% S as gypsum+50% S elemental sulphur) and next in order was S1L4.

xx. In Moth-Bajra intercropping system to obtain higher returns per unit area of land, sole moth gave highest Bajra equivalent yield.

xxi. To obtain higher seed yield of Moth bean, it should be sown first fortnight of July using 15 kg/ha seed at a row distance of 30cm in Gird region of M.P.

(d) Barley :

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme (AICAES, 1971)

Varieties: In the preliminary trials barley varieties K. 14, K. 19 and C. 84 were identified. Therefore one varietal cum manurial cum irrigational experiment was conducted for three year (1968-69 to 1970-71) at Baroda, Jora and Bhind.

At Baroda, during all the three years variety K. 19 was found to be the best (Average yield 2441 kg/ha).

At Jora on an average of three years variety C. 84 was found to be superior to the rest of the varieties.

Similar to Jora, at Bhind also variety C. 84 was found to be the highest yielder.

This year some new barley varieties viz. Russian Barley, B.G. 2 Coletsia C. 164, K 572/10, K 572/11 and Rs. 6 have been tried in observational trial at Jora.

Fertilizers: Fertilizer doses tried for three years show that increasing dose nitrogen increased the yield at all the three centres i.e. Baroda, Jora and Bhind.

Uniform basal dose of 40 kg P_2O_5 + 20 kg K_2O/ha was given in the above trial.

Irrigation: One to three irrigations have been tried for three years at Baroda, Jora and Bhind. At Baroda and Bhind, increasing number of irrigation has increased the yield of barley. At Jora due to winter rains during last two seasons, response to increasing number of irrigation beyond two was not found.

At Baroda, highest yield of 3763 kg/ha was given by variety Ballia with three irrigations and 90 Kg N + 40 Kg P_2O_5 + 20 kg K_2O/ha.

At Jora, average yield of 3339 kg per hectare was given by variety K 19 with two irrigations and 90 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha.

At Bhind, highest yield of 3080 kg/ha was given by variety C. 84 with three irrigations and 90 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha.

(e) Groundnut :

AICRP on Groundnut was started in 1965 at Zonal Agricultural Research Station, Khargone, M.P. (AICRPG, 2008)

Varieties released: JGN-3 (Released in 1997) &

JGN-23 (Released in 2008)

i. Released for cultivation in whole Madhya Pradesh
ii. Both the varieties yield up to 1850 Kg/ha and mature in 105 days, tolerant to drought and sucking pest
iii. These varieties can bear drought up to some extent
iv. Tolerant to sucking pests

JGN-3

JGN-23

Recommendations- Production technology:

(i) Application of 20:80:20 kg of NPK /ha has been found suitable for optimization of yield of Groundnut. The dose of phosphorus may be reduced to 60 kg/ha in soils which are reported for better status of this element .

(ii) The recommended dose [i.e. 20:80:20: kg of NPK/ha] may be reduced to half by using 5 to 10 tons of FYM/ha, which also gives 49% higher yield of dry pods as compared to control.

(iii) In addition to above, the application of Gypsum @ 500 kg/ha and other micro-nutrients i.e. Iron, Zinc and Boron @ 10 kg, 5 kg & 1kg/ha respectively further improves pod yield by 10-15 %.

(iv) Application of RDF (20:80:20 kg NPK /ha) with 75% plant density of groundnut was found superior over 50% of RDF with 100% of plant density. The yield level obtained was 1302 kg/ha with net return of 17877 Rs /ha and BCR of 3.517.

(v) The 30% dose of Nitrogen may be saved in wheat crop of Rabi, when it is sown after well fertilized (20:80:20 kg/ha) crop of groundnut.

(vi) When maize is intercropped with groundnut in the ratio 3:1, the application of recommended dose of maize will save 50% dose of nitrogen for groundnut crop. The row ratio 3:1 has been found

superior over row ratio 2:1 and sole crops in terms of yield and net profit.

(vii) Application of Metolachlor @ 1 kg a. i. /ha as Pre-emergence treatment followed by 2 inter culture operations at 30 & 45 DAS gave 26% & 62% higher yield respectively in compassion to farmers practices & un-weeded control.

(viii) Crop yield increased by 30% under improved practices over farmer practice.

(ix) Placement of fertilizer in furrow gave significantly superior yield over broadcasting method.

(x) Pre-emergence application of pendimethalin + HW at 30 DAS + intercultivation at 30 & 45 DAS recorded the highest pod yield (1002 kg/ha) which was significantly superior to unwedded check and farmers practice.

(xi) Groundnut + pigeonpea (3:1) intercropping system proved remunerative (net return Rs. 3794/ha) over sole crop and other intercropping systems.

(xii) Groundnut + pigeonpea (3:1) intercropping system produced maximum groundnut equivalent yield with 100% recommended dose of fertilizer and 50% plant density of groundnut with 30 cm plant spacing in pigeonpea.

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme (AICAES, 1971)

Varieties: Groundnut varieties R. 4, E.C. 1704, Gangapuri and A.K. 12-24 have tested for 5 years from 1963-64 at Bhind and Baroda and six years at Jora. At Bhind and Baroda, Variety A.K. 12-24 was found to be the best, while at Jora, variety E.C. 1704 gave the highest yield followed by A.K. 12-24.

For the year 1969-70 new promising varieties have been tested at Jora and the same varieties have also been tried last year at baroda and Bhind.

At Baroda highest average yield of 957 kg/ha was given by variety Exotic 1-1 and T.M.V.-2 followed by A.K. 12-24(8) kg/ha.

At Jora highest average yield of 1875 kg/ha was given by variety S.B. XI followed by Jyoti (1809 kg/ha) and A.K. 12-24 (1751 kg/ha).

Similar to Jora at Bhind highest yield (1467 kg/ha) was given by the variety S.B. XI followed by Jyoti. (2435 kg/ha), Exotic 1-1 (2369 kg/ha) and A.K. 12-24 (2349 kg/ha).

Fertilizer: Nitrogen and phosphate at 0 and 20 kg/ha level have been tried for 5-6 years in the first trial on four groundnut varieties i.e. A.K. 12-24, E.C. 1704, R 4 and Gangapuri.

Application 10 kg N/ha has given slight response at Baroda and Jora while good response has been noted at Bhind. Application of 10 kg. P_2O_5/ha has given good response at Baroda and Bhind while there was no response found at Jora.

Foliar application of Phosphate: In an observational non replicated trial at Jora although the yield obtained was very poor due to adverse weather condition, there was response to the foliar application of phosphorus.

(f) Maize :

The All India Coordinated Maize Improvement Research Project was incepted in the year 1960 at ZARS, Chhindwara. On the recommendation of ICAR review committee, the project was shifted to Mandsaur in 1982 and again back to Chhindwara in year 1987.

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme (AICAES, 1971)

At Jora during the year 1969-70 and 1970-71 some composite maize varieties were tried. During 1969-70 highest yield of 2907 kg/ha was given by variety Ganga Safed-2 followed by Deccan (2266 kg/ha).

During the year 1970-71 highest yield of 4343 kg/ha was given by variety composite H-1 which was followed by Deccan.

On the average of two years highest yield of 4278 kg/ha was given by variety H-1 which was followed by H. 74.

Uniform basal dose of 150 kg N + 50 kg P_2O_5 + 35 kg K_2O/ha was applied.

Fertilizers: Prior to testing these varieties existing varieties i.e. Ganga 101 at Baroda and Jora and Ambar at Bhind were taken for formulating fertilizer recommendations. The trial was conducted during 1968-69 at Baroda and Jora and during 1969-70 and during 1970-71 at Bhind.

At Baroda increasing dose of N.P. & K. increased the yield but the increase was not significant.

At Jora N at 120 kg/ha showed a great response but at 90 kg/ha there was no response. In case of Phosphate, response upto 60 kg/ha was observed, beyond this there was reduction in yield. There was detrimental effect of applying potash above 20 kg/ha dose.

At Bhind, on average of two years data, increasing dose of nitrogen was found to increase the yield. Doses of Phosphate and Potash beyond 40 kg per hectare did not give any response.

If we consider the yield data of Bhind separately for two years, it is noted that increasing dose of nitrogen increased the yield.

In the case of Phosphate, there was response upto 40 kg/ha in the first year while the response increased with the increase in the dose in the second year.

In the case of Potash also positively response upto a dose of 40 kg K_2O/ha was observed in the first year while in the next year the response was increased upto 60 kg K_2O/ha.

At Baroda highest yield of only 593 kg/ha was obtained with 120 kg N + 60 kg K_2O/ha.

At Jora highest yield of 2209 kg/ha was obtained with N 120 + P 60 + K 40 kg/ha.

At Bhind on average of two years data highest yield 2123 kg/ha was obtained with N 120 + P 80 + K 60 kg/ha.

(g) Pearl millet :

All India Coordinated Pearl Millet Improvement Project was started in 1963 at College of Agriculture, Gwalior to strengthen the on going research of state plan on millets. In the beginning the work on identification of Pearl millet varieties started for the state of Madhya Pradesh then Vijai Composite, WCC75 were identified in the period of 1980-1990. Hybrid MH 179, MBH 110 were recommended during 1990-95 (AICRPPM, 2008).

JBH-1 a first top cross hybrid recommended by the state of Madhya Pradesh in 1996. **JBH-2** Hybrid proposed for the B Zone of the country during 1997.Population **GB-1** used for state check trials during1997-99.

The following varieties were developed by College of Agriculture, Gwalior.

a. Jawahar Bajra Hybrid-I (JBH-1): Top cross hybrid released in 1996 by Govt of M.P. in collaboration with ICRISAT.

b. Jawahar Bajra Hybrid-2 (JBH-2) Hybrid identified by AICPMIP Workshop in 1998 for "B" Zone in Collaboration with ICRISAT.

c. Jawahar Bajra variety-2 (JBV-2) OPV notified by Govt. of India S. 0425(E) date 08.06.1999 (C.R.) in Collaboration with ICRISAT.

d. Jawahar Bajra variety-3 (JBV-3) OPV (MP 363) notified by Govt. of India S. 092(E) date 02.02.2001 in Collaboration with ICRISAT.

e. JBV-4 (OPV) Variety was released in SVRC in 10th plan.

The one of the parents of JBH-1 and JBH-2 became susceptible for downey mildew & smut diseases, hence their hybrid seed production did not continue, At present. JBV-2, JBV-3 and JBV-4 are still in the seed production chain. The JBV-2 and JBV-3 are being used as national check in AICPMIP Programe till to date.

JBV-2

JBV-3

JBV-4

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme (AICAES, 1971)

In an observational trial, performance of H.B. 1, H.B. 4 have been tested against local control, for two years i.e. from 1969-70 to 1970-71 at Bhind.

During both the years, variety H.B. 4 has been found to be highest yielder of course, local control was the lowest yielder.

To finalize manorial and cultural practices for the Hybrid Bajra variety H.B. 1 investigations were under taken at Jora during the year 1967-68.

Increasing dose of nitrogen increased the yield significantly but there was negative response to the application of phosphate and potash. Row spacing of 30 cm gave significantly higher yield over 45 cm spacing.

At Jora increasing dose of Nitrogen from 40 to 60 kg/ha increased the yield, beyond this level, there was no response. Again there was no

response to the increasing dose of phosphate and potash. Highest yield of 3163 kg/ha was obtained with 60 kg N + 20 kg P_2O_5 + 40 kg K_2O/ha.

At Bhind on an average of three years data, it was evident that increasing dose of nitrogen increased the yield. Similar positive response was observed in the case of Phosphate doses. Excepting in the year 1970-71, enhancing dose of Potash from 20 to 30 and from 30 to 40 kg/ha decreased the yield. Highest yield of 2600 kg/ha was obtained with 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha.

(h) Pigeon pea (Arhar) :

AICRP on Pigeon pea was started in October 1982 at Zonal Agricultural Research Station, Khargone (AICRPP, 2008).

Varieties released: JKM 189

- Pigeonpea Variety JKM 189 has been released in M.P. for cultivation during the year 2006 by state variety release committee.
- The variety is resistant against *Fusarium* Wilt, *Phytophthora* blight under medium & high pressure.
- JKM 189 is distinctly superior for grain yield in both rain-fed 2100 Kg /ha & irrigated 3200 kg/ha conditions to those of released varieties BDN 2 and ICPL 8863 by 16.2 & 9.4 % respectively.
- JKM 189 intercropped with Groundnut / soybean with 2 row Pigeonpea + 4 rows intercrop at 30 cm spacing gave highest PEY (2532 kg/ha) over locations in central zone.
- Genotype JKM-189 was found to be most promising and tolerant to pod borer complex in the CZ and SZ.
- JKM 189 + soybean recorded significantly higher yield 2119 kg/ha compared to JKM 7 + soybean [1690 kg/ha] and TJT 501+ soybean 1598 kg/ha. JKM 189 recorded higher grain yield in sole cropping 1172 kg/ha.
- JKM 189 recorded significant higher grain yield 1099.0 kg/ha followed by TJT 501 1081.8 kg/ha over Asha 1023.3 kg/ha. Closer row spacing of 60 cm produced significant higher grain yield 1127.2 kg/ha over wider row spacing of 90 cm. Among intercrop, soybean produced highest significant Pigeonpea grain equivalent yield compared to Maize intercrop in Pigeonpea.

- Pigeonpea intercropped with maize + recommended dose of Fertilizer and 5 t per ha FYM + PSB (5 g/kg seed treatment) +RDF (NPK 20:60:20 kg/ha) showed significantly high yield [1576kg /ha] followed by Pigeonpea intercropped with mungbean + recommended dose of Fertilizer and 5 t per ha FYM + PSB over pigeonpea intercropped with mungbean + recommended dose of Fertilizer.
- RDF 100 % produced significantly high yield of Pigeon pea (1029.3kg/ha) compared to 50% RDF (909.4 kg/ha). Among bio-fertilizer, Rhizobium + PSB + PGPR (5 g/kg seed treatment) gave significantly higher grain yield (1044.7 kg/ha) but at par with Rhizobium + PSB (992.5 kg/ha) compared to control. Application of FYM 5 t / ha showed significant increase in grain yield over without FYM.
- Response of the Rhizobium strains @ 5 g/kg seed treatment in pigeonpea revealed that Rhizobium strains Viz., RA-43, GRR 3-6,RGR 3-8, CPR 9 and Jawahar (Local best) were significantly superior over un-inoculated control with respect to nodule number as well as grain yield of pigeonpea. These strains were found to produce yield of pigeonpea equivalent to the application of 20 kg N/ ha. These result indicated that these Rhizobium strains (RA-43, GRR 3-6, RGR 3-8, CPR-9 and Jawahar) having potential of saving at least 20 kg.

Recommendations :

1. JKM 189 variety has been recommended for intercropping with soybean in central and south zone of India.

2. 60 cm row spacing has been recommended for Pigeon pea cultivation for intercropping system in central and south zone of India.

3. 5 t FYM, 5 g/kg seed treatment with Rhizobium, PSB and PGPR and RDF (NPK 20:60:20 kg/ha) has been recommended for Pigeon pea cultivation in MP.

4. Rhizobium strains viz., RA-43, GRR 3-6, RGR 3-8, CPR 9 and Jawahar (Local best) @ (5 g/kg seed treatment) has been recommended for optimization of pigeon pea productivity.

(i) Rapeseed – Mustard :

AICRP on Rapeseed and Mustard was started on April 01, 1987 at ZARS, Morena (AICRPRM, 2008).

Table 7: Mustard/ Toria Varieties developed and released for different farming/ cropping systems

Group	Year	Elite character
JT-1 (JMT-689)	1996	Early (85-90 days), high seed yield (15-18 q/ha), bold seed size, early duration.
JM-1 (JMMWR-93-39)	1999	Early (125-130 days), high seed yield (15-20 q/ha), resistant donors to white rust under different genetic back grounds. Having high oil content (> 40%)
JM-2 (JMWR-941-1-2)	2003-04	Medium early (135-138 days), high seed yield (15-25 q/ha), resistant to white rust, bold seed size & high oil content (> 40%)
JM-3 (JMM-915)	2003-04	Medium early (130-132 days), high seed yield (15-25 q/ha), tolerant to alternaria blight, bold seed size, high oil content.
JM-4 (JMM-991)	2007-08	Medium early (125-135 days), high seed yield (16-25 q/h), tolerant to alternaria blight, drought conditions, suitable for rainfed % irrigated condition, having high oil content (41-43%).

JM-1

JM-2

JM-3

JM-4

Significant Achievements of AICRP on Rapeseed and Mustard, ZARS, Morena.

Crops and cropping pattern (Emphasis of shift in cropping pattern)

Cropping pattern	
Irrigated	**Rain fed**
(A) Cropping sequence • Soybean / Fallow/ Urid /Mung-Mustard • Pearl millet-Mustard • Toria - wheat	• Fallow-toria • Fallow-Mustard
(B) Inter Cropping :- • Toria + Gobhi Sarson (1:1 row at 30cm part) • Wheat + mustard (9:1 row)	• Gram- Mustard (4:1 row at 30cm apart) • Lentil + mustard (4:1 rows) rain fed
Seed rate : 4-5 kg/ha	Seed rate : 5 kg/ha

Seed treatment:-

- Treat the seed with Apron S.D. 35@ 6 g/kg of seed (to reduce the primary infection of white rust and downy mildew).
- Treat the seed with Carbendazim @ 2 g/kg of seed (to reduce the primary infection of Sclerotinia stem rot).

Plant population :

	Toria	Mustard
(Row × Plants spacing)	30cm ×10 cm	30cm × 10 cm
Plant population	3.40 lakh plants/ha	3.40 lakh plants/ha

Fertilizer Recommendations (kg/ha)

	Toria	Mustard
Rainfed	30 kg N 20 kg P 10 kg K	40 kg N 20 kg P 10kg K
Irrigated	60 kg N kg 30 P kg 20 K	80 kg N 40 kg P 20 kg K

Fertilizer Application :

Irrigated : Half of the recommended dose of nitrogen and full dosage of phosphorus and potash should be applied at the time of sowing. Remaining half dose of nitrogen should be top dressed immediately after first irrigation i.e. 35-40 days after sowing (DAS)

Rainfed : Total recommended dosage of nitrogen, phosphorus and potash should be thoroughly incorporated in soil at the time of sowing.

Organic fertilizers

Rainfed : Apply farm yard manure (FYM) @ 40-50 q/ha before monsoon and incorporate thoroughly in the soil by ploughing during rains.

Irrigated : Before sowing incorporate thoroughly FYM/ compost (100 q/ha) in the soil.

Irrigation : One irrigation at flowering stage is recommended i.e. 30-35 DAS. Whereas, second irrigation at siliqua development stage is to be given when needed at i.e. 75-80 DAS.

Weed control: Pre planting (before sowing) application of fluchloralin or pendimethalin (pre-emergence) @ 1 kg/ha under well moist soil condition and one hand weeding, Isoproturon (pre & post emergence @ 0.75a.i. kg/ha (but in no case later than 35 days)

Management of *Orobanche* in Mustard :

- For the management of orobanche in mustard the complete eradication of weeds (weed free) gave higher seed yield (1893 kg/ha) followed by application of soybean oil @ 2 drop/shoots of orobanche (1847 kg/).

Table 8 : Effect of different weed management treatments on seed yield and net return of Mustard (2005-2008)

S.No	Treatments	Seed yield (kg/ha)	Net return (Rs/ha)
1	Fluchloralin @ 1.0 kg/ha (P.P.I.)	1553	14357
2	Fluchloralin @ 1.5 kg/ha (P.P.I.)	1554	13938
3	Pendimethalin @ 1.0 kg/ha (P.E.)	1651	15756
4	Pendimethalin @ 1.5 kg/ha (P.E.)	1685	15465
5	Glyphosate 0.5 % (Post E.)	1709	17093
6	Glyphosate 0.25 % (Post E.)	1666	16841
7	Soybean oil @ 2 drops/shoot of Orobanche	1847	20363
8	Weedy check	1290	10710
9	Weedy free	1893	17203
10	***SEm+***	**97**	**1834**
11	***CD (P=0.05)***	**283**	**5421**

Recommendation of Crop sequences and use of Sulphur :

On the basis of five years results it could be concluded that the mustard crop can be easily grown in double cropping system. (Bajra-mustard crop sequence) Gird agro-climatic zone, hence it can be successfully adopted by the farmers. Dose of NPK (80 : 40 : 20) along with 40 kg S/ha was found to be superior and at par with 60 kg S/ha. Hence, it proved economical for getting higher yield return and recommended for mustard.

Table 9: Seed yield and net return of mustard as influenced by sulphur application under various cropping systems.(2001-2007)*

Treatments **Crop sequence**	Seed yield (kg/ha)	Net return (Rs/ha)
Soybean-Mustard(S-M)	1660.6	23533.4
Urid –Mustard (U-M)	1925.4	26875.2
Bajra –Mustard (B-M)	1582.2	31286.6
Fallow –Mustard (F-M)	2166.4	24782.4
SEm ±	**59.6**	**1360.75**
C.D. at 5%	**190.4**	**4351.75**
Sulphur levels (kg/ha)		
0.0 (S_0)	1687.6	22848.6
20.0 (S_{20})	1795.8	25202.4
40.0 (S_{40})	1882.2	26710.0
60.0 (S_{60})	1969.2	28058.0
SEm ±	**42.6**	**908.0**
C.D. at 5%	**119.67**	**2358.67**

***Except year 2002-03**

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme (AICAES, 1971)

Varieties: During the year 1967-68, 5 mustard varieties namely L. 5904, L. 18, L. 101, B. 54, B. 85 and Local were tried at Jora and Bhind.

At Jora, highest yield of 889 kg/ha was given by variety L. 18 followed by L. 5904 (741 kg/ha) while at Bhind, highest yield of 1463 kg/ha was given by variety – L. 5904 followed by L. 18 (1383 kg/ha).

In another trial conducted for one year at Jora and two years at Bhind variety L. 5904 was found to be the best variety.

Thus, the high yielding and very popular variety of mustard i.e. L. 5904 has been compared with new promising varieties viz. Sulpha, Varuna and D. S. 17 T.

The results show that variety Varuna has out yielded variety L. 5904 at Jora and Bhind while Suphla has ranked lowest in the yield.

Fertilizer: During the year 1970-71 in variety cum manurial cum irrigational experiment, increasing dose of Nitrogen from 40 to 60 and from 60 to 80 kg/ha increased the yield of mustard at Jora as well as at Bhind.

During the year 1971-72 in two separate varieties cum manurial and irrigational cum manurial experiments, increasing the dose of nitrogen from 60 to 120 kg/ha increased the yield.

As regards response to application of phosphate, increasing the dose of P_2O_5 from 30 to 60 kg/ha showed response at Bhind while it was absent at Jora.

Therefore fertilizer dose of 120 kg N and 30 kg P_2O_5/ha may be considered suitable in mustard.

Irrigation: In the irrigational experiment during the year 1970-71 at Jora and during the year 1969-70 and 1970-71 at Bhind increasing number of irrigation increased the yield.

Stage of irrigation: In order to know what is the critical stage of irrigation if we have got only one irrigation for mustard crop. Results clearly showed that it is the late flowering stage found to be critical for irrigation at Bhind. However, at Jora it was grain filling stage.

(AICAES, 1971)

Abstract of the research work done during the period (1989-90 – 1992-93) for publication in MAPCOST report

Based on the basis of four years pooled average, the following conclusions have emerged for general recommendation.

- **i.** The maximum seed yield was obtained from the early date of sowing i.e. 16th October. However, the advancement of the dates significantly reduced the seed yield in all the varieties.
- **ii.** The highest seed yield of mustard was obtained with Krant variety followed by Pusabold.
- **iii.** The maximum seed yield of mustard was recorded at the plant spacings of 37.5 cm followed by 30.0 cm.
- **iv.** Two hand weedings (30 and 45 DAS) and herbicide pendamethalin @ 0.75 kg a.i./ha as pre-emergence application were equally effective in reducing both type of monocot and dicot weeds in early stage of crop growth period.

v. Urd (grain) mustard sequence gave maximum additional total net returns over all the sequence tried in the experiments.

vi. The maximum seed yield was recorded when full package of practices (S.U. + recommended fertilizer + irrigation + pest control + disease control) was applied.
(COAGWL, 1993)

Table 10: Rapeseed-mustard based cropping system.

The following cropping systems were found more productive, remunerative and feasible for gird Zone of Madhya Pradesh

Situation / System	Yield (Kg/ha			Net Return (Rs./ha)	B:C ratio
	I	II	III		
IRRIGATED **A. Crop sequences**					
Black gram – mustard	1512	2169	-	11,906	5.03
Green gram-mustard	712	2230	-	8950	4.29
Fallow-mustard (Check)	-	2232	-	7422	4.91
Fallow-toria – wheat	-	2131	2978	17609	2.50
Guar (F) – Toria – Wheat	13806	1785	3148	16800	2.15
Cowpea (F) – Toria – Wheat	18335	1655	2940	16500	2.13
Fallow – mustard (Check)	-	2062	-	14260	3.24
Soybean (JS 7105) – mustard	2046	1409	-	19425	2.76
Soybean (PK 472) – mustard	1773	1364	-	17425	2.67
Fallow –mustard (Check)	-	2062	-	14260	3.24
A. Intercropping					
Toria + G. Sarson) (B. napus) (1:IR)	1288	1911	-	15338	5.12
Fallow-mustard (Check)	-	2565	-	12695	4.98

Situation / System	Yield (Kg/ha			Net Return (Rs./ha)	B:C ratio
	I	II	III		
Rainfed					
A. Crop Sequence :					
Cowpea (F+P+S)-mustard	12500 (F) + 1965 (P) 415 (S)	1431	-	14938	2.98
Jowar (F) – mustard	32565	1327	-	10982	2.78
Fallow – mustard (Check)	-	1707	-	9999	3.03
B. Intercropping:					
Toria + B. Carinata (Karan rai) (1:1 R)	1053	960	-	12044	3.47
Fallow - Mustard (Check)	-	1707	-	9999	3.03
Gram + Mustard (4: row)	1513	956	-	13561	4.00
Pure gram (Check)	1926	-	-	8924	3.07
Lentil+ Mustard (4:1row)	701	1169	-	9621	3.29
Pure lentil (Check)	1504	-	-	5093	2.40

Above systems are identified on the basis of experiments conducted under Rapeseed mustard project, ZARS, Morena form 1986-87 to 2005-06

(j) Safflower :

The safflower work was initiated at Indore campus in the year 1971. The research work got momentum with the setting up of the IDRC (Canada) centre on safflower in 1979 and ICAR centre (AICRP ON SAFFLOWER) since 1986 when considerable breeding material and improved varieties/ genotype got exchanged under the All India Coordinated programme (AICRPSF, 2008).

All the material available with this centre in this crop was spiny nature and tall habit. Intensive selection and evaluation of these material resulted in the release of a variety JSF-1 during 1994.Spiny variety

possesses problems of spines during harvesting and threshing. Hence, later on work was concentrated on the development of non spiny varieties. Finally the non spiny varieties like JSI-7, JSI-73 and JSI-97 were developed and released. Efforts were also made towards the development of early maturing genotypes which resulted in the release of early maturing and short stature variety of safflower namely JSI-99.

Table 11: Different varieties released from Indore Centre are as under along with their characteristics

S. No.	Varieties	Year of release	Maturity period (days)	Oil content (%	Seed Yield kg/ha)	Distinguishing Characters	Seed index (g)
1	JSF-1	1984	140-145	30	1500-1600	High yielding, spiny, whie flower colour bold seeded	5.5-6.5
2	JSI-7	1990	142-147	32	1300-1400	Non spiny, flower colour yellow (Yellow at blooming and orange at fading) seeds smaller in size	4.0-4.5
3	JSI-73	1997	140-145	31	1400-1500	Non spiny, flower colour yellow-red (Yellow at blooming and orange red at fading) seeds medium in size	4.5-5.0
4	JSI-97	2004	135-140	33	1500-1600	Spineless, flower yellow at blooming and orange red at fading, bold seeded	5.5-6.5
5	JSI-99	2004	115-120	29	1100-1200	Semi spiny and big Capitulum, flower colour orange red bold seeded	5.5-6.5

JSF -1

JSI -7

JSI-73

JSI -97

(k) Sorghum

i. The All India Coordinated Sorghum Improvement Project was started in 1969 at College of Agriculture, Indore (AICRPSI, 2008).

ii. Varieties i.e. SPV 1, SPV 1041, JJ 741 were developed to replace low yielding late maturing, tall varieties with susceptibility to stresses and non-responsive to management.

iii. Hybrids i.e. CSH 18, Indore 12 with wide adaptability and responsive to management were developed to replace low yielding, late maturing, tall varieties susceptible to stresses.

iv. Development of varieties/hybrids for alternate uses of sorghum, starch, syrup, alcohol and cattle and poultry feeds etc. (Sources Paibasaguda, GGUB 21m GGUB 28).

v. Development of varieties/hybrids resistant to Shoot fly and stem borer (*Sources* SRF 206, Ent 12, SR 970, SR 2102, No 9379, GGUB 28, GGUB 27, SR 1333).

vi. Development of varieties/hybrids resistant to Grain mold (*Sources* GMRP 13, GMRP 34, GMRP 35, GMRP 84, AKGMR 35, Kekdi and Kewari).

Table 12: Hybrids and varieties of sorghum developed

Variety	Duration (days)	Yield (q/ha)	Remark
SPV 938	110-115	33-35	Entire MP
SPV 1041	110-115	30-32	Entire MP
JJ 741	110-115	30-32	Entire MP
CSH 18	110-115	41-43	Entire county (India) moderately resistant to leaf spool and grain disease
IMS 9A	110	25-30	Resistant to all major disease, insect pest lodging and shattering, high thresh ability
CSV 15 IMS 9B	110-115	33-36	Entire country (India)
Indore 12	110	25-30	Moderately resistant to major insect pest, lodging and shattering, high thresh ability

"CSH-18" medium maturing dual purpose hybrid of all kharif sorghum growing areas of India.

Both the parents of CSH-18, IMS-9A and Indore-12 were developed at Indore & identified as drought tolerant genotypes. Released in July 1999.

"Jawahar Jowar 1041"

Medium maturing, dual purpose variety for kharif season of M.P. Released in Oct 1999.

"Jawahar Jowar 1022"

Early maturing, dual purpose variety, suitable for intercropping with Soybean under shallow soil and low rainfall conditions of M.P. Released in Sept. 2004

(l) Soybean :

The research work on soybean was started at JNKVV, Jabalpur in the year 1963-64 in collaboration with the University of Illinois under the project PL 480. The main aim of the project was to provide a crop for Kharif fallow area in different agro-climatic zones of MP. The All India Coordinated Scheme on Soybean was started in the year 1967 and transferred to RAK College of Agriculture, Sehore in the year 1982-83 (AICRPS, 2008).

Table 13: Technologies developed at College of Agriculture, Sehore

S. No.	Technologies/ Machineries/ other items developed	Year of development
1	Sowing should be at the onset of monsoon as early sown crop observed severally infested with girdle beetle semilooper and bud blight virus	1990
2	Soybean Variety developed JS 335 (JS 78-88 x JS 71-05)	1994
3	Intercropping of soybean with sorghum and maize result in severe infestation of semilooper farmers have been advised to provide plant protection umbrella when growing soybean as inter or mixed crop with maize or sorghum	1998-2000
4	It was recommended that only optimum population i.e. 4.5 to 6 lakh/ha should be maintained as higher plant population attracts severe infestation of semilooper resulting sterility type symptoms	1998-2000
5	Identified varieties JS 71-05 and JS 335 were recommended for cultivation as these were found resistant / tolerant to the stemfly and aphid infestation	1998-2000
6	Nitrotenous fertilizer should not be broadcasted in standing crop as it resulted heavy infestation of major insect pests	1998-2000
7	For integrated weed management in soybean pre-emergence application of metachlor 50 EC @ 1 kg a.i./ha or alachlor 2 kg/ha 50 EC or pendimethaline 1 kg/ha 30 EC or Clomazone 1 kg/ha 50 EC followed by one HW at 30 DAS have been recommended pre plant incorporation of fluchloralin 48% @ 1. Kg a.i./ha followed by one hand weeding (HW) or intercultural by Dora at 25 days have been recommended.	1998-2000

S. No.	Technologies/ Machineries/ other items developed	Year of development
8	In case 60-70% larval population of semilooper is infected with white muscardine diseases caused by Beauveria bassiana insecticide application should be discontinued	1999-2001
9	Spray of carbendazim 50 w.p. @ 0.05% for Myrothecium and other leaf and pod diseases; copper-oxyxchloride (COC) @ 0.2% + streptomycin @ 200 ppm or COC + Kasugamycin (0.2 + 0.2%) for bacterial pustule and hexaconazole, propiconazole, oxy carboxin or triadimefor @ 0.1% for rust have been recommended	2000-2005
10	For post emergence weed control the post emergence herbicides viz quizalofop ethyl 5 EC 50 g/ha, Imazethapyr 10 EC 75 g/ha, chlorimurionethyl 25 WP 9 g/ha and fenoxyprop p ethyl 10 EC 100 g/ha have been recommended in standing crop of soybean at 20-02 days after sowing	2001
11	Plant population of 6 lakh/ha for erect type varieties and 4.5 lakh/ha for branching type varieties has been recommended	2002
12	In situ mulching of weeds at 30 DAS has also been recommended ofr effective and economical wee control	2002
13	In IPNM it was recommended that half of the recommended dose ot fertilizer along with 5 t FYM/ha was better	2004
14	Sulphur application @ 20 kg/ha in the form of single super phosphate (166 kg/ha) or gypsum (111 kg/ha) or pyrite (100 kg/ha) should be applied before sowing	2004

S. No.	Technologies/ Machineries/ other items developed	Year of development
15	Rhizobium strains viz Sehore 1 (SB 9) or Pantnagar 2 or Delhi 2 or inoculation of B japonicum + 40 kg K2O/ha + 0.5 kg Boron as borax is recommended for higher nodulation and yield of soybean in the zone	2004
16	In low to medium soil available NPK conditions the combined inoculation of pantnagar 2 + Delhi 2 + Bj 1 of B japonicum culture @ 5 g/kg seed is recommended for higher noduation and yield of soybean	2004
17	In pigeonpea + soybean (2:4) intercropping system the application of 50% RDF along with farm yard manure (FYM) @ 5 t/ha and bio-fertilizer (B japonicum + PSB each 5 g/kg seed) is most economical for higher yield of soybean	2004
18	Under dry conditions and low soil available phosphorus the soil application of Arbuscular mycorhiza @ 4 kg/ha mixed with 50 kg decomposed FYM and PSB 5 g/kg seed + 40 kg P_2O_5/ha is recommended for improving soil phosphorus availability and productivity	2004
19	Inoculation of PGPR RP 7 @ 20 g/kg seed alone or in combination with b japonicum @ 5 g/kg seed is recommended for better yield	2004
20	Broad bed furrow and recommended dose of fertilizer is recommended ofr moisture and nutrient management	2005
21	Microbial pesticides, *Bascillus thringensis of Beauveria bassiana* @ kg/ha or chitin inhibitor 5 EC @ 400-600/ha or Diflubenzuron 25 WG @ 300-400 g/ha or Luferon 5 EC @ 400-600 is recommended for the management of defoliators like grey of green semilooper	2005

S. No.	Technologies/ Machineries/ other items developed	Year of development
22	Seed treatment with thiamethoxam 70 WS @ 3 g/kg seed or spray of thiamethoxam 25 WG @ 100 g/ha at 7 days after germination should be done to protect the crop from early pests particularly stemfly and Blue beetle	2006
23	In integrated nutrient management of soybean based cropping system application of crop residues @ 5 t/ha + FYM 5 t/ha with RDF is recommended.	2006
24	Triazophos 40 EC @ 0.800 ml/ha for the control of girdle beetle is recommended.	2006
25	For the management of major insect, IPM module involving seed treatment with thiomethoxam 70 WS @ 3 g/kg of seed, installation of birdperches @ 50/ha followed by foliear application of NSKT @ 5% or Bt @ 1lit/ha at flowering stage and need based application of quinalphos 25 EC @ 1.5 lit or triazophos 40 EC @ 0.800 lit/ha is recommended	2006
26	New insecticides like indoxarb 14.5 SC @ 300 ml/ha, profenophos 50 Ec @ 1250 ml/ha or Lembda cyhalothrin 5 EC @ 300 ml/ha and Emamectin benzoate 5 SG @ 0.180 g/ha for green and grey semilooper of soybean	2007
27	Indoxacarb 14.5 SC @ 300 ml/ha or Lembda cyhalothrum 5 EC @ 1250 l/ha is recommended for the control of stem borers. Particularly girdle beetle and stemfly.	2008

Table 14: Varieties released / tested

	Variety	Released / notified year	Duar-ation (Days)	100 seed weight (g)	Producti -vity (q/ha)	Adaptabilty
1	JS 71-05	1980	90-95	12-13	20-25	Nimar and Malwa
2	JS 72-44	1982	100-110	11-12	20-25	Indore, Jabalpur
3	JS 72-280	1982	105-110	11-12	18-20	Malwa, Nimar and Jabalpur
4	JS 75-46	1987	100-105	12-13	25-30	Indore, Rewa and Jabalpur
5	JS 80-21	1991	108-110	11-12.5	25-30	All MP
6	JS-335	1994	95-100	10-10.5	25-30	All MP
7	JS 93-05	2002	90-95	11-12	20-25	All MP
8	JS 90-41	2003	90-95	10-11	18-20	All MP

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme

Varieties: Soybean varieties Lea, J. 2, J. 9, Clark 63 and Bragg have been tried at Baroda and Bhind during the year 1971-72.

At Baroda variety J. 2 gave the highest yield of 2306 kg/ha followed by J. 3 (2159 kg/ha). Both of these varieties matured in 114 days.

At Bhind highest yield of 1022 kg/ha was given by the variety Lea (104 days crop). This was followed by variety J. 3 which yielded 987 kg/ha and matured in 106 days.

Fertilizers: Fertility cum inoculum experiment on Bragg was also conducted for two years at Bhind (1969-70, 1970-71) and one year at Jora (1969-70).

At Jora inoculated and uninoculated soybean did not differ in yield. Increasing dose of nitrogen increased the yield. Highest dose of P_2O_5 i.e.

100 kg/ha increased the yield. Highest yield of 1083 kg/ha was obtained when soybean was sown uninoculated with 180 kg N + 100 Kg. P_2O_5/ha.

At Bhind also inoculated and uninoculated soybean did not differ significantly during both the years. Increasing dose of nitrogen as well as phosphate increased the yield. Highest yield of 2472 kg/ha was obtained by inoculated seed with 160 kg N + 100 kg P_2O_5/ha. Basal dressing with 20 kg K_2O/ha was done before sowing in this experiment.

Introduction of Soybean as kharif crop in mustard mono crop irrigated area of Madhya Pradesh

Above project was financed by National Oil Seeds and Vegetable Oils Development Board, Ministry of Agriculture Goverment of India, Gurgaon. Dr. C. D. Hirve, Department of Plant Breeding & Genetics, College of Agriculture was Principal Investigator. The results of the experiments conducted under this project during 1997-98 are mentioned below.

The higher grain yields of 1.67, 1.61, 1.57 and 1.49 tonnes per hectare was recorded for soybean varieties Pb 1, PK 416, NRC 1 and PK 472 respectively.

Mustard Pusabold yielded 1.29 tonnes hectare after soybean variety Monetta as compared to 1.22 tonnes per hectare grain yield from fallow-mustard treatment.

The highest net return of Rs. 25956 per hectare was obtained from Pb 1-Pusabold sequence as compared to Rs. 12605 per hectare from fallow- mustard. The soybean varieties JS 335, Monetta, JS 71-05, PK 416, NRC 12 and PK 564 were also found more paying in the soybean-mustard sequence as compared to fallow-mustard sequence. It shows that soybean-mustard sequence is more beneficial than fallow-mustard.

Soybean varities MACS 58, JS 335, PK 146 and PK 471 have given a grain yield of 1.26, 1.21, 1.18 and 1.14 tonnes per hectare respectively under 45 cm row spacing in All India Co-ordinated multilocation soybean varietal trial.

A total grain yield of 3.75 tonnes per hectare in the Village, Banarpura, 3.72 tonnes per hectare in the Village Jaurasi and 3.51 tonnes per hectare in the Village Sikroda with a net return of Rs. 37564, Rs. 36852 and Rs. 34849 per hectare were obtained on farmers fields respectively by soybean –mustard sequence as compared to 1.65, 1.52 and 1.49 tonnes per hectare from fallow-mustard with a net profit of Rs. 18950, Rs. 17090 and Rs. 16550 per hectare in that order.

A maximum net return of Rs. 37564 per hectare may be obtained from soybean-mustard sequence as compared to Rs. 18950 per hectare from fallow-mustard on Farmer's fields & provide its superiority fro adoption by farmer's.

(m) Sugarcane :

Historical background of Sugarcane Research in Madhya Pradesh

1952: Establishment of Sugarcane Research Stations at Dabra and Sehore under Indian Central Sugarcane Council.

1959: Commencement of a scheme on Sugarcane pests at Gwalior.

1961: Integration and re-orientation of all the existing research schemes in Madhya Pradesh and subsequent establishment of Main Sugarcane Research Station (M.S.R.S.) at Sehore and its two substations at Bagwai and Jaora under Directorate of Agriculture, Govt. of M.P.

1964: With the formation of Jawaharlal Nehru Agricultural University, all the Sugarcane Research Stations were taken over by the University.

1970: All India Coordinated Research Project on Sugarcane (I.C.A.R.) implemented at Sehore (AICRPS, 2008).

1971: Fluff Exchange Programme commenced.

1974: National Demonstration on Sugarcane started and continued up to 1976.

1976: Centrally sponsored scheme (C.S.S.) for the development of Sugarcane in M.P. was started but presently not in function due to wants of funds from M.P. Govt.

1978: Strengthening of project was made with I.E.R.P. Project.

1997: Variety Co JN 86-141 of early group has been released by Central Release Committee for the peninsular zone II of the country.

2002: AICRP on Sugarcane Project has been shifted from R.A.K. College of Agriculture, Sehore to ZARS, Powarkheda on 01.12.2002 due to scarcity of water at Sehore.

Table 15 : Varieties released

(By State Varietal Release Committee, Bhopal)

(a) Peninsular zone

S. No.	Variety	Year of release	Maturity group	Yield in qtls	Sugar (%)	Remark
1	Co 7314	1978	Early (10 Month)	750-800	19.50	Good for Jaggery, replaced by Co C 671
2	Co JN 86-141*	1997	Early (10 Month)	800-850	20.00	Good for Jaggery & higher sucrose
3	Co 1307	1970	Mid-late (12-14 Month)	900-1000	18.00	Replaced by Co 6304
4	Co 1305	1975	Mid-late (12-14 Month)	950-1000	18.00	Replaced by Co 7318
5	Co 6304	1977	Mid-late (12-14 Month)	900-1100	18.00	Erect, lodging resistant
6	Co 7318	1978	Mid-late (12-14 Month)	900-1100	18.50	Drought tolerant & good for jaggery

*****Also identified for peninsular zone of country by central varietal identification committee.

(b) North-western zone of Madhya Pradesh

S. No.	Variety	Year of release	Maturity group	Yield in qtls	Sugar (%)	Remark
1	Co 853	1970	Mid-late (12-14 Month)	900-1000	18.50	Replaced by Co., 1148 & Co LK 8001
2	Co JN 86-141	1997	Early (10 Month)	800-850	20.00	Good for Jaggery & higher sucrose

- Planting of sugarcane in October-Novemeber gave approximately 30-40 per cent more yield as compared to February-March month sown crop.
- Row spacing of 90 cm in autumn planting and 60 cm in spring planting is the best.
- Alternate row irrigation with trash mulch proved as effective as normal irrigation. It saves 36 & irrigation water.
- Nitrogen 300 kg, P_2O_5 80 kg and K_2O 60 kg/ha is the optimum dose of fertilizer in sugarcane.
- Nitrogen 225 kg/ha + Azotobacter @ 5 kg/ha proved as effective as 300 kg N/ha alone.
- Application of 6 t/ha Biogas slurry + 6 t/ha press mud alone with 150 kg N, 40 kg P_2O_5 and 30 kg K_2O/ha proved as effective as 300 kg N, 80 kg P_2O_5 and 60 kg K_2O/ha.
- Application of 6 t/ha press mud cake or 4 t/ha press mud cake + Azotobactor @ 5 kg/ha economize 75 kg N/ha.
- Use of phosphate solubilising bacteria like PSB @ 5 kg/ha economize 25 per cent phosphorus.
- Application of 60 kg/ha K_2O significantly increase cane yield and quality of juice. Split application as ½ basal + ¼ in 3 spray of 2.5% KCL + 2.5% urea + ¼ K_2O as soil application at onset of monsoon showed significantly higher yield and quality of sugarcane.
- In Sugarcane-Raton-Soybean cropping sequence, 60 kg sulphur nutrition has given significantly higher cane yield and juice quality in sugarcane plant crop. The residual effect on ratoon and

cumulative effect on soybean has also gave significantly higher cane yield and juice quality in sugarcane and grain yield in soybean, respectively. Similar trend and response were noted in available sulphur status in soil.

- Suitable intercrops in autumn season were Onion, Garlic, French bean, Erect pea and Isabgol (1:2 ratio). These crops gave traditional income of Rs. 21728, 12166, 24092, 4518, 11449 respectively. In spring planted Cane, Green gram, Groundnut, Black gram in 1:2 ratio gave additional income of Rs. 3771, 7208 and 1531 respectively over sole sugarcane.
- For weed management in plant and ratoon crop, Metribuzine @ 1 kg a.i./ha or Atrazine @ 2 kg a.i./ha both as pre emergenece plus trash mulch at 60 days found to be effective.
- Trash mulch only in inter-row spaces after off barring + hoeing or Atrazine 1 kg a.i./ha = 2, 4-D @ 1 kg a.i./ha after irrigation and off barring or Metribuzine @ 1 kg a.i./ha after proved irrigation and off barring proved as effective as conventional practices of hand weeding for controlling weeds.
- To obtain ratoons, stubble shaving off barring and application of full fertilizer dose i.e. 300:800:60 kg N:P:K/ha and gap filling are the important components.
- For late planting 20% more seed i.e. 1.50 lac buds/ha planted at 60 cm row spacing gave significantly higher yield.
- Release of 4-5 thousand viable cocoons/ha in the month of July-August effeciently control pyrilla in sugarcane.
- Crop planted in November-December had minimum incident of smut.
- Identified sugarcane lines Co 90004, Co 90005, Co 90006, Co 90007, Co 90008, Co 90010 for smut resistance and lines Co 86002, Co JN 862072, Co JN 2384, Co JN 86-572 and Co JN 86-2411 for wilt resistance.
- Moist hot air treated seed production in quintals of improved varieties for distribution to cultivators and sugar factories in last ten years from 1991-92 to 2000-01 was 1980.20, 1172.85, 1094.80, 1041.05, 1137.70, 791.27, 1263.27, 282.30, 773.20 and 499.64 respectively. However, 1976 to 1990-91 yearly seed production was 1000-2000 qtls. The breeders seed production was 1013.85 q. (1999-2000) and 1298.34 q. (2000-01).

Salient Achievements of Regional Agricultural Research Station, Bagwai

- The month of October is the best planting period for getting maximum production of sugarcane for this area.
- Optimum row to row spacing for obtaining maximum yield is 90 cm for October and 75 cm for February-March planting.
- Optimum dose of fertilizer for this area is 300:85:80 NPK per ha.
- Ridge and Furrow method of planting is found superior over flat sowing method.
- Planting of three budded sets gave higher yield than others.
- Varieties Co-833, Co-1169 and CoH-12 are identified as drought resistant varieties.
- Varieties like Co-6304, Co-7323, CoH 7803, CoLK 8001 and Co-7915 are identified as high yielding varieties for this area.

(n) Wheat :

All India Cordinated Wheat Improvement Project was started on April 01, 1987 at College of Agriclture, Gwalior. Research achievements and recommendations are as follows.

Development of varieties:

MP4010: This wheat variety was developed by the Gwalior Centre, released and notified by central subcommittee on crop standards, Government of India. Its registration number is IC 296312 (NBPGR, New Delhi) and notification No. 17-23/2003-SD IV dated 25-03-2003. It is suitable for late sown condition in central zone of India. Its yield potential is 40 to 45 q/ha in central zone. It is resistant to both stem and leaf rusts which are important biotic factors affecting productivity in central India. It is tolerant to terminal heat which affects yield as well as grain appearance. It has high nutrient use efficiency and tolerant to moisture stress up to some extent. It is better substitute of Lok-1 for late sown conditions (AICRPW, 2008).

Development of genetic stock:

i. Genetic stock JNGW-4 was identified for more number of grains per spike. (Wheat germplasm catalogue-II (Elite Genotypes Research bulletin No. 11 ISSN 0972-6098 Directorate of Wheat Research, Karnal).

ii. Genetic stock 'JNGW-9' was identified for high tillering. (National Gene bank NBPGR (New Delhi) No. 2402 dated 25-11-1999)

iii. Suitable varieties identification:

a. **For timely planting:** Varieties viz., HD2932, HI-1077, HI –8498 (Malavshakti), HI-8381(Malavshree), GW 190, GW 322, GW 366, MP 1203, HD 2864 found suitable for November sown condition in M.P.

b. **Late sown planting:** DL-788-2, GW-173 &MP 4010 found suitable for late sown condition in M.P. and provide a better option of prevalent Lok-1 variety.

Production/Protection technologies developed:

1. **Time of sowings:** Under the agro-climatic conditions of Gird region the planting of wheat in first fortnight of November gives significantly higher yields (55 to 60 q/ha) than the other planting dates.
2. **Intercropping in wheat:** Wheat with mustard (8:1) eight rows of wheat and one row of mustard at 100:40:40 kg N, P_2O_5 and K_2O/ha has been found to increase over all returns which can be adopted profitably
3. **Weed management:** Pre-emergence application of pendimethalin (stomp) @ 1.00 kg a.i. /ha and post-emergence application of Isoguard, a chemical brand of isoproturon and 2,4-D @ 1250 g/ha in 600 litres of water, applied after 30-35 days of sowing at sufficient moisture was found most effective in control of *Phalaris minor* and other narrow and broad leaved weeds.
4. **Nutrient managements:** Application of 120 kg N/ha in two splits i.e. 1/3 at sowing and 2/3 at FN stage gives the maximum yield for improving the productivity and quality of wheat grain.
5. Late planting of wheat can be done up to first week of January with suitable varieties like GW 173, and MP 4010 with extra seed rate of 25% atcloser row spacing up to18 cm.
6. Application of 120:60:40 Kg N, P2O5 & K2O /ha in wheat produced highest grain yield in row spacing of 23 cm at timely sown condition.
7. The bread wheat variety 'GW-273' out yielded all other varieties across the nitrogen levels and gave the highest yield of 5900 kg/ha at 120:60:40 kg N,P2O5 and K2O /ha.
8. Durum wheat 'HI 8498' produced highest grain yield of 5700 kg /ha with 120:60: 40 kg N P K/ha.

9. Application of 120 kg N/ha in two splits 1 /3 at sowing and 2/3 at FN stage, improved the productivity and quality of wheat grain.
10. In wheat crop, application of 120 kgN /ha with treatmentof *Azospirillum* recorded maximum production of 5920 kg/ha grain yield.
11. **Restricted irrigation**: Three irrigations at pre sowing,CRI and late jointing stage produced significantly higher yield compared totwo and one irrigations in timely sown crop.

MP 4010

The results of trials conducted under All India Cordinated Agronomic Experiments Scheme

Varieties

In the pre-mexican wheat era, selection of suitable promising wheat varieties was in progress at Baroda, Jora and Bhind. On the basis of the results obtained for the three regions of Chambal Command area the following varieties were selected.

Baroda	Hy. 11	Hy. 277	Hy. 65
Jora	C 281	C. 273	C. 277
Bhind	C 273	N.P. 710	Hy. 65

The above varieties have been tested in a varietal cum manurial experiment for three consecutive years at three centres (from 1964-65 to 1966-67).

Thus for Baroda, Jora and Bhind wheat varieties Hy. 11, C. 281 and Hy. 65 respectively have been recommended.

Fertilizer:

At Baroda increasing dose of nitrogen as well as phosphate increased the yield. Highest average yield of 2201 kg/ha was obtained by variety

Hy. 65 with N 60 + P 60 kg/ha followed by variety Hy. 11 which yielded 2182 kg/ha with N 40 + P 60 kg/ha.

At Jora increasing dose of nitrogen and phosphate did not respond positively. Highest average yield of 3061 kg/ha was given by variety C. 281 with N 20 + P 20 kg/ha.

At Bhind increase in yield due to increased in the dose of nitrogen and phosphate was observed. Highest average yield of 2896 kg/ha was given by variety Hy. 65 with N 60 + P 60 kg/ha.

Mexican Wheat era

Varieties: Selection of suitable variety for the regions represented by Baroda, Jora, Morena and Bhind has been done for three years (1968-69 to 1970-71).

At Baroda and Jora variety R.R. 21 was found to be the best followed by Kalyan Sona.

At Morena and Bhind variety Kalyan Sona was found to be the best followed by R.R. 21.

Fertilizers: Different fertilizers doses have also been tried on the above varieties.

At Baroda very good response to the increasing dose of nitrogen and phosphate was observed. Highest average yield of 4369 kg/ha was given by variety R.R. with 150 kg N and 80 kg P_2O_5/ha.

At Jora, increasing nitrogen dose beyond 90 kg/ha did not respond positively. Similarly there was no response to increasing dose of phosphate beyond 40 kg/ha. Presence of excessive sodium salts in the Jora Farm soils, prevents the uptake of nutrients. Highest average yield of 3856 kg/ha was given by variety S. 331 with N 120 kg + P 80 kg/ha, followed by R.R. 21 with N 90 + P 40 kg/ha (3779 kg/ha) and by Kalyan Sona with N 120 + P 80 kg/ha (3721 kg/ha).

At Morena, there was increase in yield due to increase in the dose of nitrogen. But in the case phosphate increasing the dose beyond 40 kg. P_2O_5/ha did not respond positively. Highest average yield of 4521 kg/ha was given by variety S. 307 with 120 kg N + 80 kg P_2O_5/ha.

At Bhind, response to the application of Nitrogen upto 120 kg N/ha was deserved in the first two years which increased upto 150 kg N/ha in the third year. On an average of three years yield data response to the application of N beyond 120 kg/ha was not observed. Response to the increasing dose of phosphate however, was observed. Highest average

yield of 5369 kg/ha was given by variety Kalyan Sona with 120 kg N + 40 kg P_2O_5/ha.

In the above experiment uniform basal dose of 40 kg K 20/ha was given.

Fertilizer application: In an experiment conducted at Jora and Bhind for two years (1969-70 to 1970-71) and at Morena for one year i.e. 1969-70, highest yield was obtained when 1/3 dose of nitrogen at sowing 1/3 at the time of first irrigation and the remaining 1/3 in the form of Urea spray was applied. Nitrogen was applied at the rate of 120 kg/ha. Basal dressing of 60 kg P_2O_5 + 40 kg K_2O/ha was done at the time of sowing.

Irrigation: To find out optimum time of irrigating Mexican wheat an experiment has been conducted at Baroda, Jora and Bhind for three years.

At Baroda increasing number of irrigation increased the yield. increasing the number of irrigation from 3 to 4, 4 to 5 and 5 to 6 gave additional yield of 291, 591 and 569 kg/ha respectively. Highest average yield of 4270 kg/ha was given by the variety R.R. 21 with six irrigations.

At Jora increasing number of irrigation increased the yield in the year 1968-69 but in the subsequent two years, winter rains coupled with high velocity wind, specially immediately after fifth and sixth irrigations caused lodging of the crop and thus the response to the level of irrigations was limited. However, highest average yield of 4473 kg/ha was given by variety R.R. 21 with five irrigation.

At Bhind increasing number of irrigation increased the yield. increasing the number of irrigation from 3 to 4, 4 to 5 and 5 to 6 gave additional yield of 431, 295 and 270 kg/ha respectively. Highest average yield of 4518 kg/ha was given by variety Kalyan Sona with six irrigations.

Date of sowing: To find out optimum date of sowing for Mexican wheat, experiment at Baroda, Jora and Bhind was conducted for two years (1968-69 to 1969-70).

On the basis of two years average data it is seen that at all the three centres highest yield of wheat was obtained when it was sown on 1st November. Subsequent delay in sowing by a fortnight results in considerable reduction in yield.

Seed rate: Two seed rates have been tried at Baroda, Jora and Bhind during the year 1968-69, higher seed rate i.e. 125 kg/ha has given higher yield at all the three centres.

(o) MULLaRP

AICRP on MULLaRP was started in the year 2001 at College of Agriculture, Sehore (AICRP MULLaRP, 2008).

Research Achievements (2001-2007)

(i) Crop improvement

The salient achievement of the project made during last five years are mentioned below

a. Development and release of variety

i. Lentil

JL-3: It was developed from selection of Sagar local (Masra). It mature in 113 days with average yield potential 1400 - 1500 kg/ ha and having large seed size of 3.4 gram. It is resistant to wilt and tolerant to drought.

ii. Mungbean

TJM 3: State Variety Release Committee, M.P., releases this variety in collaboration of BARC and JNKVV in 2006 for general cultivation in kharif and summer season in Madhya Pradesh. It is resistant to YMV, powdery mildew and *Rhizoctonia*. Average yield potential 950kg/ha in moisture stress condition.

iii. Urdbean

JU 8-6: This variety is released in 2003 by SVRC. It is an early maturing and high yielding variety having tolerance to powdery mildew. It is recommended for cultivation for kharif season in M.P.

b. Varieties identified for release based on testing at this centre

Table 16: The following varieties have been released based on their evaluation at this centre (Sehore).

Crop	Variety	Year of release	Maturity (days)	Yield (kg/ha)	Rec. Zone	Special features
Lentil	IPL 81	2000	113	1245	CZ	Tolerant to rust and wilt
Fieldpea	IPF 99-25	2000	111	2300	CZ	Resistant to PM

Crop	Variety	Year of release	Maturity (days)	Yield (kg/ha)	Rec. Zone	Special features
	KPMR 400	2001	109	2000	CZ	Resistant to PM
	IPFD 99-13	2005	102	2300	CZ	Resistant to PM
	IPFD 1-10	2006	110	2200	CZ	Resistant to PM
Urdbean	KU 96-3	2003	73	800	CZ	Tolerant to YMV

c. Promising genotypes developed

Lentil

Early maturing, bold seeded and high yielding:

SL 94-04, SL 94-07, SL 94-158, SL 94-20, SL 94-25, SL 94-49, SL 94-50, SL 94-51 and

SL 94-06

Bold seeded, high yielding genotypes having resistance to *Fusarium* wilt:

SL 94-21, SL 94-23, SL 94-27, SL 94-28, SL 94-38, SL 94-43, SLC 01, SLC 22, SLC 28 and SL 94-19.

High yielding, bold seeded and drought tolerant genotypes:

SL 94-18, SL 94-17, SL 94-14, SL 94-12, SL 94-08, Udaipura local, RWL 12, RWL 11 and RWL 1

d. Genetic resource management

i. Germplasm collected and evaluated

This center maintained, characterized and evaluated the germplasm of lentil, mungbean, urdbean and fieldpea. The details are given below:

MULLaRP	Germplasm lines collected maintained and evaluated
Mungbean	101
Urdbean	120
Lentil	345
Fieldpea	36

ii. Donors identified

Black Masra	Extra bold seed
JL 30	Early, bold seeded, resistant to wilt
JL 3	Bold seeded, resistant to wilt and drought
JL 73-3	Bold seeded, resistant to wilt

iii. Donors used in breeding programme

Lentil	FLIP 96-51, Sagar Black Masra, BLU 4 L –M 9564, IPL 406, SKUL-1, VL 506, L 4076, PL 5, PL 02, DPL 58, JL 30, L 4603 and JL 3
Mungbean	JM 721, TARM 7, TM 98-50, TM 99-58, BPMR 145, TARM 2 and TARM 1
Urdbean	JU 8-6, PDU 1, JU 2, JU 3, TPU 4, RBU 38 and OBG 27

(ii) Crop production technologies

a. Lentil

i. Nutrient management:

1 On the basis of three years (2002-03 to 2004-05) application of FYM @ 5 t/ha in bold seeded lentil increased seed yield (1099 kg/ha) significantly over control (No FYM) 1003 kg/ha, gave net incremental returns of Rs 18,624/- per ha under rainfed conditions.

2 On the basis of four years (2001-02 to 2004-05) application of 40 kg P_2O_5/ha in bold seeded lentil increased seed yield (1108 kg/ha) significantly over control (877 kg/ha) and gave Rs 19305/- net incremental returns per ha under rainfed conditions.

3 Two spraying of DAP and Urea 2% at pre-flowering and 10 days thereafter increased seed yield by 31 and 25 percent (1260 and 1202 kg/ha) respectively over control under rainfed conditions and gave Rs 22,344/- and 21,376 net incremental returns per ha. respectively.

4 In bold seeded lentil application of 20-27-16-20 Kg NPKS/ha recorded maximum seed yield (1220 kg/ha), found significant over control (982 kg/ha) and gave Rs 20,633/- net incremental returns per ha.

ii. Seed rate:

1 In bold seeded lentil under rainfed conditions 50 kg seeds/ha was found optimum (1017 kg/ha). The seed yield decreased with the increasing seed rate i.e. 62.5 and 75 kg/ha.

b. Urdbean:

i. Nutrient management:

1 Application of 40 kg P_2O_5/ha through DAP with PSB to urdbean crop followed by wheat crop in sequence recorded maximum Urdbean equivalent seed yield 1175 kg/ha.

2 On the basis of four years (2002-03 to 2005-06) application of sulphur 20 and 40 kg/ha to urdbean and mustard crop in sequence recorded maximum urdbean equivalent yield 2435 kg/ha.

ii. Performance of genotypes:

The response of genotypes tested under inter cropping system was found non-significant. The genotype JU-3 recorded the maximum pigeonpea equivalent seed yield (1179 kg/ha) followed by JU 8-6. The planting system 2:1 ratio gave maximum pigeonpea equivalent yield (1487 kg/ha) as compared to 1:1 ratio. Pigeonpea paired row planting at 30cm spacing recorded maximum seed yield (1671 kg/ha) as compared to pigeonpea sole (1540 kg/ha).

(iii) Varieties identified for release based on testing at this center

The following varieties have been released during the report period based on their evaluation at this center.

Crop	Variety	Year of release	Maturity (days)	Yield (kg/ha)	Rec. Zone	Special features
Lentil						
Fieldpea	Prakas	2006	110-120	2500 - 3000	CZ	Resistant to powdery mildew.

a. Breeding programme

i. Hybridization and Selection Programme:

Year	**Season**	**Crop**	**Crosses made**	**No. of Parent involved**	**Grow Advanced Generation**				
					F_1	**F_2**	**F_3**	**F_4**	**F_5**
2006-07	Kharif	Mungbean	30	10	21	-	28	-	-
		Urdbean	10	6	21	-	13	-	-
	Rabi	Lentil	16	8	16	20	8	4	-
2007-08	Kharif	Mungbean	-	-	30	20	-	28	-
		Urdbean	-	-	10	21	-	13	-
	Rabi	Lentil	14	8	16	16	19	7	4

b. Promising genotypes developed

i. Lentil

Early maturing, bold seeded and high yielding:

RVL 30, RVL 31, RVL 32.

Bold seeded, high yielding genotypes having resistance to *Fusarium* wilt:

RVL 30, RVL 31, RVL 32

High yielding, bold seeded and drought tolerant genotypes:

Udaipura local, RWL 12, RWL 11 and RWL 1, RVL 31

ii. Mungbean

Early maturing and high yielding

RVM 10, RVM 11, RVM 12, RVM 13, RVM 14 and RVM 15

iii. Urdbean

Early maturing and high yielding

RVU 50, RVU 51, RVU52 RVU 53 AND 54

(c) Genetic resource management

i. Germplasm collected and evaluated

This center maintained, characterized and evaluated the germplasm of lentil, mungbean, urdbean and fieldpea. The details are given below:

MULLARP	Germplasm lines collected maintained and evaluated
Mungbean	172
Urdbean	158
Lentil	702

ii. Donors identified

Black Masra	Extra bold seed
JL 30	Early, bold seeded, resistant to wilt
JL 3	Bold seeded, resistant to wilt and drought
SL 73-3, RVL 31,RVL 48	Bold seeded, resistant to wilt

iii. Donors used in breeding programme

Lentil

Sagar Black Masra, BLU 4 L –M 9564, IPL 406, SKUL-1, VL 506, L 4076, PL 5, PL 02, DPL 58, JL 30, L 4603 and JL 3

Mungbean

JM 721, TARM 7, TM 98-50, TM 99-58, BPMR 145, TARM 2 , TARM 1, HUM 1,BM 4, TM 99-58, ML 131, BPMR 145, PDM 54, TJM 3 And JM 10

Urdbean

JU 8-6, PDU 1, JU 2, JU 3, TPU 4, RBU 38 , OBG 27, AKU 321, PDU 1, AKU 9802 AND JU 8-6,RVU 54

d. Crop production technologies

i. Lentil

Integrated nutrient management in lentil.

A study conducted for four continuous years (2005-06 to 2008-09 on INM in lentil. It also observed that all nutrient management practices out yielded control treatment. Application of RDF (20:17:20:20) along with FYM @ 5t /ha recorded maximum seed yield followed by RDF + vermicompost@ 2t/ha. Use of FYM @ 5t/ha+ seed inoculation with Rhizobium +PSB or vermicompost @ 2t/ha + seed inoculation with Rhizobium+ PSB recorded on par yield to that of recommended dose of NPK (20:17:20 kg/ha)+ Rhizobium + PSB .

Effect of seed priming and Urea spray in lentil.

Two years continuous experiments (2005-07) revealed that seed priming (soaking seed in water 6hrs.) before sowing increase seed yield in Lentil by 8%. Two spraying of 2 % Urea at branching and pod initiation stage of crop growth significantly increased seed yield of 1208 kg/ha as compared to control.

Recommendation : Soaking of seeds in water for 6 hrs before sowing. Two spraying of 2 % Urea at branching and pod initiation stage of crop growth is beneficial in rainfed condition.

ii. Urdbean

Performance of Urdbean genotypes under sorghum intercropping systems (1:1) from 2006-07 to 2009-10

Study conducted for four consecutive year (2006-09) on evaluation of urdbean genotypes in intercropping system (1:1)with sorghum revealed that the amongst ten varieties T 9 recorded maximum seed yield (394kg/ha) followed by JU 3 (393kg/ha), TPU 4 (386kg/ha) and RBU 38 (380kg/ha). These varieties found suitable for intercropping with sorghum.

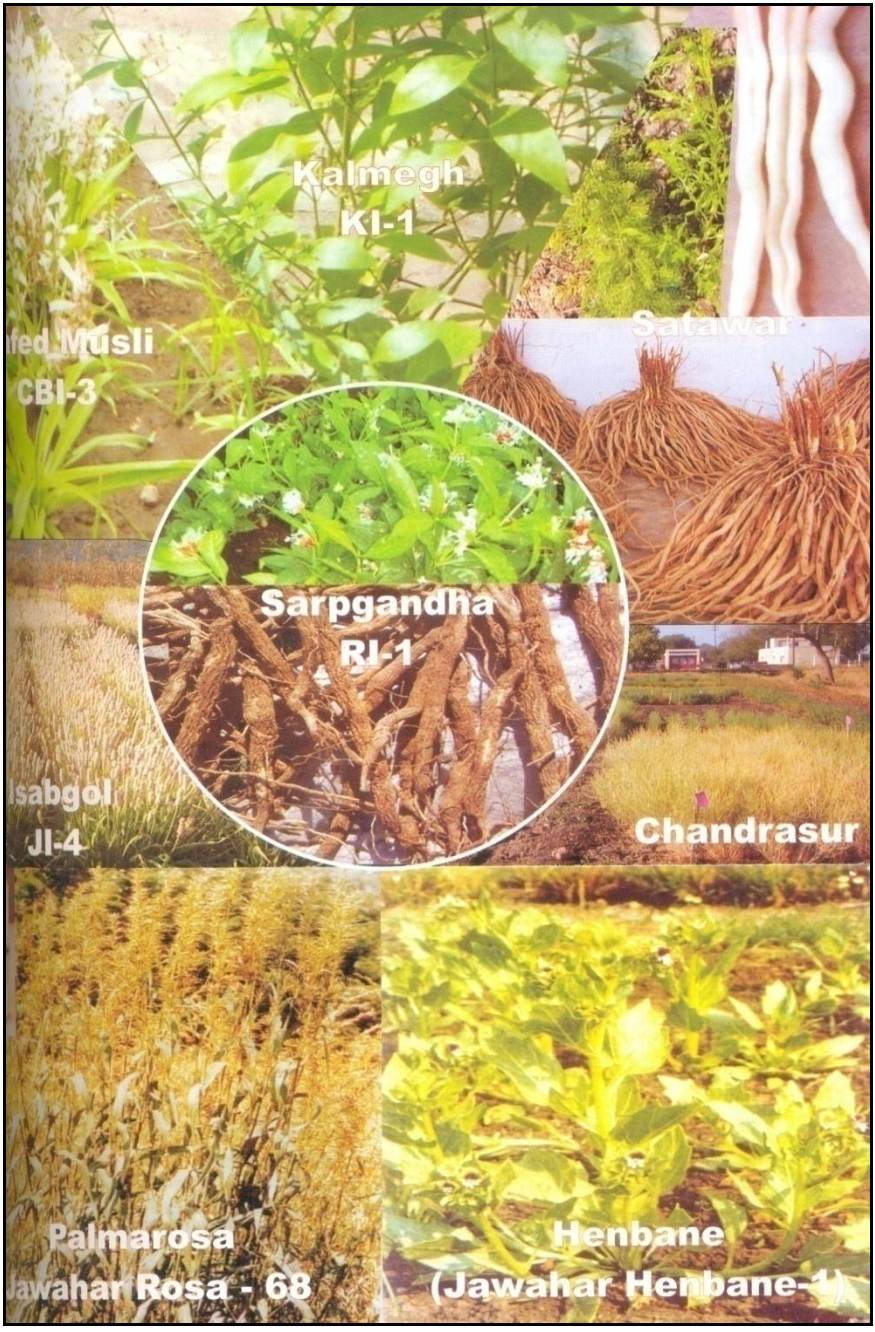
(p) Medicinal and Aromatic Plants:

Genetic Resources & Varietal Improvement

All India Coordinated Research Project – Medicinal & Aromatic Plants, Campus, Indore (AICRP – MAP – 1975 to 2004)

Centre had worked on Breeding, Physiology, Plant protection and Agronomical aspects of medicinal and aromatic plants. In addition to it survey, collection and documentation of germplasm of medicinal and aromatic plants have been done. The mandatory crops under AICRP – MAP were Liquorice, Palma Rosa, Rauwolfia, Vetiver, Henbane, Chlorophytum, Periwinkle, Anise, Ishabgol, Withania, Kalmegh and Musk Dana.

AICRP on Medicinal and Aromatic Crops



All India Coordinated Research Project on Medicinal & Aromatic Plants, Campus, Mandsaur (AICRPMAP, 2008)

Opium poppy research work was initiated after receiving request from the Narcotics Department of the Union Ministry of Revenue to increase the productivity and reduce crop loss from downy and powdery mildew diseases from 1973. All India Coordinated Research Project on Medicinal and Aromatic Plants was started during sixth plan period from 1980. Three new centres were created to cater the need of opium poppy growing state viz. Madhya Pradesh, Uttar Pradesh and Rajasthan. In M.P. the centre is located under Jawaharlal Nehru Krishi Vishwa Vidyalaya, at College of Agriculture Mandsaur. The centre continue to work on opium poppy and other Medicinal plants research in seventh, eight and ninth five year plans from the year 1980. Mandsaur centre has made very significant contributions in germplasm assembly, release of high opium and seed yielding varieties and development of cost effective package of practices giving recommendations on populations density, irrigation, fertilizer, weed control, crop rotation an disease management. A wide spectrum of variability was noticed in these collections in terms of leaf morphology, flower colour and shape, capsule shape and size, latex yield, disease and insect pest reactions and alkaloid content.

Opium poppy *(Papaver somniferum):* This centre of AICRP – MAP has a credit to get their varieties of opium released at national level for commercial cultivation. Production technology was generated and made available to farmer. Crop improvement in opium poppy was initiated during 1980-81, selection carried out at different centres resulted in development of number of high latex and seed yielding cultures with resistance to downey mildew. These were tested under the multilocation coordinated trials over the years and three varieties were released.

R & D on other MAP species:

Aswagandh (*Withania somnifera*): Research work on other medicinal crops viz. Aswagandh, Isabgol, Liquirice, Chlorophytum species has been started. The high yielding varieties of Withania somnifera (Aswagandh) viz. Jawahar Aswagandh-20 (JA-20) and Jawahar Aswagandh-134 (JA-134) with yield potential of (6-8 and 8-10 q/ha) of dry roots respectively and similar seed yield potential. Production technology was generated and made available to farmers.

Isabgol (*Plantogo ovata*): This improved variety of Plantogo ovate viz. Jawahar Isabgol-4 (JI-4) with seed yield potential of 15-20 q/ha has been developed. Other varieties viz. Gujarat-1 and Gujarat-2 are also

found suitable for Madhya Pradesh. Production technology was generated and made available to farmer.

Safed Musli (*Chlorophytum spp.*): Germplasm collected from different locality was planted and evaluated for high yield and quality root. Three high yielding varieties viz. MCB-405, MCB-412 and MCB-414 of *Chlorophytum borivillianum* have been identified and multiplied. These varieties are tested under advance evaluation trial in All India Coordinated Research Project. Other medicinal planted viz. liduirice (*Glycerrhiza glabra*), *Rauwolfia serpentine* (Sarpgandha), *Lipidium sativum* (Chandrasur), Dil (Sua), *Cantharenthus, Osimun canum* has been evaluated and recommended accordingly.

These two AICRP-MAP centres have given twelve improved varieties of seven species of medicinal plants, which are popular all over the country.

Department of Plant Physiology Campus, Jabalpur, Indore and Mandsaur and Krishi Vigyan Kendra of Vishwa Vidyalaya are providing quality seed and planting material of 20 potentially viable medicinal and aromatic plants representing 435 different species having demand in the trade.

Table 17: Varieties released

S. No.	Crop	Variety	Research Station
1	Opium Poppy *(Papaver somniferum)*	Jawahar Ophim-16	Bahaduri Res. Farm, Mandsaur, M. P.
		Jawahar Ophim-539	
		Jawahar Ophim-540	
2	Aswagandh *(Withania somnifera)*	Jawahar Aswagandh-20 (JA-20)	MAP Centre, Bahaduri Res. Farm, Mandsaur, M.P.
		Jawahar Aswagandh-134 (JA-134)	
3	Henbane *(Hyoscymus niger)*	JH-1	MAP Centre, Indore
4	Sarpgandha *(Rauwolfia serpentina)*	RS-1	MAP Centre, Indore

S. No.	Crop	Variety	Research Station
5	French Anise *(Pimpinella anisum)*	EC-22091	MAP Centre, Indore
6	Palma Rosa Grass *(Cumbopogan martini)*	JR-68	MAP Centre, Indore
7	Safed Musli *(Chlorophytum borivillanum)*	MCB-405, MCB-412	Bahaduri Res. Farm, Mandsaur, M. P.

Crop Production

Under crop production in ashwagandha growth retardants TIBA showed highest dry root yield with TIBA 50 ppm (7.50q/ha) and lowest in the control (2.3q/ha).

Chandrasur varieties MLS-1 and MLS-7 showed highest seed yield at 30 x 10 cm spacing (1800kg/ha). Soil fertility experiment in chandrasur crop, 20:40:20 NPK kg/ha exhibited maximum grain yield 19.2q/ha.

Testing of 3 irrigation schedules and 4 seed rates in chandrasur showed that irrigation at 30, 60 and 75 DAS along with the use of 8kg/ha seed rate produced maximum seed yield (1430kg/ha)

Experiments on potassium level and mode of application on opium poppy exhibited maximum latex yield (81kg/ha) and seed yield (1315 kg/ha) in potassium levels with 1/3, 1/3, 1/3 mode of application at sowing rosset stage and first ranching respectively.

Crop Protection

Crop protection experiments showed that new diseases namely root rot of opium poppy, die back and alternaria blight of ashwagandha, powdery mildew of mulhthai, powdery mildew of opium poppy , downy mildew of chandrasur, alternaria blight of chandrasur, collor rot of stevia, root knot of chandrasur have been identified and control measures for their eradication is also carried out.

Phytochemistry

Phytochemistry of ashwagandha revealed that berry ripening stage or physiological maturity is the proper stage for obtaining less fibrous root with economical alkaloids content.

Suitable methods for withanoloides in ashwagandha leaves were developed. Steroidal profile of different germplasm of ashwagandha was also developed. In opium poppy few elite lines have been selected on the basis of high alkaloid content :

a) High morphine lines - MOP-1054, 1074 JOP- 540
b) High codeine lines – UO-201, MOP-587, IC-19
c) High the bain lines – MOP -541, IC-114, MOP- 278
d) High narcotics lines – MOP-537, MOP-541, UO-221

On the basis of overall alkaloid profile, latex and seed yield MOP-541, MOP-581, UO-201, IC-19 and IC-14 are found superior.

Steroidal sapogenine was maximum on 90 days and decrease continuously up to 270 days. Appropriate time of harvesting the crop is when root becomes harder after 150 days.

Maximum steroidal sapogenine was found (1.138) in unprocessed sun dried samples.

The centre is also continuously working for maintenance, breeding of all released varieties.

Centre has also developed improved agro techniques for higher herb/ root/ oil yields with higher active ingredients in safed musli, henbane, sarpgandha, satawar, periwinkle, gudmar, gwarpatha, aniseed, mucunna, kalmegh, kiokand, muskdana, rosa grass, khas grass, rajnigandha and lemon grass crops. It has also developed techniques for quality root production of ashwagandha in rabi season and techniques for direct sowing in kalmegh and tulsi. The center has identified suitable conditions for intercropping of medicinal crops with traditional and agro forestry crops to get better economic returns.

The two centre i.e. Indore and Mandsaur have given 12 improved varieties of seven species of medicinal plants which are popular all over the country.

Powdery Mildew of Opium Poppy
(Erisyphae polygoni)

Safed Musli
Fascicutated root rot

Powdery mildew Mulhatti
(Glyceyrrhiza glabra)

Alternaria Blight of Chandrsur
(Lipidium sativum)

Raj Vijay Safed Musli-414

Local infection
Downy Mildew of Opium Poppy
(Pernospora arboresence)

Effect of 80 kg k/ha as 1/3, 1/3, 1/3

20:40:20 NPK kg/ha

(2) Crop Production

Field Crops

Agronomical research is aimed to generate production technology for improving the productivity of almost all crops grown in the State with the efficient use of available resources under the aegis of various research projects funded by the State Government and ICAR.

(i) Crop Management

The agro-techniques of crop production have been dealt under crop management including sowing, intercropping, sequential cropping, crop diversification etc.

Sowing management refers the sowing of suitable crop/variety at optimum time with proper method by using adequate seed rate to regulate the optimum plant population for high crop yields. Earlier a row spacing of 30 cm was congenial for rice and wheat crop, when tall indigenous varieties were grown. Now narrow row spacing at 20-22.5 cm has been found ideal to realize the potential yields of high yielding dwarf varieties of these crops. Further narrowing down of the row spacing as 15-20 cm for these crops under late sowing conditions has also been established (Gwalior 1968 to 70). Alteration of planting geometry for efficient utilization of natural resources like square planting in cotton (Indore 1982) increased productivity and profits. Combined yields of sorghum (Indore 1978) based inter-cropping systems are superior with alternate row and alternate paired row planting geometry under fertility and high fertility status, respectively. Optimum planting geometry has been identified for various crops/varieties grown in the State.

Table 18: Optimum planting geometry of different crops

Crop	Variety	Planting geometry (cm x cm)	Location & Year
Sorghum	Tall (Indigenous)	45 X 20	Indore & Gwalior (1965)
	Hybrid & Composite	30 X 15	Indore & Sehore (1966)
Cotton	American type in poor soils	45 X 30	Indore, Khandwa, Badnawar (1964-70)
	American type in	50 X 40	Indore, Khandwa,

Crop	Variety	Planting geometry (cm x cm)	Location & Year
	fertile soils		Badnawar (1964-70)
	Desi type for regular planting	45 X 30	Indore, Khandwa, Badnawar (1964-70)
	Desi type for square planting	45 X 45	Indore (1972)
	Hybrid regular planting	120 X 90 or 150 X 75	Indore, Khandwa (1984)
	Hybrid square planting	60 X 60	Indore, Khandwa (1984)
Sugarcane	All varieties	90 cm row to row and set to set	Sehore (1966-67)
Rice	Late varieties timely	25 X 20 or 20 X 20	Jaora, Sehore (1966)

Sowing time

Sowing time of crops has great correlation with germination and seedling establishment, development and ultimately yields of crops. Rice, soybean (Sehore, Indore 1983-85), sorghum and wheat are widely grown crops in the State and their yields reduced by 23.33, 31.40, 49.63 (Indore & Gwalior, 1982-85) and 15.24% (Indore & Gwalior 1972-83) respectively with 20 days delayed sowing over normal sowing time (Indore 1980-84). Optimum sowing time of important crops were recommended for different crops varieties in varying situations.

Table 19: Optimum sowing time for different crops/ varieties in varing situations.

Crop	Variety	Situations	Sowing time	Location & Year
Wheat	Tall	Rainfed	October 15 to November 5	Indore (1964)

	Mexican	Irrigated	Mid to end of November	Indore (1964)
Sorghum	Tall	Rainfed/irrigated	1st week of July	Indore, Gwalior (1970)
	Hybrid & Composite	When rains coincides with maturity	3rd week of July	Sehore (1974)
Cotton	Local & Improved	Rainfed/irrigated	1st week of July	Indore, Khandwa (1968)
Soybean	All varieties	Rainfed/irrigated	1st week of July	Indore (1970)

Sequential cropping systems

A large number of need based sequential cropping (double and multiple cropping) systems have been identified for both rainfed and irrigated conditions of different agro climatic zones of the State. Rapid and wide spread of soybean cultivation in the State during last 3 decades of 20th century, resulted into several soybean-based cropping systems.

Table 20: Suitable cropping systems for different agroclimatic zones/ situations

Cropping System	Suitable Agroclimatic Zone	Purpose	Location and Year
Double cropping system for Rainfed Production System			
Soybean*-Chickpea	All zones except Gird & Nimar valley	Higher profit	Indore (1970) & Sehore (1980-82)
Soybean*-Safflower	Malwa plateau & Vindhyan plateau	Higher profit	Indore (1982-85)
Pearl millet-Chickpea	Gird and Bundelkhand	Higher grain production	Gwalior (1978-80)

Cropping System	Suitable Agroclimatic Zone	Purpose	Location and Year
Double cropping for Irrigated Production System (Irrigation upto March)			
Soybean-Wheat	All zones	More yield and profit	Indore & Sehore (1980-84)
Hy. Sorghum-Wheat	Nimar valley & central Narmada valley	More grain yield	Indore (1972) & Sehore (1986)
Pearl millet/Moong-Mustard	Gird and Bundelkhand	More Production	Gwalior and Morena (1974-80)
Soybean-Potato	Malwa plateau	More profit near to towns	Indore (2000-02)
Intensive Cropping Systems under Assured Irrigation Throughout the Year			
Hy. Sorghum-Wheat-Green gram	Malwa plateau & Satpura plateau	Higher grain production	Sehore (1972-75) & Indore (1972-86)
Soybean-Wheat-Okra (V) / Sorghum (F)	Malwa plateau, Satpura plateau & Central Narmada Valley	Higher production & profit	Indore (2004)
Maize-Wheat-Sorghum (F)	Vindhyan plateau	More grain production	Gwalior (1976-80)

* Early duration variety, (V) Vegetable, (F) Fodder crop

Table 21: Pulses, Oil seeds and cereals based cropping system for different situation of Gird Zone of Madhya Pradesh

Situation / System	Yield (Kg/ha)			Total Yield	Net Returns (Rs./ha)
	I	II	III		
RAINFED					
Cowpea (Fodder + Pod+ Seed)-Mustard	12500 (F) 1965 (P)	1431	415 (S)	-	14,938
Fallow-Mustard (Standard check)	-	1707	-	1707	9,998
• Gram + Mustard intercrop (4:1) rows	1513	956	-	2469	13,531
• Pure crop of gram (S.Check)	1926	-	-	1926	8,924
• Lentil + Mustard intercrop (4:1)	701	1169	-	1870	9,621
• Pure crop of lentil (S.check)	1504	-	-	1504	5,093
SEMI IRRIGATED (2-3 IRRIGATION)					
• Green Gram-mustard	712	2230	-	2942	11,906
Black gram-mustard	1512	2169	-	3691	8,950
• Fallow – mustard (S.C.)	-	2232	-	2232	7,422
• Soybean-mustard	2046	1409	-	3455	19,425
Bajra-mustard (S.Check)	3633	2110	-	5743	-
Fallow-mustard (S.Check)	-	2024	-	2024	14,260

Situation / System	Yield (Kg/ha)			Total Yield	Net Returns (Rs./ha)
	I	II	III		
IRRIGATED (4-6 IRRIGATIONS)					
Pigeonpea-wheat	1973	3219	-	5192	8,378
Clusterbean-wheat	2946	2977	-	5923	7,668
Pearlmillet-wheat (s.c.)	3014	3665	-	6679	6,977
Fallow – mustard (Standard C.)	-	2232	-	2232	4,824
ASSURED IRRIGATION (5-7)					
Greem gram – Toria – wheat	757	1507	3152	5416	15,322
Black gram – Toria – wheat	740	1567	3201	5508	16,406
Cowpea (F)-Toria – wheat	18335	1655	2940	-	16500
Clusterbeans (F) – Toria – wheat	13806	1785	3148	-	16800
Fallow mustard (S. check)	-	2281	-	2281	12583

The above cropping systems having higher production, net return were identified on the basis of results of 2-4 years experiments conducted at ZARS, Morena from 1982-83 to 2005-06.

Promising intercropping systems

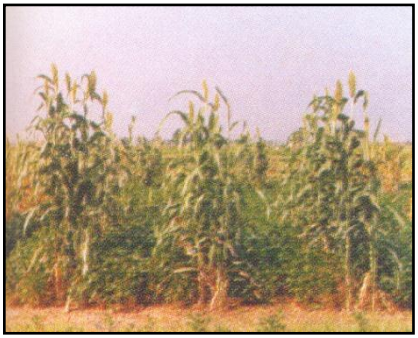
Growing of two or more crops simultaneously is the practice to further intensify the agriculture for maximization of production and profit per unit area and per unit time besides minimization of agricultural risks, improvement of soil properties and increase in resource use efficiency under both rainfed and irrigated production systems. Significant advantages from a large number of need based intercropping systems in terms of resource use efficiency, combined crop yields, monetary returns and improvement of soil-properties over sole cropping of either crop component have been investigated for different agro climatic zones of the state.

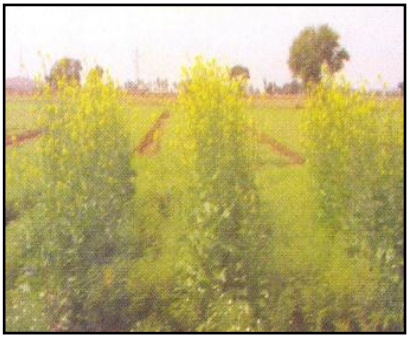
Table 22: Improved production technology of intercropping systems for different regions

Intercropping System	Row proportion	Row distance (cm)	Seed rate (kg/ha)		Fertilizer dose (NPK kg/ha)		Location and year
			Main crop	Intercrop	Main crop	Intercrop	
Pigeonpea + Sorghum	1:1	30	15	8	20:60:20	40:0:0	Indore (1980-82)
Pigeonpea + Pearl millet	1:2	30	15	15	20:60:20	40:0:0	Gwalior (1980)
Hy. Sorghum + Soybean/Black gram	2.4:2	30	12	50/12	100:60:40	0:30:0	Indore (1990)
Sorghum + Groundnut	2:2	30	20	50	50:30:20	0:30:0	Gwalior (1976)
Hy. Cotton + Soybean/ Groundnut	1:2	30	2	50/50	100:80:40	0:30:0	Khandwa (1976-82)
Hy. Cotton + Blackgram/ Green gram	1:2	30	2	12/12	100:80:40	0:30:0	Indore (1980-84)
Cotton + Soybean/ Groundnut	2:2	30	20	50/50	60:40:20	0:30:0	Indore (1980-84)
Cotton + Soybean/Maize	1:4	30	8	60/20	80:60:20	For both crops	Indore (1990)
Cotton + Sesame	1:2	30	20	2	60:40:20	30:20:0	Khandwa (1978)

Intercropping System	Row proportion	Row distance (cm)	Seed rate (kg/ha)		Fertilizer dose (NPK kg/ha)		Location and year
			Main crop	Intercrop	Main crop	Intercrop	
Wheat + Chickpea (Rainfed)	4:2	22.5	100	40	50:30:20	For both crops	Gwalior (1978-82)
Wheat-Safflower (Rainfed)	8:2	22.5	100	8	50:30:20	For both crops	Gwalior (1979-81) & Indore (1979-81)
Chickpea + Linseed (Rainfed)	3:1	22.5	60	6/10	20:60:20	For both crops	Sehore (1986)
Chickpea + Mustard (Rainfed)	6:2	30.0	60	6/2	20:60:20	For both crops	Gwalior (1974-78)
A. Sugarcane + French bean/ Pea / Chickpea	1:2	30	8000	50-60	250:100:60	20:40:0	Sehore (1970-74)
S. Sugarcane + Okra/Blackgram / French bean	1:2	30	8000	20-30	250:100:60	20:40:0	Sehore (1980-86)

(A- Autumn planted, S- Spring planted)





Intercropping systems at Sehore

Eco – friendly cropping system

Several intercropping or sequential cropping systems, which are earlier described, have been found to reduce the weed intensity and thereby reducing the cost of weed control. intercropping of broad leaved and short growing leguminous crops like black gram, green gram, cowpea, soybean and groundnut with tall growing widely spaced crops like maize, sorghum, cotton, pigeon pea during rainy season as well as, chickpea and linseed in sunflower; wheat, chickpea and linseed in mustard and potato in onion, wheat in sugarcane during autumn or winter seasons found advantageous to reduce the weed infestation. Adoption of rice-berseem (fodder) system in place of rice-wheat system reduces *Phalaris minor* infestation to a great extent, which is otherwise not achieved even through the use of herbicides. Not only weeds are minimized to reduce the use of herbicides by several intercropping / sequential cropping system, but use of insecticides / fungicides can also be minimized to a considerable extent through them.

Efficient cropping system under resource constraints

Fertilizer application appeared to be main yield contributing resource for cereal crops. Weed management was next important resource for Kharif crops; while irrigation appeared to be next most important resource influencing the Rabi crop yields. Growing of pulse and oilseed crops appeared to be more remunerative than growing of cereal crop during Rabi season under limited (one or two irrigations) irrigation supplies. Weed control in soybean and irrigation in wheat proved to be most critical inputs for increasing the productivity of soybean-wheat system (Indore & Sehore 1983-85).

AICRP on Cropping Systems Research, Indore

Diversification of cropping system

Soybean (JS 335)

Potato (Jyoti)

Late wheat (GW 173)

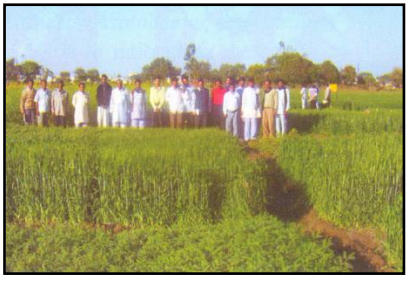
High value organic based cropping system

Maize (JM 216)

Potato (Kufari Lawkar)

Onion (Agrifound light Red)

Dr. Mangla Rai DG ICAR & Secretary DARE, New Delhi



Farmers of Madhya Pradesh and other states visited CSR

Intensification of cropping system

Soybean (JS 335) + Sorghum (CSH 18) 4:2

Soybean (JS 335) + Maize (JM 216) 4:2

Sustainable model

Soybean (JS 335)

Wheat (HI 8498)

(ii) Nutrient Management

Balanced use of fertilizers

Balanced fertilizer application to important field crops grown under existing production systems of the State has been evaluated.

Table 23: Fertilizer recommendations for major crops

Crop(s) and Varieties	Production system	Fertilizer dose (kg/ha)			Location and Year
		N	P_2O_5	K_2O	
Sorghum Deshi	Rainfed	40-60	30	20	Indore & Gwalior (1964-1968)
Sorghum Composites/Hybrids	Rainfed/ Irrigated	100-120	50-60	30-40	Indore & Gwalior (1964-1970)

Crop(s) and Varieties	Production system	Fertilizer dose (kg/ha)			Location and Year
		N	P_2O_5	K_2O	
Soybean/Ground nut/Pigeonpea	Rainfed/ Irrigated	20	60-80	20	Indore, Khargone & Gwalior (1966-1990)
Black gram/Green gram	Rainfed/ Irrigated	20	50	-	Gwalior(1964-1970)
Cotton Deshi	Rainfed	40	20	10	Indore, Khandwa & Badnawar (1968-1996)
Cotton Improved	Rainfed/ Irrigated	60-80	30-40	15-20	Indore, Khandwa & Badnawar (1968-1996)
Cotton Hybrids	Rainfed/ Irrigated	120	60	30	Indore, Khandwa & Badnawar (1968-1996)
Tall Wheat	Rainfed	20-50	10-15	-	Sehore, Indore & Gwalior (1966-1970)
Tall Wheat	Irrigated	50-60	20-25	15-30	Sehore, Indore & Gwalior (1966-1970)
Wheat Dwarf	Rainfed/ Haveli	50-60	20-25	15-20	Sehore, Indore & Gwalior (1966-1970)
Chickpea	Rainfed	10	30	0	Gwalior & Sehore (1966-1988)

Crop(s) and Varieties	Production system	Fertilizer dose (kg/ha)			Location and Year
		N	P_2O_5	K_2O	
Chickpea	Irrigated	18-20	60	0	Gwalior & Sehore (1966-1988)
Peas	Irrigated	20	60	10	Gwalior (1976-1984)
Mustard	Irrigated	90-100	40-50	25-30	Morena (1986-1990)
Safflower	Rainfed	40	20	-	Indore (1974-1978)
	Irrigated	40	40	-	Indore (1974-1978)
Sunflower	Irrigated	80	60	40	Indore (1990-1996)
Sugarcane	Irrigated	250-300	100-125	50-60	Sehore, Bagbai & Jaora (1970-74)

INM for predominant cropping systems

Integrated use of 50 to 75% of recommended dose of NPK fertilizers (RDF) through inorganic with FYM or green manures (Sunhemp) @ 12 or 6 t/ha, respectively to sorghum in sorghum-wheat system at Indore during 1987-94 followed by 75% RDF to succeeding wheat in sorghum-wheat sequence was comparable to application of 100% RDF through fertilizers only to each crop component in sorghum-wheat sequence in terms of yields of individual crops or total yields of entire system on long term basis. Integration of wheat straw in place of FYM or green manure with the same rates reduced the crop yields up to 6 crop-cycle and then orderly increased the crop yields by equalizing the level of 100% RDF up to 12 crop-cycle. Thus, a saving of about 50% RDF could be made by integrated use of FYM or green manure of crop residues on long term run basis with the maintenance of sustainable productivity level.

Nutrient use efficiency

Among the slow release N-fertilizers, S-coated urea, lac coated urea and neem or mauha cake coated urea helped to increase the grain and stover yields of sorghum at Indore (1976-80). Application of neem cake coated urea in sugarcane helped to curtail about 25 to 50 kg N/ha depending on the dose of fertilizers at Sehore (1980-86).

Application of 60 kg P_2O_5/ha alternate year to chickpea only in soybean-chickpea system was comparable to application of 60 kg P_2O_5/ha to both crops every year in terms of the productivity from entire system at Indore and Sehore during 1990-98.

Use of secondary and micronutrients in crop / cropping systems

After popularization of new sequential cropping systems by growing high yielding crops/varieties with the use of NPK fertilizers, sporadic and wide spread occurrence of deficiencies of S and micro-nutrients (Zn, Fe, Mn and B) were noticed in intensively cultivated areas. Several crops responded to S-application according to crop/varieties, S-status of soil and rainfall distribution as well as irrigation. Rice, wheat, soybean groundnut, linseed, mustard and chickpea markedly responded up to 10-15 kg S/ha under rainfed conditions, while these crop increased yields up to 30 kg S/ha with irrigation. Application of 25 kg S/ha through gypsum as well as 10 kg Zn/ha through $ZnSO_4$ in alternative years to both crops along with recommended dose of NPK fertilizers in a soybean-wheat cropping system increased the productivity and monetary returns in multi location studies made for 6 years (Indore & Sehore 1990-96). In zinc deficient soils, application of 25 to 30 kg $ZnSO_4$/ha to either crop under sorghum-wheat (Indore & Sehore, 1976-80) system was found quite promising. Application of Zn, Cu, Mn and Mo at 30, 65 and 90 day growth stages in cotton increased 8-10% yields at Indore, (1966-70).

Bio-fertilizers as a cheap source of plant nutrition

Crop specific Rhizobium strains have been evaluated for different legume crops grown in the State. Inoculation has been found effective to enhance N-fixation by increasing nodulation in Groundnut at Khargone (1980) and Chickpea (Gwalior 1970-76). The performance of Rhizobium was not much impressive in Pigeon pea and Lentil at Sehore during 1982-86. Bacterification of 500 gram of Azotobactor mixed with 50 kg FYM/ha in crop rows of non-legume crop like Cotton (Indore, 1986-90) have found promising to save nearly 20-25 kg N/ha. Inoculation of 500 g PSM along with 50 kg FYM/ha in the rows of almost all crops below the seed helped in improving the P-use efficiency at Indore during 1998-2000.

(iii) Weed Management

The weed problem is serious in the state. It's seriousness depending on the climate, soil types, cropping pattern etc., weed management by hand weeding and mechanical means in heavy soils are difficult. The problem of weed management is also serious due to dependence of cultivation on precarious rainfall, small holdings and socio-economic status of the farmers (AICRPWC, 2008).

Crop-weed competition and losses

Weeds compete with the crops for nutrients, moisture, sunlight and space and they cause serious damage to crop in terms of yield and quality. Mostly weed-competition depends on nature and intensity of weed flora, soil type, agro climatic condition and management practices. The duration of weed infestation and time of weed removal have great concern with growth and yield of crops. The critical period of crop weed competition and yield losses due to weed infestation in different field crops were estimated.

Weed Management Practices

(i) Cultural

(a) Stale Seedbed Technique

A stale seedbed technique is one where successive flushes of weeds are destroyed before planting of any crop and therefore, less number of weeds are expected to interfere with the crop. Where light rains occur for an extended period before the onset of monsoon or irrigation is available, it may be possible to kill several flushes of weed growth before planting during Kharif season. Stale seedbed was more effective in reducing weed population in soybean. Higher weed control efficiency in wheat under stale seedbed condition was reported as compared to normal sowing .

(b) Crop-rotation and intercropping

In mono-cropping system, numerous weed species persist and expand rapidly but crop rotation helps in interrupting the life cycle of weeds and prevents any weed species to become dominant. Incidence of *Phalaris minor* was higher in rice-wheat system than in maize-wheat system. Adoption of rice-berseem system for 2 years helped to manage the problem of *Phalaris minor*. Intercropping suppresses weeds better than sole cropping and thus, provides an opportunity to utilize crop themselves as tool of weed management. Intercropping of maize with soybean, groundnut, pigeon pea and blackgram suppressed the weed growth by 15.4 to 33.7% as compared to sole crop of maize (Khargone & Indore, 1980-90).

(ii) Mechnical

Inter-culture operations are performed primarily to destroy the weeds present in the field and create favourable soil conditions for plant growth. One hand weeding in winter season crop and two hand weeding in rainy season during critical stage of crop-weed competition provide satisfactory control of weeds in almost all the crops.

(iii) Chemical

In modern agriculture, weed control through herbicides is the most popular method as it is more labour and energy efficient than other methods. Several herbicides have been recommended for weed control in different field crops by AICRP-WS.

Weed control recommendations (AICRP on Weed Control, Gwalior)

(i) Rice

Butachlor 1.5-2.0 kg/ha, thiobencarb 2.5 kg/ha, anilofos 0.45, pretilachlor 0.5-1.0 kg/ha, Pendimethalin 1.0-1.5 kg/ha at 4-7 DAT or oxadiazon 0.75-1.00 kg/ha or oxyfluorfen 0.23 kg/ha as pre-emergence or clomazone + 2, 4- D EE 0.75kg/ha at 20-25 DAT.

Effect of Butachlor 1.5-2.0 kg/ha in Rice

Effect of Anilofos 0.45 kg/ha in Rice

(ii) Wheat

Pendimethalin 1.0 kg/ha as pre-emergence or isoproturon 0.75–1.0 kg/ha pre or post emergence or clodinafop 0.6 kg/ha as pre- or early post-emergence or sulfosulfuron 0.025 kg/ha, trisulfuron 0.015-0.020 kg/ha, carfentrazone-ethyl + isoproturon 0.020 + 1.0 kg/ha, 2,4- D Na salt 0.50 kg/ha, 2,4-D + isoproturon 0.5 + 0.75 kg/ha, oxyfluorfen 0.2 kg/ha, metsulfuron 0.004-0.006 kg/ha, or trisulfuron + isoproturon 0.015 + 0.75 kg/ha as early post-emergence or isoguard 1.0 kg/ha / metsulfuron 0.004 + isoproturon 1.0 kg/ha as post emergence. Carfentrazone ethyl 0.015-0.020 kg/ha post.

Effect of Pendimethalin 1.0 in wheat

Weedy check situation in wheat

Effect of Isoproturon 1.0 in wheat

(iii) Groundnut/Sesamum

Trifluralin 0.75 kg/ha or Fluchloralin 1.0 kg/ha (post emergence) as pre-plant incorporation or alachlor 1.5-2.0 kg/ha, Pendimethalin 0.75 kg/ha, quizalofop ethyl 0.050 kg/ha butachlor (niger) 2.0 kg/ha or oxyfluorfen (groundnut) 0.120 kg/ha as pre-emergence. Imazethapyr 0.010 kg/ha as post emergence (Groundnut).

Effect of Fluchloralin 1.0 kg/ha in Groundnut

Weedy check situation in Groundnut

Effect of pendimethalin 1.0 kg/ha in Groundnut

Effect of Pendimethalin 0.75 kg/ha in Sesamum

Weedy check situation in sesamum

Effect of Quizalofop 0.050 kg/ha in sesamum

(iv) **Soybean**

Pendimethalin 1.0 kg/ha, metribuzin 0.25 kg/ha, clomazone 0.75-1.0 kg/ha, metolachlor 1.0 kg/ha, lactofen 0.12 kg/ha, alachlor 2.0 kg/ha or oxyfluorfen 0.23 kg/ha as pre-emergence or imazethapyr 0.10 kg/ha as early post-emergence at 20 DAS or fluchloralin or trifluralin 1.00 kg/ha as pre-plant incorporation or chlorimuron-ethyl + fenoxaprop 0.09-0.10 kg/ha as early post-emergence as quizalofop ethyl 0.05 kg/ha as post emergence (20 DAS)

Effect of Pendimethalin 1.0 kg/ha in soybean

Weedy check situation in soybean

Effect of imazethapyr 0.10 kg/ha in soybean

(v) Mung/ Urd/ Arhar

Fluchloralin 1.0 kg/ha as pre-plant incorporation or alachlor, pendimethalin, or Metolachlor 1.0 kg/ha as pre-emergence or fluazifop-P-butyl 0.25 kg/ha as early post-emergence.

(vi) Maize

Alachlor 1.0-1.5 kg/ha, atrazine 0.5-1.0 kg/ha or Pendimethalin 1.0-1.5 kg/ha or metolachlor 1.0 kg/ha as pre-emergence or 2,4–DEE 0.75-1.0 kg/ha as early post-emergence at 20-25 DAS.

(vii) Pearl millet

Atrazine 0.5-1.0 kg/ha or Pendimethalin 1.0 kg/ha as pre-emergence.

Soybean (JS 335)

Potato (Jyoti)

Late wheat (GW 173)

(viii) Gram/ Lentil/ Pea

Fluchloralin 1.0 kg/ha as pre-plant incorporation or Pendimethalin 1.0 kg/ha, isoproturon 1.0 kg/ha as pre-emergence and prometryn 1.0 kg/ha as pre-emergence in (Pea)

Effect of Fluchloralin 1.0 kg/ha in Pea

Weedy check situation in Pea

Effect of isoproturon 1.0 kg/ha in pea

(ix) Mustard

Fluchloralin 1.0 kg/ha as pre-plant incorporation or Pendimethalin 1.0 kg/ha, isoproturon 0.75-1.0 kg/ha, oxadiargyl 0.09-0.12 kg/ha or oxadiazon 1.0 kg/ha as pre-emergence, quizalofop – ethyl 0.050 kg/ha as post emergence.

Effect of Pendimethalin 1.0 kg/ha in mustard

Weedy check situation in mustard

Effect of oxadiargyl 0.09 kg/ha in mustard

(x) Potato

Pendimethalin 1.0 kg/ha, prometryn 1.0 kg/ha or metribuzin 0.5 kg/ha as pre-emergence or paraquat (early) 0.5 kg/ha as post emergence.

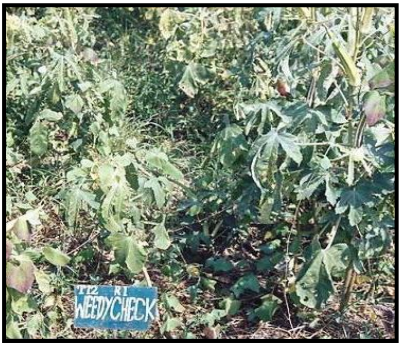
(xi) Isabgol

Sulfosulfuron 0.025 kg/ha or isoproturon 0.75 kg/ha as early post-emergence.

(xii) Okra

Metolachlor 1.0 kg/ha as pre-emergence or fluchloralin 1.0 kg/ha as pre-plant incorporation.

Effect of Fluchloralin 1.0 kg/ha in Okra



Weedy check situation in Okra

(xiii) Coriander

Pendimethalin 1.0 kg/ha or isoproturon 0.75 kg/ha as pre emergence + one hand weeding at 30 DAS.

Effect of Pendimethalin 1.0 kg/ha in coriander

Weedy check situation in coriander

Effect of isoproturon 0.75 kg/ha in coriander

(xiv) Onion

Oxadiargyl 0.090 kg/ha or Oxyfluorfen 0.25 kg/ha as pre emergence + one hand weeding at 45 DAT.

Effect of oxyfluorfen 0.25 kg/ha in onion

Effect of oxadiargyl 0.090 kg/ha in onion

Integrated Weed Management in different crops:

1. Sorghum/Maize	:	Atrazine 1.0 kg + hand weeding 35 DAS
2. Soybean	:	Oxadiazon 1.0 kg/ha / fluchloralin 1.0 kg/ha / metribuzin 0.5 kg/ha + hand hoeing / Hand Weeding at 30 DAS
3. Groundnut	:	Alachlor / pendimethalin 1.0 kg/ha + hand hoeing at 30 DAS
4. Green gram/ Blackgram	:	Fluchloralin 0.5 kg PPI + Hand Weeding at 30 DAS
5. Pea	:	Fluchloralin / pendimethalin 1.0 kg/ha + 1 Hand Weeding at 30 DAS
6. Okra	:	Metolachlor 1.0 kg/ha PE or fluchloralin 1.0 kg/ha PPI + one hand weeding

Tillage: Pearl millet-Wheat

Minimum tillage (Blade harrowing once followed by cultivator and leveling) in kharif for Pearl millet and minimum tillage (Two round of cultivator followed by leveling) in rabi for Wheat, were found remunerative than other tillage practices under sandy clay loam soils

Cropping systems

(i) Rice-wheat:

Butachlor 2.0 kg / ha as pre-emergence superimposed with 2,4-D 1.0 kg/ha at 20 DAS in rice and isoproturon as pre-emergence in wheat.

(ii) Soybean-wheat:

Fluchloralin 1.0 kg/ha as pre-plant incorporation or oxyfluorfen 0.2 kg/ha or metolachlor 1.5 kg/ha, as pre-emergence in soybean and isoproturon 1.0 kg/ha as post-emergence in Wheat.

(iii) Soybean-gram:

Alachlor 2.0 kg/ha or pendimethalin 1.00 kg/ha as pre-emergence in soybean and isoproturon 1 kg/ha as pre-emergence in subsequent gram.

Inter cropping systems:

(i) Wheat based

Wheat+mustard: pendimethalin 1.0 kg/ha or isoproturon 1.0 kg/ha as pre-emergence

(ii) Soybean based

Soybean + pigeon pea: Metolachlor 1.0 kg/ha or Pendimethalin 1.0 kg/ha as pre- emergence.

(iii) Problematic weeds

***Parthenium hysterophorus*:** Glyphosate1.5 kg/ha, 2, 4- D Na salt 3.2 kg/ha, common salt 15% solution or metribuzin 0.3% at pre-flowering stage.

Asphodelus tenuifolius: Oxadiazon 0.75 kg/ha or oxyfluorfen 0.23 kg/ha or Oxadiargyl (0.090kg/ha) or butachlor 2.0 kg/ha as pre-emergence.

Lawn: 2,4-D 1.0-1.25 kg/ha to control the broad leaf weeds and sedges. Repeat at an interval of 25-30 days, if necessary.

Herbicide Residue Studies

(i) Persistence of herbicides in soil : In post harvest soil, no residual activity of different herbicides applied to different crops (Wheat, soybean, maize, pearlmillet, etc.) were found. Herbicides Atrazine, alachlor, isoproturon and 2,4-D persisted in soil up to 30 days: metribuzine, metolachlor, chlorimuron ethyl, fenoxaprop and clodinafop

persisted from 30-45 days while pendimethalin and sulfosulfuron persisted from 45-75 days applied to different crops.

(ii) Persistence of herbicides in soil applied to wheat : Sulfosulfuron (25 g/ha) and metsulfuron (6 g/ha) applied to wheat persisted in soil up to 45 days while all other herbicides viz. IPU (0.75 kg/ha), fenoxaprop (120 g/ha), metribuzine (250 g/ha), metsufuron + IPU (4 g + 0.75 kg/ha), clodinafop (60 g/ha) and clodinafop + metribuzin (60 + 150 g/ha) persisted up to 30 days and isogourd (IPU + 2,4-D 1.0 kg/ha) up to 15 days as per bioassay technique using cucumber as test plant.

(iii) Persistence of atrazine in soil applied to Bajra under different tillage practice : Atrazine persisted in soil upto 30 DAA under different tillage practices in pearlmillet and afterwards the residues were not found in soil as per bioassay technique using barley as test plant.

(iv) Persistence of Pendimethalin in soil applied to different crops: Pendimethalin persisted in soil under different crops (gram, lentil, linseed, safflower, fenugreek, fennel and coriander) up to 75 DAA and beyond that no residues were left in soil.

(v) Leeching behaviour of herbicides : Pendimethalin leaches in soil (sandy clay loam) up to 10 cm, Chlorimuron ethyl 20-25 cm, Fenoxaprop-p-ethyl 30-35 cm, Atrazine and 2,4 D up to 30 and 40 cm and Sulfosulfuron up to 50 cm.

(vi) Residual activity of herbicides in the farmers field : Herbicides Atrazine, pendimethalin, Isoprotouron, 2,4 – D, sulfosulfuron and oxydiargyl applied to different crops (pearl millet, wheat and mustard) at farmers fields did not show the residual activity in post harvest soil.

(vii) Under lab conditions higher degradation of sulfosulfuron at 100% moisture level in soil was recorded as compared to 50% moisture level.

(viii) Effect of herbicides on succeeding crops : Chlorimuron ethyl applied to soybean @ 18 g/ha reduced the growth of succeeding mustard crop.

(ix) Residual effect of herbicides applied to coriander on succeeding crops (2008) : Herbicides trifluralin 1.0 kg/ha (PPI), pendimethalin 1.0 kg/ha (PE) and isoproturon 0.75 kg/ha (PE/PoE) applied to coriander do not leave any residue in post harvest soil as evident by the growth of succeeding maize, cucumber and moong plants.

(x) Residual effect of herbicides applied to mustard on succeeding crops (2008): Herbicides Fluchloralin 1.0 kg/ha (PPI), oxyfluorfen 0.25 kg/ha PE, pendimethalin 1.0 kg/ha (PE), isoproturon

0.75 kg/ha (PE), oxydiargyl 0.090 kg/ha (PE) and quizalofop ethyl applied to mustard as such or followed by one hand weeding 25 DAS do not leave any residue in post harvest soil as evident by the growth of succeeding maize and moong crops.

Table 24: Persistence of herbicides in the farmers field

Year	Crop	Recommendation
2006	Pearlmillet	Atrazine applied to pearlmillet in farmers field of Morena district @ 0.5 kg/ha post emergence does not leave any residue in post harvest soil.
2007	Wheat	Isoproturon, 2,4-D and sulfosulfuron applied to wheat does to leave any residue in post harvest soil.
2008	Mustard	Herbicides pendimethalin and oxydiargyl applied to mustard in farmers' fields do not persist in post harvest soil.
2008	Wheat	Out of three herbicides viz. pendimethalin, isoprotouron and sulfosulfuron, sulfosulfuron persisted in soil after harvest of wheat as per bioassay study using maize as test plant.

(iv) Water Management

a. Irrigation Schedule

Different factors viz crop, soil and climate play a key role for determining the proper time of irrigation to any crop. Scheduling of irrigation to crops based on various approaches were established (AICRPWM, 2008).

Table 25: Irrigation guide of important crops (Consolidated Report AICRP Water Management Morena 1980-90)

Crop	Water requirement (cm)	Depth of irrigation (cm)	Number of irrigation	Irrigation schedule criteria		
				Critical growth stage	Available soil moisture	ID/ CPE
Wheat (dwarf)	35-50	5-6	3-6	CRI, Flowering	60% ASM	1.0

Crop	Water requirement (cm)	Depth of irrigation (cm)	Number of irrigation	Irrigation schedule criteria		
				Critical growth stage	Available soil moisture	ID/ CPE
Wheat (Tall)	25-32	7-8	2-4	Flowering, grain filling	50% ASM	0.8
Sorghum	24-45	6-7	2-6	Flowering, premodia initiation	45% ASM	-
Maize	30-45	6-7	3-6	Knee height, tussling, siking	50% ASM	-
Pearl Millet	10-30	5-6	1-5	Flowering, tillering	-	0.6
Soybean	20-35	5-6	3-6	Flowering	50% ASM	0.6
Mustard	15-30	5-6	2-3	Flowering, Pod filling	60% ASM	0.6-0.8
Safflower	10-25	7-8	2-3	Flowering, pod filling	40% ASM	0.6
Chickpea	15-25	6-7	2-3	Floral bud initiation, seed	50% ASM	0.6

b. Cropping system based irrigation scheduling

Based on the significant findings of AICRP on Cropping Systems (1980-86) continuous submergence of water 5 ± 2 cm followed by allowing the field to a saturation limit for 3-4 days at the interval of 10 days in rice and then irrigating wheat at crown root initiation (CRI) and flowering (F) stages proved to be the most efficient water use in rice-wheat system. It is notable that wheat yield increased, when it was sown after rice by irrigation preceding crop 10 days before harvesting compared to its sowing in dry field after harvesting rice and irrigated for germination. Soil moisture stress at CRI and F stages in wheat reduced its grain yields by 20 and 15% respectively.

(v) Dryland Farming

a. Improved Agro-techniques for Dryland Farming

Basic principle to ensure desirable productivity level of crops in such areas is to use all possible fractions of rainfall for proper germination, establishment and then further growth of crops. Since onset and termination of rainfall and its distribution have great concern with the availability of soil moisture for the success of crops under rainfed / dryland farming situations, contingent plans are developed according to rainfall aberrations mentioned as below.

b. Early season rainfall aberrations

Dry sowing of kharif crops like rice, sorghum, pigeon pea and soybean can be successfully done with the onset of the rainfall in order to compensate the delay in sowing time, because of difficulties in land preparation. This practice will be helpful to utilize the benefit of available rainfall under early season rainfall aberration resulting in low crop yields because of delayed sowing.

c. Exceptional delay in onset of monsoon

If the rainfall is delayed for substantial period, timely sown suitable crops due to timely onset of monsoon may not perform well under dryland condition. Practice of sunflower + pigeon pea and maize + pigeon pea inter cropping systems followed by mono cropping of pigeon pea and sunflower was found more economically viable than mono cropping of soybean and maize.

d. Intermittent rainfall aberrations

Moisture stress during crop growth stages of high foliage resulted in to maximum reduction in crop yields. Defoliation of 30% leaves from lower half stalks of sorghum and removal of plants from every third rows of sorghum were found to be advantageous to mitigate the effect of moisture stress during crop growth period (AICRPDA, Indore, 1980-84)

e. Selection of suitable plant types

Improved varieties of various crops suitable for dryland farming have been identified (Table) which have high harvest index because of more WUE.

Table 26: Improved crop varieties suitable for dryland farming (AICRPDA, 1972-2002)

Crop	Variety	Reference
Soybean	JS. 75-01, JS 335, JS 86-31	Indore (1989-93)
Maize	Navjot, JM-8, NLD, JM-12	Indore (1972-80)
Sorghum	JS-398, JS 1041, JS-1026	Indore (1974-78)
Pigeon pea	JA-4, ICPL-87, JLA-30, ICPL-88039	Indore (1990-92)
Groundnut	Jalgaon 24	Indore (1998-2002)
Chickpea	JG-218, U-21	Indore (1982-85)
Safflower	JSF-1, JSF-8	Indore (1992-95)
Sunflower	Mordan	Indore (2000-2002)
Wheat	Narmada 4, 112, Sujata, Meghdoot	Indore (1980-84)

f. Use of different mulches growth regulators and anti transpirants

Use of safflower or soybean, haulma @ 4t/ha, or green weed biomass of crop 6t/ha as well as foliar spray of CCC 50 ppm or kaolin 4% was found quite effective in enhancing the WUE in soybean, cotton and sunflower at Indore (1980-88).

g. Rain water harvesting and its recycling

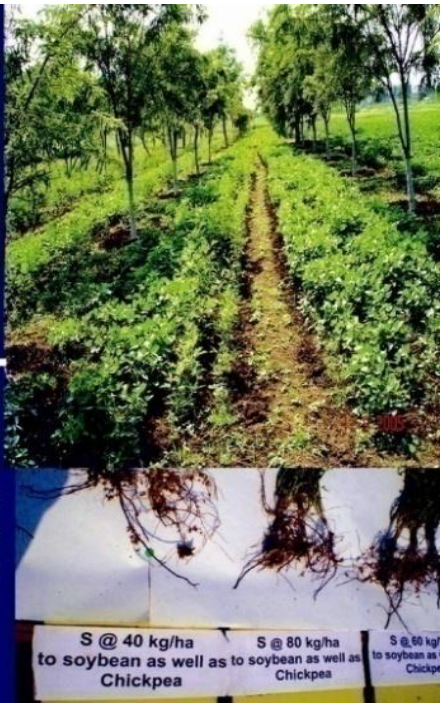
Giving an irrigation to stabilize and improve the yield of a crop, which is otherwise dependent on rainwater, is termed supplemental irrigation. Giving a supplemental irrigation during prolonged drought by using harvested rain water in tanks can make all the difference between a

total crop failure and good yield. The productivity of different crops can be increased per unit of area and thus risk of uncertainty can be significantly minimized by effective utilization of harvested runoff water in suitable farm ponds.

Hydrological studies (Indore, 1981-87) revealed the tremendous scope of harvesting and recycling runoff. Runoff potential in western parts of the State of MP varies from about 21-54% of annual precipitation depending upon soil type and intensity of rains. Runoff water may be collected during rainy season when it is in surplus and being utilized during dry spells. If there are no drought spells during the rainy season, then it may be utilized for ensuring double cropping under rainfed situation. Only one irrigation of runoff collected water not only enhanced the productivity of rainy season soybean and maize by 14.2% and 17.0 % respectively, but an average production of chick pea (552 to 979 kg/ha) and of safflower (1290 and 1859 kg/ha) could be realized which otherwise was not possible. Recycling runoff only once prior to emergence enhanced the productivity of wheat and safflower by 36% and 25%, respectively by ensuring germination and optimum plant population (AICRPDA, 1998-90).

Fruits spp. like Aonla, Drumstick, Ber, Custard apple, Phalsa, Guava planted at 6 m x 6 m with crop components viz., Soybean and Pigeonpea as sole and intercropped (4:2). Among different combinations tested, Soybean – Chickpea with Ber was superior with B:C ratio of 2.66. Followed by Soybean – Chickpea with Aonla with B:C ratio of 2.85 in the study.

In sulphur deficient soil, application of Sulphur through Gypsum or Sulphur dust @ 40 to 60 kg ha^{-1} can be recommended as it has recorded the highest B:C ratio of 3.41 and 3.57 respectively, and enhances the productivity upto 17 % in Soybean and Soybean –Safflower and Soybean – Chickpea cropping sequences.



Pigeonpea sole and along with soybean exhibited the higher SEY of 2668 & 3672 Kg ha^{-1}, 4.40 & 6.05 B:C ratio and 3.43 & 4.76 RUE respectively over other treatments. If monsoon was delayed by 10 or 20 days from normal then intercropping of Soybean /Sunflower + Pigeonpea were found remunerative

Maximum net return recorded with sweet corn cob-limonium cut flowers cultivated by using harvested rain water adoptingd rip irrigation.

For effective control of soil erosion construction of Gabions, plugging of *Nalhas*, and diversion bunds at suitable sites are recommended.

BBF or Ridge & Furrow system enhances soybean productivity and helped in reducing seed rate by 25%.

AICRP for Dryland Agriculture, College of Agriculture, Indore

AICRP for Dryland Agriculture was started in 1971 at Indore. The Project commissioned to fast track efforts to conserve, develop and sustain basic means of production i.e. soil and water.

The significant achievement emerged out on – station and on – farm studies lead to the following practical recommendations for farmer's use and are summarised as below (AICRPDA, 2008):

- Deep ploughing upto 30 cm in summer improves moisture storage by 2% to 3%.
- For lands having 1 to 1.5% slope, flat sowing on grade (0.3 to 0.4%) provides good surface drainage.
- For lands having slope > 1.5% adoption of ridge and furrow (RF) system & BBF have been found effective.
- Planting of rainy season crop across the slope is recommended for in – situ water conservation. Soybean planted across the slope helped in minimising the runoff.
- In – situ soil mulching by "DORA" (small blade harrow) is recommended for weed control and moisture conservation. An increase in WUE of chickpea and linseed has been recorded as 25% and 10% due to soil mulch.
- Soil mulch was effective in conserving the moisture and in increasing the yield of wheat and safflower by 11 and 15%, respectively.
- Use of straw as mulch was effective for soil moisture conservation, increase in soil fertility and productivity and water use efficiency. An increase in WUE of chickpea and linseed has been recorded as 45% and 18% due to 6 t/ha straw mulch respectively.
- On medium to deep vertisols, soybean based sequential cropping viz. soybean – safflower/ chickpea/ linseed were found most remunerative than the black gram based ones. These recorded a net profit of Rs. 17366, 16394 and 17900/ha respectively whereas of black gram based systems net profit ranged only in between Rs. 9000 to 10000/ha.
- Conjunctive use of FYM/ compost and fertilizer increase and stabilize the productivity, WUE and mitigate short term drought effect. Application of 4 t/ha FYM enhanced the rainfed sorghum yield as well as recovery of P_2O_5 from soil by 27.5% and 141% respectively over control. Application of 5 t/ha of FYM resulted in tremendous increase in yield of soybean and safflower (80%

& 84%) grown in sequence as compared to the ionic level of nutrients through fertilizers.

- Soybean – safflowers, urid – safflower & soybean – chickpea are the most suitable crop rotation under rainfed condition for sequential cropping.
- Under rainfed condition application of 50% of the recommended of fertilizers to rabi crops: chickpea/ safflower/ mustard when sown after soybean (RDF) has been adequate to realise optimum productivity.
- Under rainfed condition sequential cropping, 50% RDF needs to be applied for releasing optimum yield of chickpea/linseed/mustard crops.
- Soybean + pigeon pea has emerged most profitable intercropping system.
- Studies on requirement of plant population for intercropping revealed that sorghum + pigeon pea (100% + 50%) recorded 7%, 1.5% and 108% higher sorghum equivalent yield than sole pigeon pea, sorghum + pigeon pea (100% + 100%) and sole sorghum, respectively.
- Studies on soybean + castor intercropping resulted in a net profit of Rs. 17513/ha as compared to sole soybean (Rs. 12272/ha) followed by soybean + cotton (net profit of Rs. 106999/ha).
- In soybean + pigeon pea intercropping application of 20, 40 and 80 kg P_2O_5 /ha enhanced yield of soybean by 14%, 28% and 54% and pigeon pea recorded 11%, 12%, & 41% yield improvement.
- BBF or ridge & furrow system enhance soybean productivity and helped in reducing seed rate by 25%.
- For effective control of soil erosion construction of gabions, ploughing of Nalhas and diversion bunds at suitable sites are recommended.
- Maximum net return recorded with sweet corn cob- limonium cut flowers cultivated by using harvest rain water adoption drip irrigation.
- Pigeon pea sole and along with soybean exhibited the higher SEY of 2668 & 3672 kg/ha, 4.40 & 6.05 B:C ratio and 3.43 & 4.76 RUE respectively over other treatments, if monsoon was delayed by 10 or 20 days from normal then intercropping of soybean / sanflower + pigeon pea were found remunerative.
- Fruit spp. like aonla, drumstick, ber, custard apple, phalsa, guava planted at 6m × 6m with crop components viz. soybean and

pigeon pea as sole and intercropped (4:2). Among different combination tested, soybean – chickpea with ber was superior with B:C ratio of 2.66 followed by soybean chickpea with aonla with B:C ratio of 2.85 in the study.

- In sulphur deficient soil, application of sulphur through gypsum or sulphur dust @ 40 to 60 kg/ha can be recommended as it has recorded the highest B:C ratio of 3.41 and 3.57, respectively and enhances the productivity upto 17% in soybean and soybean – safflower and soybean – chickpea cropping sequences.
- Planting of soybean – safflower in sequence on BBF + 30 kg P_2O_5 + 6t/ha FYM + 2.5 lt. Fluchloralin (PPI)/ha in combination enhanced the yield of soybean by 66% & that of the succeeding crop of safflower by 36% as compared to conventional planting i.e. FB + 30 KG N + 60 kg P_2O_5.
- Make provision for collection of runoff in appropriate water storage structure & recycle runoff harvested water for life saving irrigation during dry spell season and ensure double cropping under normal monssonic conditions.
- Mechanically metered CIAE seed drill has been found most suitability for planting of soybean, sorghum and safflower crops.
- Heavy duty cultivator either alone or along with butchering (blade harrow) proved superior over other tillage operations.
- For effective control of soil erosion construction of gabions, plugging of Nalas and Drivers bunds of suitable sites are recommended.
- Raised and sunken beds proves most effective in insiter conservation of rain water, checking soil and nutrient losses.
- Graded bunds alone and/or along with vegetative barrier at vertical interval of 50 cm proved most effective in controlling soil erosion and nutrient losses on 2% sloppy soils.
- Silparelin (a polymer plastic material) of 90-120 gsm has been found an effective lining material for farm ponds.
- The inter-row distance of 25cm gave 10 and 17% higher yield of soybean (JS 71-05) over planting at 45 and 35 cm respectively.
- Soybean JS 71-05 proved to be drought resistant consistently higher yielder and recommendation for sole/ intercropping.
- Organic matter recycling- Indore compost method developed at IPI offers an ideal method of increasing the manure supply this method has proved successful and within reach of every cultivator.

Vegetative barriers of Rosha grass (*Cymbopogan martini*) reduces runoff and increase soyabean productivity

Glyricidea foliage for green manuring

Soybean+Arhar intercropping for more production and economic return per unit area

Earthing in Maize increases 10.4% yield

More productivity of soybean on ridges

AICRP on Microbiological Decomposition and Recycling of Farm and City Wastes

The project was functional at College of Agriculture, Indore from April, 1997 to March, 2002 to improve the quality of compost by way of incorporating low cost inputs, such as mineral additives and microbial inoculants in the organic wastes. The salient findings of practical utility are given as under:

a. Development of technology for the production of P-enriched compost (Phosphocompost) using indigenously available low-garde rock phosphate from Jhabua (M.P.)

The compost-mix comprising farm/organic waste (Soybean straw, linseed straw, mustard straw, weeds, feeds of dairy farm, vegetable and fruit market wastes etc.), cattle dung, soil and well decomposed plain compost/FYM in the ratio 8:1:0.5:0.5 is charged with 12.5% Jhabua rock phosphate (JRP) of 100 mesh size (containing 20% P_2O_5). For effective transformation of rock phosphate during composting, a slurry of cattle dung, soil, compost/FYM and the calculated quantity of rock phosphate (12.50 kg/100 kg of compost-mix) is prepared and added to the organic waste by simultaneous mixing of the entire mass.

In a pit of 3 x 2 x 1m size, well pasted with a mixture of soil and cattle dung, the compost-mix, as outlined above, is filled in the pit in layers, each of 1 q quantity, keeping 60 to 70% moisture. In a pit, normally 14 to 15 layers are arranged one over the other till the compost-mix reaches to 1.5 feet above the ground level. Finally, al thin layer of soil and cattle dung is coated onto the pit to cover the entire material. Composting of the material is carried out for a period of 3-5 months providing turnings of the contents at 20, 40 and 60 days. Appropriateness of moisture level (50 to 60%) is checked at each turning. Phosphate solubilising microbial inoculatant (1.5 kg/pit) is applied after 5 to 6 weeks of filling the pit by pouring the suspension of the inoculums prepared in 30 to 50 liters of clean water. To enrich the compost with N_2-fixing micro-organism, 0.5 kg inoculum, each of Rhizobium and Azotobacter is mixed at the time of second turning at 40 days. Normally, from a pit of 3 x 2 x1m size, about 1 tonne of phospho-compost becomes ready for use after 3.5 months.

The technology of preparation and use of phospho-compost is economically viable as the expenditure involved is less than tha cost of single super phosphate on equal P_2O_5 basis.

b. Jhabua rock phosphate-charged compost as a substitute of phosphatic fertilizer for wheat, chickpea, soybean and urdbean

Phospho-compost (charged with low grade JRP @ 12.5% of the compostable material) possesses the potential of fulfilling the entire requirement of P for crops like wheat, chichpea, soybean and urdbean, when applied to soil @ 1.7, 2.0, 2.5 and 2.0 t/ha, respectively, and it brings about as much yield of these crops as is obtained with the application of 40, 50, 60 and 50 kg P_2O_5 /ha, respectively through single super phosphate.

c. Nitrogen and pyrite-based phospho-compost as a source of P and N for a soybean crop

Phospho-compost charged with 12.5% jhabua rock phosphate and supplemented with 1% N (as urea) and 10% pyrite, when applied @ 2.5 t/ha alongwith recommended K (20 kg K_2O/ha) and 25% of the recommended dose of N produces as much yield of soybean as is obtained with 100% NPK application (20 kg N+60 kg P_2O_5 +20 kg K_2O/ha) through chemical fertilizers. Thus, N and pyrite-based phosphor-compost can fulfil the entire requirement of P for soybean and meet N requirement of the crop to the tune of 15 kg N/ha.

d. Economy of Phosphate fertilizer through use of rock phosphate-charged compost in soybean-based cropping systems

In a study on fertilizer economy through use of phospho-compost (PC) in three soybean-based cropping systems (soybean-wheat, soybean-chickpea and soybean-musturd), it was found that the total P requirement of both Kharif and Rabi crops e.g. soybean and wheat/soybean and chickpea/soybean and mustard, when applied once through PC as a single application to a Kharif crop of soybean, not only fulfils the entire P-requirement of soybean but also of the subsequent Rabi crop. The same was found true when the total P-requirement of both Rabi and Kharif crops was applied once as single application to a Rabi crop of wheat/ chickpea/ mustard. Thus, application through PC can be made once, instead of twice, either in Kharif or in Rabi season to grow both Kharif and Rabi/ Rabi and Kharif crops.

e. Dynamics of soil microbial biomass and activity under conventional and organic farming systems

The chemical and microbiological analysis of the soil samples collected from three sets of farming systems.

i. Where crops were grown adopting only organic farming practices
ii. Where crops were grown using both organic manures and chemical fertilizers in the ratio of 60:40 and
iii. Where crops were grown using only chemical fertilizers, was made during the year 2000 and 2001.

It was noted that the soil samples under organic farming system recorded the highest soil microbial biomass C and N as well as the activity of dehydrogenase and acid phosphatise, whereas the soil samples under fertilizer use showed the lowest level of these parameters. Further the soil samples under organic farming system recorded the maximum population of Azotobacter, P-solubilizing bacteria, Actinomycetes and Fluorescent Pseudomonas. These samples were found to be richer in organic C, available N, P_2O_5 and K_2O, total mineral N as compared to those under chemical fertilizers use only. Higher microbial biomass C and n as well as dehydrogenase and phosphatise activities were observed with higher fertility status of soil and vice-versa.

AICRP on Cropping Systems

The Project started functioning in the year 1969 as Model Agronomical Experiment (MAE) at Indore as sub-centre now renamed as All India Coordinated Research Project on Cropping Systems. This centre is actively engaged in identifying problems and finding out their soloutions particularly for Agro-Climatic Zones of Malwa Plateau, Nimar Valley and Jhabua Hills having medium and deep balck soil classified as Vertisols with poor infiltration rate. The system based technology generated by this centre for irrigated conditions are as follow (AICRPCSR, 2008).

Crop Sequences

i. Crop sequence (rotation) with 200% cropping intensity, using high yield in cultivars with recommended package of practices increase yield of wheat either by growing soybean or red gram in kharif. Soybean-wheat sequence gave the highest grain

production as well as monetary returns under irrigated condition. This was followed by red gram-wheat sequence.

ii. It two crop rotations in sequences are to be followed under irrigated condition of the Malwa region, the following crop sequences were found most suitable providing 200% cropping intensity. Sorghum (CSH 9) – wheat (WH 147); Sorghum (CSH 5) – gram (JG 218); Soybean (JS 72-44) – wheat (WH 147).

iii. In black cotton soils of Malwa Plateau, the following crop sequences were found profitable and remunerative with respect to bio-mass production and economic returns under irrigated condition, giving 300% cropping intensity. Sorghum (CSH 5) – wheat (WH 147) – moong (Pusa Baisakhi); Soybean (JS 72-44) – wheat (WH 147) – maize (fodder)

Soybean – Wheat

i. Application of Zinc @ 10 kg/ha every year to only soybean through zinc sulphate (35% Zn and 17.8% S) increase the yield of soybean by 24.8% and of wheat by 7.5% in the system.

ii. Sulphur @ 50 kg/ha through gypsum (20% S) every year to soybean, enhanced yield of soybean by 23.3%. Diversification in the existing sequential cropping system (soybean-wheat) to soybean-potato-late wheat was the more remunerative system under irrigated conditions with gross monetary return (GMR) Rs. 79,864 per ha, net monetary return (NMR) Rs. 44,544 per ha and B:C ratio (2.26).

iii. Intensification of soybean crop by intercropping with maize followed by wheat was more profitable (GMR Rs. 51,228 per ha, NMR Rs. 28,125 per ha with B:C ratio of Rs, 2.22) than the existing system of soybean-wheat.

iv. In soybean-wheat cropping system, fertilizer application on the basis of soil-test values was more productive (total productivity 5411 kg/ha) and profitable (NMR Rs. 17,435 per ha with B:C ratio of 1.86) and saved 32% potash and 14% of phosphorus/year.

Soybean – Gram

For obtaining higher productivity (21.7 and 17.4 q/ha) from soybean – cropping system, it was necessary to apply 60 kg P_2O_5/ha to each crop every year under irrigated condition.

Sorghum – Wheat

Under continuous cropping system with sorghum – wheat, application of only nitrogen at 120 kg/ha did not elevate yield, unless it was supplemented with 40 or 80 kg P_2O_5 and 40 kg K_2O/ha.

Intercropping

Intercropping of soybean and sorghum (4:2) with recommended dose of fertilizer to both the crops gave the maximum production. Maximum economic return of Rs. 7,323/ha was obtained with intercropping of wheat and linseed (4:2).

Tillage

The number of tillage operations was minimized to one blade harrow followed by planking (minimum tillage) for conservation of moisture in the feild after the harvest of soybean in Kharif season. This was as good as the normal or conventional tillage practice under limited irrigation for raising rabi crops like wheat, gram, mustard, linseed, sunflower and safflower. Besides, this practice saved time and money.

(3) Soil Management

Soil and Water Conservation

(i) Indo UK Project (1971-86), College of Agriculture, Indore

a. Land and Water Management

- Storm drains: Constructed about 6 km long storm drains to divert run off water protecting over 400 ha land from water logging.
- Grassed Water Ways: Constructed over 10 km waterway followed by their grassing for stabilization to drain run off safely from about 850 ha land.
- Gabion structure: Constructed 22 gabion structures for waterways bed stabilization and gully reclamation.

Gully Stabilization Through Soil and Water Conservation Measures

- Waste Weirs: Constructed 40 waste weirs to drain run off water from field into waterways.
- Run off Collection Tanks: Constructed two tanks for run off collection and recycling.
- Loose Boulder Structure: For estabilization of small gully by loose boulder structure.
- Demonstration of dry land technology for efficient management of natural resource improved overall socio-economic condition of farming community throught better crop and livestock management in selected villages.

b. Model Watershed Development work at Hingonia Pipliyatapha watershed (1986-96)

The success of Indo-UK Project, prompted ICAR to start Operational Research Project on Dryland Agriculture at 8 locations in the country including Indore during 1986. It was given additional responsibility of developing model watershed by the Government of Madhya Pradesh in the year 1987. The Operational Research Project, College of Agriculture, Indore, implemented the program of watershed research and development.

Tank at Hingonia with Gabion Outlet

The project area is located in the village Hingonia and Pipliyatapha. The site is located at about 26 km in the North-West of Indore city and the watershed covers 424 ha area. Geographically, it is located at 76.4^{o} E longitude and 22.7^{o} N latitude with a mean altitude of 540 m above mean sea level. These villages are situated in lower reaches of river Gambhir, a tributary of river Chambal. The following activities were executed undet the ORP programme.

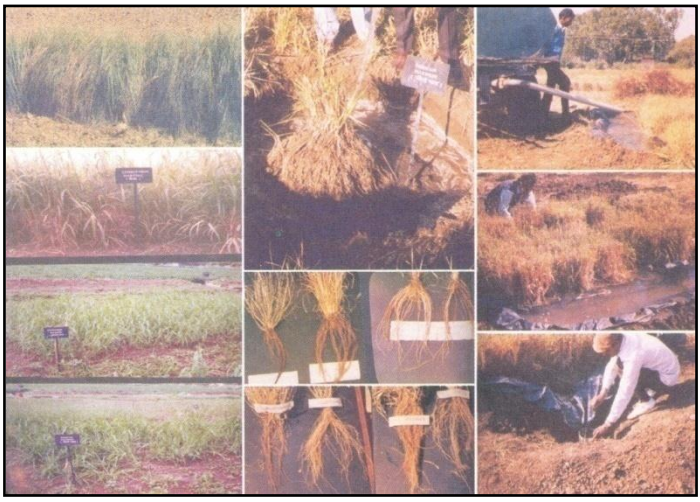
Particulars	Base 1987-88	Year 1995-96
Water harvesting tank		
i. Storage capacity 10000 cu. m.	-	1
ii. Storage capacity 17000 cu. m.	-	1
Gabion	-	5
Graded bund	-	10 (155 m length)
Grassed waterway	-	5 (1800 m length)
Loose boulder structures	-	9
Spurs	-	2
Diversion drain	-	4 (1375 m length)
Agro-forestry	-	3.5 ha

(ii) Indo US Project on soil and water conservation (1990-96)

a. Soil and water conservation through vegetative barriers

The research work was carried out by the Department of Plant Physiology in collaboration with Agricultural Engineering on the identification of suitable vegetative barriers for soil and water conservation. The recommendations are –

- Use of vegetative barriers to strengthen the mechanical bunds at suitable vertical intervals in order to reduce run off and associated soil losses from the cultivated fields.
- The Vetiver and Dichanthium are most suitable grass species for soil and water conservation, identification on the basis of hydro-physiological characterization i.e. infiltration, runoff, soil loss, soil conservation value, rooting pattern (root modeling), soil binding capacity, transpiration and water use efficiency, value addition and overall performance index (OPT).
- Graded bunds alonw or along with vegetative barriers at vertical intervals of 50 cm proves most effective in controlling soil erosion and nutrient losses on soils having slope up to 2 per cent.



Grass species	Root studies	Runoff studies
Vetiver, Cymbopogon Dichanthium, Panicum	Root monolith exacavation Vetiverm, Cymbopogon	Water-inlet, water flow and water outlet

b. Water harvesting

Silpaulin (a plastic material) of 90-120 gsm was found effective lining material for ponds used for water harvesting purpose.

(iii) Developing live fencing system for soil and water conservation, crop diversification and sustaining productivity in rainfed regions (National Agricultural Technology Project, 1999-2003)

Planting of Prosopis and Jatropha in two rows, on raised beds with trench on the outer side of the field boundary, employing periodical pruning and incorporation, is beneficial for the farmers in terms of field protection, soil and water conservation, soil fertility improvement, value addition and sustaining the productivity of the rain fed regions.

Characterization and Management of Salt affected Black Soils

The genesis, nature and occurrences of salt affected soils differ considerably, thereby calling for locality specific reclamation / management practices and utilization of such soils. The semi-arid tracts of central and southern region of the country (Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu) and arid and semi tracts of Rajasthan and Gujarat posses extensive tracts of black soils

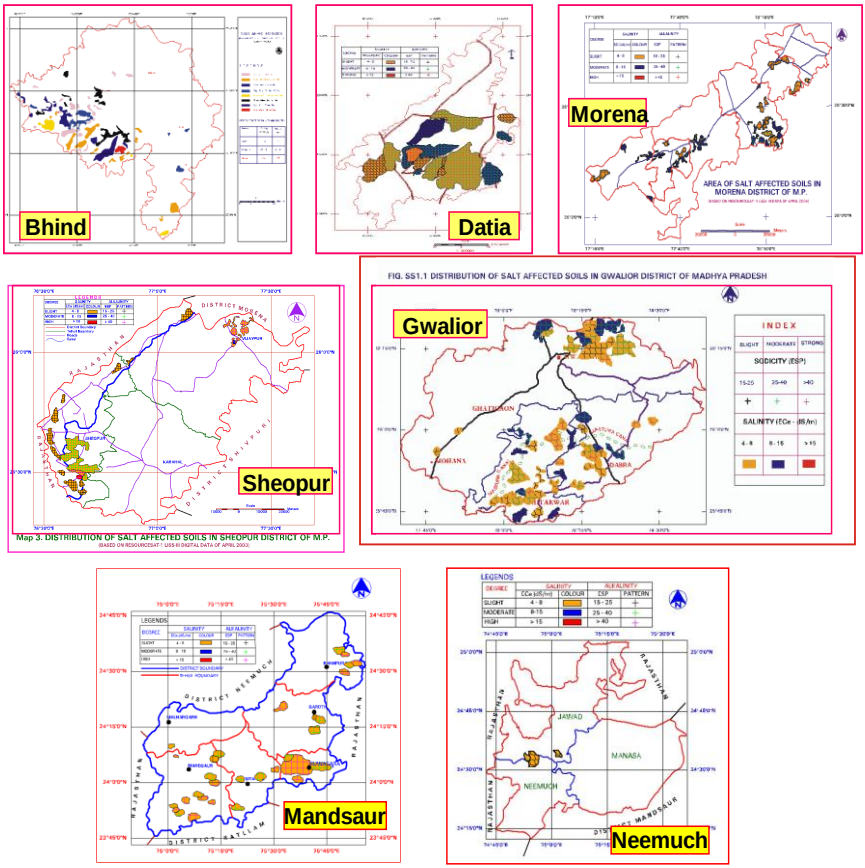
affected by salinity and sodicity problems. To cater the problem the Indian Council of Agricultural Research, New Delhi has sanctioned a project on Characterization and Management of Salt Affected Black soils with a centre at College of Agriculture, Indore (AICRPMSAS, 2008).

The research on reclamation, drainage and management is being conducted on the sodic black clay soil at Soil Salinity Experimental Station, Barwaha located in the Narmada Valley of South West Madhya Pradesh at 185 m above MSL in between 22^{o} 14' N latitudes and 76^{o} E longitude. Deccan Trap underlain by Bagh Beds is the principal geological formation of the area. The area represents a case of contemporary sodicity developed due to basin topography and poor drainage under rainfed situations.

Soil Survey and Characterization

The reconnaissance soil survey conducted under the project revealed that 33,398 ha land in black soil region of Madhya Pradesh extending over 11 districts in the semi-arid regions is affected by salinity sodicity problems. An area of 8,70,000 ha was delineated as salt affected soils in Gujarat. Maximum area is occupied by coastal saline soils in the coastal arid regions of Gujarat.

The delineation of salt affected soils and preparation of map with the help of remote sensing data (ERDAS Imagine 8.6/8.7 software) was started during the year 2000-01 by the center. The map of Bhind, Datia, Gwalior, Morena, Sheopur, Mandsaur and Neemuch districts has been generated and area of about 25000, 9245, 28612, 22692 19547, 15437 and 3150 ha respectively has been delineated along with category classification and village identification.



Maps showing categories of salt affected soils in the districts

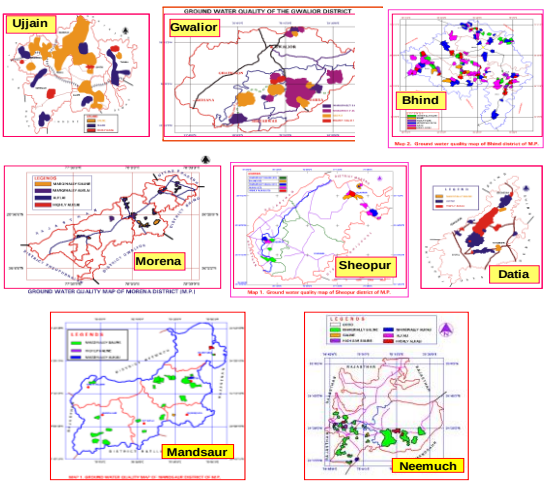
Survey and characterization of underground irrigation waters, salinity associated problems in irrigation command

The ground water quality survey was carried out by AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, College of Agriculture, Indore in Indore, Ujjain, Bhind, Gwalior, Datia, Morena Sheopur, Mandsaur and Neemuch district of the state. The samples were classified under different categories as per the criterion given by Central Soil Salinity Research Institute, Karnal. The per cent distribution of samples collected and analyzed from the districts is presented in following table.

Distribution (per cent) of ground water samples in different categories

Categories	Indore	Ujjain	Bhind	Gwalior	Datia	Morena	Sheopure	Mandsaur	Neemuch
Good	96.9	80.3	52.3	78.3	72.7	66.7	86.6	88.70	72.6
Marginally Saline	1.9	8.8	6.6	3.7	1.8	6.7	1.5	10.17	24.2
Saline	0.3	4.2	2.3	0.0	0.0	0.0	2.0	0.28	0.5
High SAR Saline	0.0	0.6	1.7	0.0	0.0	0.0	0.0	0.28	0.7
Marginally Alkaline	0.3	4.6	15.6	12.4	14.5	22.2	4.5	0.28	0.5
Alkaline	0.0	1.4	15.6	3.7	10.9	2.2	4.5	0.00	0
Highly alkaline	0.6	0.0	6.0	1.9	0.0	2.2	1.0	0.28	1.5

Irrigation water quality maps showing categories has been generated for Indore, Datia, Ujjain, Gwalior, Morena Sheopur, Mandsaur and Neemuch districts of Madhya Pradesh.



Maps showing categories of ground water quality in the districts

Research on Basic Concepts

Criterion of exchangeable sodium content for Black Alkali soils

A new criterion for classification of alkali soil has been established by the centre for black clay soils on the basis of their physical properties. It has been established and widely accepted by the scientific community that the soil properties starts deteriorate at soil ESP of 10 rather than 15 as given in previous hypothesis and soil pH has no relation with extent of sodicity in black alkali soils.

Concept of available water in Black Alkali soils

A new concept regarding classification of available water in black soil was given by the Indore centre and clearly indicated that the upper and lower limits to the amounts of water that is available for crop use are highly altered in sodic clay soils and does not holds good in such soils. The increased alkalinity of sodicity of soil produces problems in root growth, air exchange and water movement during crop production. The increase in bulk density restrict downward root growth and roots are remains only in plough layer of soil where some loosening is done during field preparations and sowing operations. Poor pore space due to presence of finer clay particle do not provides much space for air and water, hence slight change in water content cause either very poor air exchange or available percent causes restriction in water movement whether it is through mass flow or diffusion and it ceases almost negligible at a soil exchangeable sodium percent (ESP) more than thirty.

Suffering of crop due to water and associated stress increase with increasing sodium content on exchange complex. Supply and demand ratio of water becomes wide to wider with advancing stage of plant and comes to a critical level at critical growth stages (flowering and grain filling stage) of crops and ultimately affects crop production in such soils. There are two major factors, which controls the wide supply demand ratio first, is poor root growth and exploitation of very little soil volume to fetch water supply to crop and second is restricted lateral and upward water movement. Irrigation to crop in such soils requires very special management through all the means that is should not produce further deterioration in conditions.

Solute transport in black clay soil

Transport of ions (Chloride and Nitrate) in black clay soils by displacing surface applied salts with infiltrating water at different initial moisture contents under transient and steady rate infiltration was studied. The result indicated that in black soils the infiltrating water moves by

displacement of resident water and not by invasion. The salt peak moves very close with waterfront in dry soil whereas it remains well behind as the antecedent water content increases. The salt displacement was significantly deeper with the slow rate of water flow as compared to that with faster one.

Reclamation

Type and dose of amendment

Several soil amendments viz. gypsum, pyrites, aluminium sulphate, sulphuric acid & acid powder were found to be equally effective when applied on the basis of sulphur or calcium content. If calcium carbonate content is low (1.5%), use of gypsum is advocated. Flushing out of excess soluble salts should follow the application of amendment @ 70-80% of gypsum requirement. If finance is a constraint split dose of gypsum @ 50% of gypsum requirement followed by 25% of gypsum requirement in the following year can be adopted. Gypsum, pyrites and acid powder were recommended over other amendments on the basis of cost and handling hazards.

Amendments application methodology

Gypsum should be mixed in the upper 15 cm of the soil and standing water of 5 cm should be kept for at least 15 days. Due to very poor water transmission characteristics of the soil, the product of chemical reaction should be flushed off through surface drains. Replication of pounding and flushing gives better results. The work on methodology and superior efficacy of pyrites on reclamation of black alkali soil was carried out by the centre during the years 1984 and 1985 given new dimensions to proven methodology for pyrites application. Pyrites or acid powder in very fine from should be applied on the surface followed by light irrigation to achieve field capacity moisture regime so as to have maximum oxidation of pyrites or acid powder. The moisture in the treated plots should be maintained at field capacity for a week. Thereafter the amended plots should be provided with 5 cm water for a week so as to bring the reaction product in solution phase. After this, the excess water should be flushed off.

Textural Modification

A new approach for utilization of alkali soils was achieved by carrying research on modification of texture in root zone layer soil. As black alkali soils are rich in clay content with high cation exchange capacity (CEC) requires huge quantity (15 to 25 tones ha^{-1}) of gypsum / pyrites depending on exchangeable sodium content. Application of 25 to

50 tones of sand gravel in plough layer soil facilitates seed germination, checks crust formation, helps in plant establishment and ultimately results in good crop yield. This is very good alternate of chemical amendments in rain fed conditions as chemical amendments require high amount of water for dissolution and leaching of salts.

Reclamation of Sodic Vertisols in conjunction with soil and conservation practices under rainfed conditions

A very special and indigenous method of reclamation of black alkali soil under rainfed conditions was innovated by the centre. Raised and sunken bed system was designed and tested over years for its suitability for reclamation of black alkali soils. The system helps in conservation of water (50%), soil (95%), nutrients (90%) and crop production. The system is also economically viable as it is single time expenditure and design has flexibility to adopt under various conditions. The crops like cotton, sunflower and sorghum can be planted on raised bed and paddy in sunken beds during Kharif season.

Biological amelioration of sodic soils

Twenty four grasses collected from different sources were planted in the month of August 2002 at four different soil ESP (ESP Viz., 25, 30, 35, 40(±2) to record their survival and growth parameters. The survival percent of different grasses decreased with the increasing level of soil ESP. The survival of Napier, Para, Sewan, Vetiver, Karnal, Rhoads, Marvel, Lemon / Borthriochloa / Deenanath was more than 50 per cent up to soil ESP 40 whereas other species failed to survive at this sodicity. Some grass species like, Anjan, Spear, Andropogen, Guinea (all three varieties) and Setarial grass could not survive at any level of soil ESP and were found very sensitive for planting in sodic clay soil. The performance (survival % > 50) of different grass species at various soil ESP is as below.

The results of the experiment suggested that planting of tolerant grass species in a sodic Vertisols for a period of more than two years could be an effective measure in conservation of soil, water and nutrient resources. Plantation of Marvel, Para and Karnal grasses for a period of three to four years are found more beneficial in amelioration of the soil. Soil ESP decreased up to tune of 15-20 unit and thus it reduced the quantity of gypsum up to about 8 to 12 tons/ha. Application gypsum @ 50% of GR alter these grasses was found sufficient to harvest normal mustard and sorghum crop under rainfed farming system.

Spent wash and spent wash vermi-compost

Application of spent wash @ 5.0 cm is highly effective for reclamation of salt affected black soils. Paddy – Wheat cropping sequence was successfully taken up after reclamation through spent wash.

Leaching studies

Leaching with respect to desalinization and desodification at moderate salinity (< 20EC) and sodicity (< 25ESP) revealed no particular advantage either intermittent over continuous or gypsum saturated water over ordinary irrigation water. Leaching curve with respect of desalinization and desodification has been computed which enables to calculate amount of water needed to be passed through profile for a particular salinity/ESP reduction.

Screening of crops and varieties for sodicity tolerance

Studies were conducted in artificially created saline and sodic soils for evaluation of salinity and sodicity tolerance of important economic crops of the region viz., cotton, sorghum, rice, pearl millet, maize safflower, mustard, wheat, linseed and barley.

Critical limits of crop tolerance (on the basis of 50% reduction in yield) have been found out in respect of the above crops. Screening of elite varieties / hybrids of different crops was carried out in sodic soils under field conditions at different ESP levels achieved through application of gypsum @ 0, 33, 66 and 100% GR. The best performing varieties of different crops in sodic soils are presented in following table.

Table 28: Crops and their Salinity/ Sodicity tolerant varieties

Crop	Critical Limits		Varieties
	ECe (dSm-1)	ESP	
Safflower	10-15	40-45	JSF-1, IC 11839
	15-20	45-58	IC 11750, JSF 144
Barley	15-20	48-56	DL4, 106, 120, 157, 165, BHS – 12
Mustard	15-20	20-45	CSN 3, 6, 13, 14, 15
	15-20	48-56	TH17,UP-70, RLM632, RIC 1012, 1013, Varuna, Pusa bold.
Wheat	15-20	45-55	Kalyan Sona, NP 404, Malavraj, K - 227, WH – 157
Rice	10-15	50-55	CSR-4, Kalarata, Jhona - 349, SAR-328, Kranti, IR-36

Crop	Critical Limits		Varieties
	ECe (dSm-1)	ESP	
Cotton	10-15	50-56	Maljari, Vikram. 70 - IH - 452, Khandwa – 2, KH 33/ 1146, Jwahar Tapti, G.Cot.19
Maize	5-10	15-24	Ganga – 5
Sorghum	5-10	<10	CSH - 1 and 3, 1584
	5-10	50-60	61-1-1, SPV – 235, 938, 1041

Management of salt affected soils and irrigation water

Evaluation of crop rotation

i. Rice-berseem crop sequence was found to be most suitable for saline sodic soils followed by rice-wheat crop sequence. Due to short winter season a medium duration salt tolerant rice cultivar CSR-4 is preferred for this area. Wheat cultivar WH-157 gives better performance.

ii. Planting of Kharif crops (in particular cotton and sorghum) on the side of ridge was found to perform better than planting in flat beds.

Method of planting and spacing

The planting geometry in rice and cotton at 20 x 15 cm^2 and 45 x 30 cm^2 respectively was found to give higher yields of rice and cotton. For wheat the seed rate should be 1.5 times more than of normal soil.

Fertilizers

i. Ammonium sulphate has slight edge over urea in improving grain yields of rice and wheat grown on a sodic clay soil. Calcium ammonium nitrate (CAN) is not a suitable source of N for paddy and wheat on these soils. Application of N beyond 100 kg/120 kg results in marginal increase in yield/kg of nutrient applied.

ii. Application of nitrogen as ½ basal + ¼ at tillering + ¼ at flag leaf stage to rice furnished the best application schedule. KNO_3 (providing 10% N as basal) + urea gives maximum grain yield of rice.

iii. The sodic soils are found to be poor in zinc status. Application of 25 kg $ZnSO_4$ / ha (once in every year) to rice crop increased the mean yields (5 years) of rice by 10.7 and of wheat by 0.7 q/ha in partially reclaimed sodic soil.

Irrigation scheduling

On the basis of IW/CPE ratio, irrigation schedule of a number of crops have been established for normal black cotton soils and sodic black soils. Irrigation scheduling in normal soils for Kharif crops viz. cotton, maize and soybean under Malwa conditions should be kept at 0.6, 0.8 and 0.6 respectively. For Rabi crops, wheat, gram, linseed and potato it should be 1.0, 0.6, 0.6 and 1.2, respectively. In sodic Vertisol, for wheat 3 cm depth of irrigation water at an IW/CPE of 1.0 or 1.2 is recommended.

Monitoring ground water salinity and use of saline water

i. Irrigation with waters of 2 dSm^{-1} and above cause sodicity in the upper 0-30 cm of soil with in one year Kamliakheri soil series. Irrigation with waters of 3 dSm^{-1} in maize and with 5 dSm^{-1} in wheat caused 25% reduction in yield. The hydraulic conductivity of normal black clay soil decrease with EC of irrigation water.

ii. The empirical relationship to predict reduction in hydraulic conductivity of a clay soil has been developed if SAR and ECe are specified.

iii. Irrigation waters having electrolyte concentration of 50 me L^{-1} or more containing either chloride or chloride and bicarbonate ions should not be used for irrigating the black soil irrespective of their SAR because they create sodicity.

iv. Irrigation with CI-SO_4 waters resulted in precipitation of Ca and SO_4 ions at 50 me L^{-1} electrolyte concentrations. Water with low electrolyte concentration (10 me L^{-1}) and SAR 10/20 results in dissolution of metastable minerals.

v. The survey of underground waters of Indore district revealed that 97% samples have no problem of salinity or sodicity. About 1.7% of the samples are marginally good whereas about 0.3% each have either salinity or salinity and sodicity problem. The residual sodium carbonate problem was encountered in only 0.72% of the samples. Thus, the underground waters in the districts are quite safe for irrigation purpose.

Effect of grasses on control erosion losses, reclamation and crop of production in sodic vertisols

The Para and Karnal grasses work well as biological ameliorator it promotes water and land (80% each) conservation. The nutrient losses (N, P, K, Zn, Mn, Cu & Fe) could be minimized through cultivation of grasses.

Evaluating trees and fruit plantation for alkali black soils

The evaluation of sodicity tolerance of different tree species was done. It was observed that apart from the native check plant *Prosopis juliflora, Azadirachta indica* and *Eucalyptus tereticomis* were the tree species which revealed better survival and growth in alkali soils under rainfed situations. Aaonla (*Emblica officinalis*) and Ber (*Zizyiphus jujube*) were found to be sodicity tolerant fruit plants.

Agroforestry in black alkali soils

Neem (*Azadirechta indica*) and Vilayati babool (*Prosopis juliflora*) are identified as most effective and potential trees for rehabilitation of black alkali soils under rainfed conditions.

Agro-horticulture in black alkali soils

Anola and Ber were found suitable fruit trees for planting in black soils. The survival and growth of these fruit plant are comparatively good in black alkali soils.

Use of Urban and Industrial Effluents in Agriculture

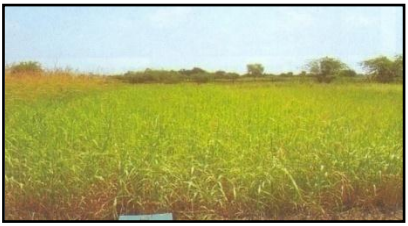
The use of sewage water for producing vegetables, cereals and grains are in practice since last two decades on the bank of Khan River between Indore and Ujjain. The river carries sewage water and industrial waste water through out the year. The results gathered on the basis of study carried out industrial wastewater for irrigation are unsafe for soil, animal and human health. The heavy metals like cadmium (>0.01 mgL^{-1}), lead (>5.0 mgL^{-1}), Chromium (>0.10 mgL^{-1}) and cobalt (>0.05 mgL^{-1}) are enrooting to food chain through its agricultural uses. The underground water qualities in vicinity of its use are also getting polluted and are not potable. Reed grass (*Phragmatis kakra*) in combination with sand is good and suitable for sewage waters treatment.

Other Utility of Black Alkali lands

Black alkali soils are identified as most suitable and economical land for construction of water harvesting tanks as the soil has almost negligible seepage loss due to its poor water transmission properties. Thus the most deteriorated land having higher exchangeable sodium can be utilized for construction of water storage structure.

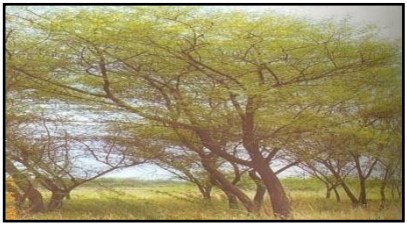
AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture

Aonla and Ber and Tolerant Fruit Species for Black Alkali Soils



Para Grass in Tolerant and Best Bio-ameliorent for Black Alkali Soils

Raised and Sunken Bed System for Reclamation of Alkali Soils Under Rainfed Conditions



Neem and Babool are Tolerant Tree species for Black Alkali Soils

Soil Testing Service Scheme

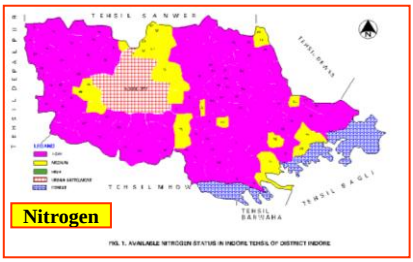
Soil testing service scheme, College of Agriculture Indore is a center for providing Soil testing services to farmers of Indore and adjoining areas of the district since 1964. Usually, soil samples are collected by farmers and supplied to the laboratory for their analysis / acquiring soil test values and fertilizer recommendations. On the basis of soil test values and available irrigation facilities, recommendations are also given for balance use of fertilizer for different crops. This facility is available on nominal charges prescribed by the VV. Besides the farmers, other beneficiaries viz. Department of Agriculture, NGOs and Private Organization are also in regular contact with the scheme for consultancy.

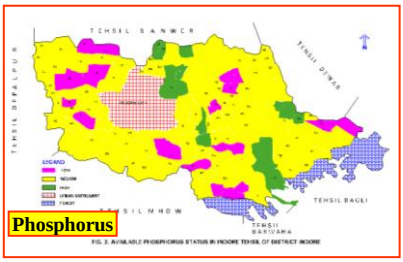
For delineation of nutrient deficiency in the soils of Indore district, soil samples (minimum 5 samples from each village) were collected for generation of fertility maps. Total number of villages in the district is 504. Total number of samples collected and analyzed for pH, EC, OC, N, P, K, S and Zn were 2935. The per cent distribution of samples under different classes is as follows.

Table 29: Analysis of soil samples and their per cent distribution under different process

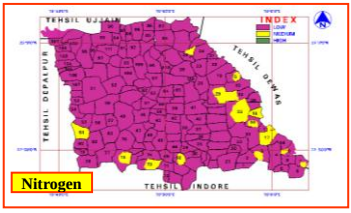
Soil properties	Low	Medium	High	Low (%)	Medium (%)	High (%)
pH	< 6.5	6.5-7.5	>7.5	0.03	10.73	89.24
EC (dSm^{-1})	< 0.8	0.8-1.6	> 1.6	96.90	2.83	0.27
Organic carbon (%)	< 0.5	0.5-0.75	> 0.75	43.30	51.86	4.84
Nitrogen (kg/ha)	< 250	250-400	> 400	85.82	14.18	0.00
Phosphorus (kg/ha)	5-10	10-20	> 20	35.58	56.18	8.24
Potash (kg/ha)	< 250	250-400	> 400	0.03	11.97	88.00
Sulphur (mg/ kg)	< 10	-	> 10	66.99	-	33.01
Zinc (mg/ kg)	< 0.6	-	> 0.6	13.84	-	86.16

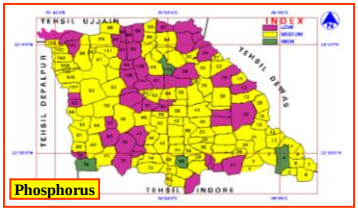
Soils of Indore district are slightly alkaline in nature, low in salt content, medium to low in organic carbon and phosphorus content, low in nitrogen and rich in potash content. Sulphur content is in alarming condition (about 67 per cent samples are deficient), which is due to cultivation of soybean after soybean since last 20 years and use of DAP instead of Single Super Phosphate. Zinc deficiency is starting to appear in the district (about 14 % samples are deficient in Zn).

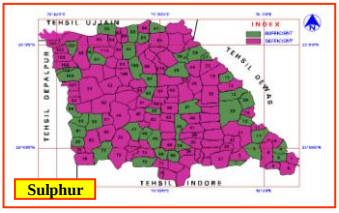




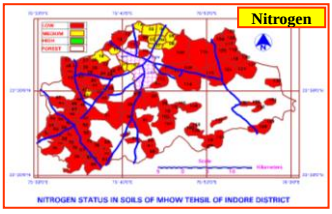
Maps showing nitrogen and phosphorus content in soils of Indore Tehsil

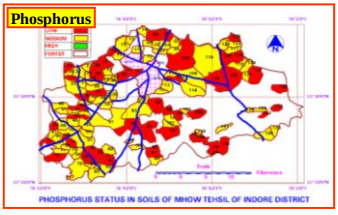


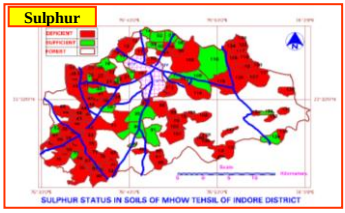




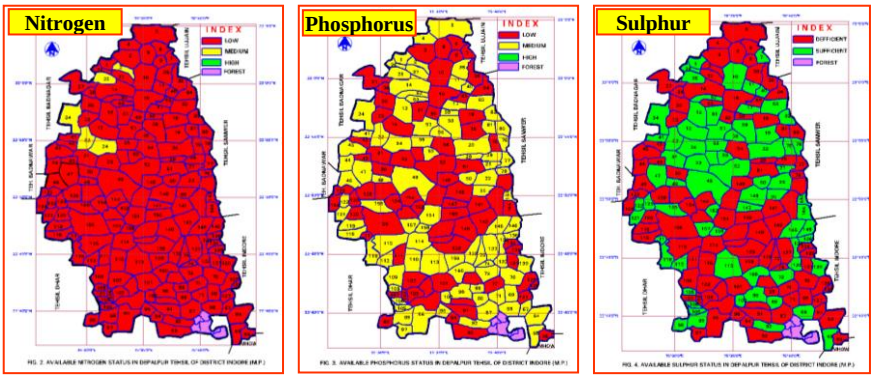
Maps showing nitrogen, phosphorus and sulphur content in soils of Sanwer Tehsil







Maps showing nitrogen, phosphorus and sulphur content in soils of Mhow Tehsil



Maps showing nitrogen, phosphorus and sulphur content in soils of Depalpur Tehsil

Long Term Fertilizer Experiment

The long term fertilizer experiment under All India Coordinated Research Project sponsored by ICAR was started in April 1972 with soybean-wheat-maize fodder multiple cropping system prevalent in the region.

The soil is deep black clay which is identified as Kheri series of very fine, montmorillonitic, hyperthermic family of Typic Haplustert. High yielding varieties of soybean and wheat are grown under irrigated condition. The objectives were to study the effect of continuous application of plant nutrients, singly or in combination with the organic forms including secondary and micronutrient element (as per the need) on crop yield, nutrient composition and the nutrients uptake under multiple cropping system and to monitor the changes in soil properties as a results of continuous manuring and cropping with respect to the physical, chemical and microbiological characteristics of the soil in relation to its productivity. There are following ten treatments.

T_1	50% optimal NPK dose
T_2	100% optimal NPK dose
T_3	150% optimal NPK dose
T_4	100% optimal NPK dose + Hand weeding
T_5	100% optimal NPK dose + Zinc
T_6	100% optimal NP dose

T_7	100% optimal N dose
T_8	100% optimal NPK dose + FYM
T_9	100% optimal NPK (sulphur free)
T_{10}	Control (unmanured)

The response to fertilizers are in order of NPK>NP>N but the degree of response varied year to year due to weather conditions and change of varieties. Continuous use of N alone produced greatest decline in yield and had deleterious effect on long-term fertility and sustainability. The effect of urea alone (100% N) was at par with control (unmanured). Application of P along with N (100% NP) eventually raised the yields of soybean and wheat by 62% and 175% respectively. This indicated the role of P supply in crop production particularly in black soils (Vertisoils) due to low available P and high P fixation. The yield of crops showed further improvement with the balanced use of N, P and K fertilizers. The availability of K is becoming limiting factor for crop growth because of over exploitation of native K. Integrating chemical enhancing productivity and achieving sustainability in crop production. The yield response of crops to sulphur addition was marginal over 11 years of intensive cropping. Deficiency of S has been manifested through yield reduction in plots where S free NPK fertilization have been applied continuously. Thus, addition of S becomes essential after a few cycles of intensive cropping.

The results of long term fertilizer experiment indicate that the real response to NPK fertilizers can be realized only when all the essential plant nutrients are applied in optimal amounts. Thus monitoring of not only major nutrients (N, P and K) but also secondary and micronutrient elements becomes important for maintaining sustained high level of crop production in years to come. There is no perceptible change in soil reaction and soil salinity as a result of continuous use of fertilizers and intensive cropping for over the last 29 years. The use of optimum doses of NPK (100% NPK) and integration of inorganic and organic (100% NPK + FYM) resulted in improvement in organic carbon, available phosphorus and sulphur status. A decline from its initial level of available K status was noticed as a result of continuous cropping indicating considerable soil mining of available K. Application of super phosphate as a source of P raised not only the level of P but also the level of available sulphur.

Research trials on Alluvial soils

Studies ion response of potassium application in pearl millet – mustard and pearl – millet cropping sequences were conducted on alluvial soils of Gwalior region. The data suggested that in alluvial soils, the grain yield of pearl millet improved about 10% by applying 40 kg K_2O/ha. If the same amount of potash in applied to mustard or wheat crops during Rabi season, the grain yields of these crops could increase 18% and 16% respectively. Further, application of 5 t FYM/ha also increase the crop yield to the same extent.

Micro and Secondary Nutrients

Delineation of areas of micro and secondary nutrients deficiency in Madhya Pradesh, critical limits in soils and plants response of crops to micronutrients and their interactions were studied.

Extent of micro and secondary nutrients deficiency

Among the micronutrients disorders, zinc deficiencies is most widespread. About 60.6 per cent of 13800 soil samples were tested zinc deficient. Amongst the soil groups, zinc deficiency was the largest in alluvial soils (86%) followed by mixed red and black soils (68%), red and yellow soils (62%), medium black soils (61%) deep black soils (35%) and skeletal soils (31%).

Plant analysis also confirmed zinc deficiency as the wide spread disorder of fields. About 57 per cent of 4327 wheat plant samples tested low in zinc. These were analysed to have 3.4 to 150 mg kg^{-1} Zn with a mean value of 22.2 mg kg^{-1}.

Copper content in soils varied from 0.12 to 32.0 mg kg^{-1} with a mean value of 2.12 mg kg^{-1}. Practically no deficiency of copper was observed in of Madhya Pradesh. Overall 4.9 per cent of the samples indicated copper deficiency. The copper content in the plant samples varied from 1.0 to 37.5 mg kg^{-1} with a mean values of 7.5 mg kg^{-1}

Available iron content in the soils ranged from 0.30 to 420 mg kg^{-1} with a mean value of 26 mg kg^{-1}. About 9 to 58 per cent soil samples from Narsinghpur, Hoshangabad, Betul, Chhindwara, Seoni, Damoh, Sagar, Sehore and Ratlam districts were tested low in iron considering 2 mg kg^{-1} ammonium acetate extractable iron as the critical limit. However, response of crops to iron application was observed to be poor. DTPA soil test did not indicate iron deficiency in soils.

Plant analysis indicated iron deficiency in some plants growing on alluvial soils. Iron concentration in wheat plants, in all the districts studied, varied from 50 to 1633 with a mean value of 257 mg kg^{-1}.

Available manganese content in soils of Madhya Pradesh varied from 0.5 to 0.6 mg kg^{-1} with a mean value of 19.2 mg kg^{-1}. Only 1.5 per cent samples tested low in Mn. Some alluvial soils and plant samples, indicated Mn deficiency. Manganese content in plant samples varied from 9 to 448 mg kg^{-1} with a mean value of 58 mg kg^{-1}.

Available b content in soils varied from 0.03 to 3.82 mg kg^{-1} with a mean value of 0.32 mg kg^{-1}. Soils in general are adequate in B for common field crops.

Sulphur deficiency was observed in soils of Seoni, Khandwa, Sidhi, Chhindwara, Indore, Dhar, Rajnandgaon, Gwalior and Morena districts where more than 50% samples tested low in sulphur. Sulphur content in the soils varied from 0.5 to 249.5 mg kg^{-1} with a mean value of 19.2 mg kg^{-1}.

Response of crops to micro and secondary nutrients

Wide occurrence of zinc deficiency revealed by soil and plant analyses was confirmed by studying the response of crops to applied zinc in several green house and field experiments. In 246 farmers field trials on various crop such as wheat, rice, soybean, sorghum, gram, green gram, pigeon pea, linseed, Zn application yielded more than 2 q ha^{-1} grain in 66 per cent of total experiments. Strikingly in about 36 per cent of the experiments NPK + Zn over NPK alone yielded more than 5 q ha^{-1}. Response to micronutrients, varied from crop to crop. The average increase in yield due to zinc application in Zn deficient soils ranged from 2-10 ha^{-1} in cereals, 2 to 5 q ha^{-1} in oilseeds and pulses. Kharif crops are more susceptible to Zn deficiency than Rabi crops. In chickpea, response to Fe application in Fe deficient clay textured soil ranged from 2.1 to 5.1 q ha^{-1}. Response of wheat to Mn application in alluvial soils ranged from 1.9 to 6.4 q ha^{-1}. Response of crops to S application was observed in sunflower, maize, sorghum and soybean. Yield of these crops increased by 4.2 to 8.6 q ha^{-1} over control due to S application.

Deficiency of Zinc could be corrected by application of material containing zinc. Among the different sources of zinc, zinc sulphate is, so far, the most common carrier of zinc. Relatively insoluble zinc oxide, zinc phosphate and zinc carbonate have also been found satisfactory and can serve as a alternative to highly zinc sulphate. The results so far neither favour zinc blend with macronutrient fertilizers nor use of multi-

micronutrients mixtures. To alleviate zinc deficiency 25 kg zinc sulphate to coarse textured and 50 kg to fine textured soils is recommended. This is broadcasted on the surface of the soils and mixed prior to seeding or transplanting. One application is expected to persist for 2 to 3 years. If zinc deficiency observed in a standing crop it can be corrected by foliar application of zinc sulphate sprays (0.5% zinc sulphate + 0.25% lime). Other methods such as soaking of seeds in zinc salt solution and dipping rice seedling roots in ZnO suspension proved either inferior of just at par with soil application of zinc in combating its deficiency in crops.

Iron deficiency in black calcareous soil in chickpea could be corrected by soil application of 20 kg ha^{-1} Fe and spray application of ferrous sulphate 2% solution. However foliar application was superior to soil application of iron. Iron deficiency is soybean and wheat grown in fine textured clay soils was corrected by spray application of 1 to 2% $FeSO_4$ solution at an interval of 10 to 15 days.

For correcting Mn deficiency in wheat in black calcareous soil foliar spray of 1 per cent $MnSO_4$ solution proved at par with the soil application of 10 kg ha^{-1} manganese sulphate. Manganese deficiency in alluvial soil could be corrected by soil application of 25 kg ha^{-1} mananese sulphate.

Sulphur deficiency in soils can be corrected by the application of 20 to 40 kg S ha^{-1} to cereals and pulses and 40 to 60 kg S ha^{-1} to oilseed crops like soybean and mustard.

Gypsum, super-phosphate and ammonium sulphate are good sources of sulphur to crops. However ammonium sulphate was tested to be superior source of sulphur to soybean-wheat sequence.

Micronutrient interactions

In Zn x P interaction study it was observed that Zn concentration in wheat, soybean and safflower decreased with increasing levels of P. However, Zn x P interaction did not influence yields of crop. In another study on Zn x N interaction, synergistic influence of Zn on N and N on Zn in grain and straw yields and Zn concentration of linseed was recorded. In Zn x Fe interaction study, the interaction effect was found non-significant on dry matter yield of sorghum but significant on concentrations of Zn and Fe. Zinc concentration in crop decreased significantly due to iron application.

However, in other study Zn x Fe interaction effect was significant on grain straw yields of mustard. In a zinc deficient alluvial soil Zn x Mn interaction effect on yield of wheat was found non significant but the same, influenced significantly the zinc concentration of grain and straw.

Zinc concentration decreased with increasing rates of Mn. In black clay soil Zn x Mn interaction significantly influenced the grain yield of rice. Maximum yield was obtained at combined application of 5 mg kg^{-1} Zn and 10 mg kg^{-1} Mn. Concentration of Mn in rice grain and straw was significantly influenced by levels of Zn applied. Adverse effect of Zn on Mn content was more pronounced in wheat than in the rice crop.

In a study of Zn x Cu interaction on wheat grown in alluvial soils, the interaction effect was found non-significantly on dry matter yield and Zn and Cu contents of the crop. Results of Zn x S interaction study on sunflower grown in Vertisol showed non-significant effect on yield and Zn and S concentration of the crop. Synergistic effect of Mn and P on yield and Mn and p concentration of wheat was observed in a Mn x P interaction study conducted in black soil.

In a green house experiments P x Mo interaction synergistically influenced the yield, P and Mn concentration of berseem crop. A strong antagonistic effect between S x Mo in berseem was observed. Sulphur application decreased the Mo concentration in berseem significantly.

Depletion of micronutrients from soils

Depletion of micronutrients from soils increased with the increasing fertility levels. Different soils were exhausted differently as the result of continuous cropping. The nutrient uptake values were found in the following order.

Zn	Clay	>	Clay loam	>	Sandy clay loam
Cu	Clay	>	Clay loam	>	Sandy clay loam
Mn	Clay	>	Clay loam	>	Sandy clay loam
Fe	Sandy clay loam	>	Clay	>	Clay loam

In general more nutrients were removed from the fine textured soils than from coarse textured ones. This was attributed to the greater capacity of the formers soils to renew the depleted available micronutrient pool. In a long term experiment on continuous use of fertilizer on a Vertisol, exclusion of sulphur from fertilizer schedule reduced the yield of soybean by 1.4 q, wheat by 2.1 q and maize fodder by 7.6 q ha^{-1}. Application of zinc in conjunction with 100% NPK

fertilizer did not show significant effect over 100% NPK application on yield of soybean, wheat and maize due to increased status of available soil Zn caused by continuous microbial activity on left out root residues of the crops.

Application of Zn to deficient fields not only increases the yield but also greatly improves the quality of crops. Significant increase in amylase and Zn content in rice grain has been recorded with the application of zinc. Zinc fertilization of crops increases its concentration which is vital for human and animal health. In another experiment significant positive effect on protein content and negative effect on either extract of soybean was recorded due to Mn application. Major recommendation on micro and secondary nutrients are as below:

i. To alleviate zinc deficiency in soybean, sorghum, wheat and gram, broadcast 25 kg $ZnSO_4$ /ha to coarse textured soil and 50 kg $ZnSO_4$ ha^{-1} to fine textured soil and mix in the soil before sowing.

ii. Apply 50 to 100 kg zinc sulphate ha^{-1} in fine textured clay soils in rice if the soil is deficient in Zn.

iii. Among the different sources of Zn, zinc sulphate is the most efficient carrier of Zn. Relatively insoluble zinc oxide, zinc phosphate and zinc carbonate have also been found satisfactory and can serve as an alternative source to zinc sulphate.

iv. In case deficiency of Zn is observed on any standing crop, foliar spray of 0.5% $ZnSO_4$ with or without urea should be done thrice at an interval of 10-15 days.

v. To correct iron deficiency in soybean, wheat and gram, apply 20 kg ha^{-1} Fe through ferrous sulphate or spray 1 to 2% $FeSO_4$ solution at an interval of 10-15days. At least 2-3 sprays are essential. Foliar application of Fe was found superior to soil application on soybean and wheat crops. Neutralize ferrous sulphate solution with half the quantity of lime before spray.

vi. Sulphur deficiency in soils may be corrected by application of 20 to 40 kg ha^{-1} S in maize, sorghum, soybean, urid, wheat and gram and 40 to 60 Kg S in Mustard. It may be applied through, ammonium sulphate, gypsum or superphosphate. Ammonium sulphate was tested to be superior source of S in wheat.

Phosphorous Dynamics

Research Project Studies on Residual P was started in the year 1994. Summary of research finding are as under –

From the inception of project total nine crops (5 wheat and 4 soybean) were taken. In each season phosphorus gradient of one strip was created and in subsequent season three phosphorus levels were applied. Half of recommended dose was taken as the highest dose i.e. 40 kg P_2O_5 P ha^{-1}. Other two doses corresponding to this dose i.e. 0 and 20 were also taken for comparison purpose. Crops were grown with the application of these doses. Soil and plant samples were collected at the harvest of each crop. The samples were processed and analyzed and the important finding of the project are summarized below.

Depletion pattern of P reservoir with duration

i. The deletion pattern of P reservoir in wheat-wheat and soybean wheat cropping sequences was same.

ii. The depletion pattern shows that available P status reaches to a low value of 9-10 kg P ha^{-1} after the harvest of four crops (2 wheat and 2 soybean) in medium P gradient while in high P gradient it reaches to similar low value after the harvest of six crops (3 wheat and the soybean). It was also observed that the abrupt reduction in available phosphorus occurs up to the harvest of two crops in cropping sequence and there after the reduction becomes gradual.

iii. One interesting observation noticed was that there was much difference in soil teat values of P due to P application in both the gradients and cropping sequences. The might be due to higher P uptake in high P test values due to higher yields.

Balance of addition of P through fertilizer and uptake of P by crops was calculated. Data obtained indicated that application of P at marginal P_1 level (20 kg P_2O_5 ha^{-1}) will never maintain the soil P but application of P at sub optimal P_2 level (40 kg P_2O_5 ha^{-1}) may start maintaining soil P after a long duration. This prediction is based on the fact that build up is approximately @ 5 to 6 kg after each crop. P fixation capacity is 140 kg P ha^{-1}. If the soils P is to be maintained for sustaining yield levels, the level of application of P should be above sub optimal level i.e. above 40 kg P_2O_5 ha^{-1}. The Pattern of utilization of P by crops grown under medium and high P gradient are given below.

i. Grain and straw yield of wheat and soybean in wheat-soybean and soybean-wheat cropping sequence decreased with the harvest of subsequent crops.

ii. Created fertility gradients did not show any over all effect on grain yields of crops.

iii. In case of soybean crop the grain yield was almost the same for first and second crop grown. Onwards when third and fourth crop of soybean were grown, there was continuous reduction in grain yield.

iv. In case of wheat there was continuous reduction in the grain yield from 1st to 4th crop. The yields were 46.28 q ha^{-1} in first crop 39.45 ha^{-1} in 2nd crop, 37.93 q ha^{-1} in 3rd crop and 28.09 q ha^{-1} in 4th crop.

v. The total phosphorus uptake by both the crops was found to be highest during the 1st crop and decrease gradually in the subsequent crops.

vi. At medium and high P gradient wheat yield obtained when soybean sequence was followed, wheat yield were higher as compared to wheat yield obtained when soybean wheat sequence was followed. However soybean yields were not markedly affected by the sequence in which crop were grown. The values were averaged over the number of crops grown in each strip.

vii. If can be concluded that though the P removal by the soybean is lowers as compared to wheat in most of the season even then its requirement is more, if the total biomass produced and the P uptake is considered. This results in significant lowering of STV of P. Thus the available P can be maintained if the phosphorus is applied in soybean to optimum level and in wheat to sub optimal in both the cropping sequences.

Changes in inorganic P fractions with duration

i. There was no marked change in saloid bound P inorganic fraction at low and high P gradient with duration. AI-P fraction of the medium and high P gradient increased up to the harvest of second crop and then decreased continuously with duration.

ii. There was a continuous build up to Fe-P fraction till the harvest of 3rd crop and 4th crop in medium P gradient and high P gradient respectively and then content of fraction decreased.

iii. Red-P fraction increased upto the harvest of 2nd crop and then values remain almost content.

iv. There was marked increase in Ca-P fraction with duration upto the harvest of 5th crop and 3rd crop in high and medium P gradient respectively.

v. If can be calculated that there was a build up of inorganic P fraction with duration upto the harvest of 5th crop in high P gradient where as in medium P gradient soil the build up of fractions was recorded only upto the harvest of third crop.

vi. Increasing levels of P increased the AI-P and Ca-P inorganic fractions where as the remaining inorganic P fraction were not much affected by the levels of phosphorus.

vii. Soil test values were positively and significantly correlated with grain yield of wheat. In case of soybean STV of P was significantly and positively correlated with the straw yield and P uptake by soybean.

viii. P uptake by wheat was positively and significantly correlated with grain yield and crop response of wheat while in case of soybean it was observed that P uptake was significantly and positively correlated with grain and straw yield of soybean.

Biological Nitrogen Fixation

The project is functioning since March 1980 and the significant findings are as given below –

i. Among different modes of application viz. through seed bacterization, furrow application, mixing with FYM and broadcasting, seed bacterization, exhibited successful point of entry of inoculant into the rhizosphere. *Azospirillum* inoculation alone increased 305 more yield of Kodo, Kutki and Niger which was a par to 29 kg fertilizer N.

ii. Composite inoculant of soybean rhizobia on inoculation to nodulating and non-nodulating lines showed the effectiveness of the rhiozia strains on nodulating line which was equal to 120 kg fertilizer N on non-nodulating line.

iii. Seed inoculation of soybean rhozobia was superior to foliar spray on plant and soil.

iv. Dual inoculation of soybean rhizobia was superior to foliar spray on plant and soil.

v. Use of soybean rhozobia on soybean and *Azotobacter* inoculants on wheat under soybean-wheat cropping system saved 30 kg fertilizer N for wheat crop.

vi. Glasshouse studies have shown that VAM (*Glomus mossae*) application resulted the zinc and P requirement to half in Vertisols low in zinc.

vii. Following promising isolates have been screened for *R. Japonicum, Cicer rhizobia, Azotobacter and Azospirillum.*

a. Symbiotic
   i. Soybean S-8, S-14, S-17, S-18
   ii. Gram G-9, G-11, G-12

b. Associate symbiotic
   Azospirillum Pd-7, Pd-8, Pd-11

c. Non symbiotic
   Azotobacter Az-1, Az-3, Az-5

Godrej India Limited for testing Urea coating material (Nimin) for N economy

In order to find out the efficiency of their product "Nimin" a urea coating material, Godrej Soaps Limited Bombay financed the trials to be conducted in alluvial soil of Agriculture College Gwalior. An experiment was conducted to compare Nimin with other urea coating materials, Tarcoal, Neem cake. Various levels of Nimin coating urea in split and full dose at a time were used and were found superior over other coating material and control. Highest yield of wheat grain (53.96 q/ha) was obtained with the use of 120 kg N as urea coated by Nimin and applied in two splits however it was almost at par with same level of urea added before sowing, however, they were significantly superior over other coating materials. N content and uptake were also higher in Nimin coated treatments (128.8 kg/ha) than remaining ones.

National Fertilizer Limited Vijaypur – Testing on CAN

National Fertilizers Limited Vijaypur financed a trial for the testing of their product calcium ammonium nitrate as a source of nitrogen in comparison to urea. CAN was found useful as a basal application to mustard crop. However as a top dress its utility was not better than urea.

Studies on the Effect of Manganese Micronutrient and its doses on Mustard

The experiment was conducted with the financial aid of Union Carbide Limited Bombay. Use of 100 kg ha^{-1} manganese minronutrient a byproduct of union carbide limited produced highest length of siliqua and number of seeds per siliqua as well as yield (27.27 q/ha). The product contained 4-8% $MnSO_4$ and 5-10% $FeSO_4$.

ICAR ADHOC Research Project on Potassium depletion and build-up under different cropping sequences

The main objective of the project was to monitor changes in exchangeable and nonexchangeable forms of K in different cropping sequences. The other objective of the project was to find out the fertility of wheat straw as K source on different crops.

About 2 quintal increase in pearl millet and 1.5 quintal in mustard were recorded by the application of 20 kg k_2O as wheat straw, however significant increase were noticed by 60 kg K_2O to both the crops. About 10 ppm build up in available K in soil was also seen by the same level of K. Total K uptake by pearl millet and mustard ranged from 78.43 to 98.18 kg/ha and 67.62 to 100.38 kg/ha, respectively.

Maximum yield of wheat (45.60 q/ha) and uptake (110.64 kg/ha) was recorded with the application of 60 kg K_2O/ha, a buildup of 12 ppm in available K was also recorded in this treatment after perarl millet wheat sequence, however a negative balance was noticed in $INHNO_3$ – extractable K in all the treatment.

It can be concluded that in order to avoid depletion of K from the soil required quality of K should be added to each crop.

Soil Testing Scheme

Soil testing services was established in 1956 in agriculture research laboratory in Madhya Bharat state with the help of USAID with the responsibility of analysis of cultivators sample of state. Since then it is solving the problems of farmers related to soil fertility, nutrient status (available P, K, organic carbon) and soil reaction (pH and conductivity). After 2005, the STS Gwalior has been entrusted to analysis the micronutrient cations also.

Since then one lakh seventy five thousand (175000) samples have been analysed and recommendations for nutrient use were made. Under the Soil Health Card Project of Govt. of M. P. STS Gwalior has analysed 16032 soil samples collected from 188 villages of Gwalior district covering different block viz. Morar, Ghatigaon, Dabra and Bhitarwar cards showing status of all the nutrients (available N,P,K, organic carbon, micronutrients, DTPA extractable) Zinc, Copper, Manganese and Iron as well as secondary nutrient sulphur and recommendation for balanced use of nutrients on the basis of their were sent to the cultivators through the department of Agricuture.

Village wise soil test summeries have been prepared which may be useful for generated recommendations for a village.

Irrigation Soil Survey / Post Irrigation

It was financed by Govt. of M. P. in order to find out the feasibility of soils of Chambal command area and their suitability for irrigation. Subsequently pre-irrigation soil survey of 700000 ha of command area of different Tehsils of Bhind and Morena districts was carried out, with an objective of finding the morphological soil properties, their genesis and to classify for sustainable development, predicting adaptability of soils to various uses and productivity under definite set of management practices, 71459.34 ha was affected by alkalinity.

For carrying out pre irrigation soil survey 2713 profiles were exposed and 23524 soil samples were collected and 15 series on the basis of soil characteristics and external land festures, soil horizons etc were established. Nearly 370409 ha land found to be most suitable for irrigation, 67225 needs to be irrigated with restriction and 46391 ha is pasture land whereas 156825 has is uder gullies and ravines and not suitable for irrigation.

(i) Soil survey of Narmada Sagar Command Area

Soil survey of Khandwa and Khargone districts (M.P.) was carried out during 1975 by grid system. 2.65 lakh ha area of 7 Tehsils of two districts was classified by collecting 1798 soil samples from 265 profiles. 63.28% area was noticed to be suitable for irrigation covering an area of 168000, remaining 36.67% (91000 ha) is required with restriction. Six series were established.

(ii) Omkareshwar Command Area

Reconnaissance survey was under taken in 1975 by grid system. 702 soil samples were collected from 222 soil profiles and an area of 222000 ha was covered in 6 Tehsils of Dhar, Khargone and Khandwa districts. 73.87% area (164000 ha) was observed to be suitable for irrigation, 25.68% (57000) could be irrigated with care. Eight series were established.

(iii) Chotta Tawa Command Area

The survey in 40000 ha area was carried out in Khandwa and Harsud Tehsils during 1975. 126 soil samples collected from 40 soil profiles established 4 series and indicated 26000 ha suitable for irrigation and 6000 ha for restricted irrigation.

(iv) Rajghat Command Area

Pre irrigation soil survey of 39600 ha in Seondha and 24600 ha in Pichhore and Chaderi was carried out during 1981-83. Bhula and Patra series established in Seondha Tehsil having an area of 4000 ha (6.23%) indicated strong alkalinity 13 soil series were established. It was noticed that 48400 ha (75.45%) was suitable for irrigation 15600 ha (24.29) can be irrigated with adequate care.

(v) Detailed Soil Survey of Ambah Intensive Block

Detailed soil survey of 16000 ha was carried out during 1985-86. 1543 soil samples were collected from 232 profiles exposed in 100 villages. Seven series were established. Soils of Madhaiyapura series were strongly alkaline (207 ha).

(vi) Soil Survey of Harsi Command Area

Detailed soil survey of 53185 ha area of Bhitarwar and Dabra Tehsils was conducted during 1987-1997. 3542 soil samples collected from 576 soil profiles exposed in 181 villagese indicated that Bagwani and Samudhan series (8398 ha 15.80%) are mod. Alkaline. 46604.65 ha (87.67%) area is suitable for irrigation while 6552 ha (12.33) needs careful irrigation.

(vii) Detailed Soil Survey of Waterlogged soil of Bhind and Morena

Survey of 16 villages severaly affected by water logging and high water table undertaken during 1999. 1469 ha was surveyed and classified in to two series. Taton series was strongly alkaline (654 ha).

(viii) Reconnaissance Soil Survey of Shivpuri District

Survey of 413534 ha area of seven Tehsils of Shivpuri district conducted during Feb-March 2000 established 4 series. Soils have been classified in to 3 irrigability classes. 250148 ha (70.49%) area was noticed to be suitable for irrigation. Remaining area needs levelling for proper irrigation.

Performance of Liquid Bio-Fertilizes

Evaluation of carrier and liquid based *Rhizobium* inoculants in Chickpea

Field experiment conducted during 2001-2002 and 2002-2003 on evaluation of liquied and carrier based inoculants under AICRP on chickpea at RAK College of Agricutlure, Sehore (M.P.) indicated

significant increase in nodulation and grain yield by both types of inoculants, Grain yield increased by 14.4% by the use of liquid inoculants of CCRI-III (carrier based inoculants) from UAS Banglore whereas the yield increase with the same strain in carrier based culture was 14.0% over the un inoculated control (1419 kg/ha). Both of these inoculants were statistically identical in performance. However liquid inoculants has extra advantages of possessing greater shelf like and less chances of contamination as compared to carrier based inoculants, hence may be better utilized at farmenrs field for more secure response to inoculation.

Evaluation of Biofertilizers – Rhizoliq + Premax (liquid *Rhizobium* inoculants + sticker of *Rhizobacter argentina*) in Soybean

Field experiment on evaluation of bio fertilizer viz., Rhizoliq + permax alone and in combination with the fungicide Thirum + carbendazim 50 WP (10,5,1, day prior to sowing and on the day of sowing seed treatment and its inoculation) and its comparison with the carrier based cultures (Nofed and oil fed Rhizobium inoculants) and uninoculated fungicidal treated and uninoculated untreated treatment in soybean, it was found that the maximum nodulation and grain yield increase was recorded with the treatment. Thirum + carbendazim 50 WP + Rhizoliq + permax inoculation on the day of sowing which was 13.3% higher over the uninoculated untreated check (2319.4 kg/ha) and this was superior over the Nafed culture and Oilfed culture (carrier based) alone without fungicidal treatment.

(4) Crop Protection

(a) Plant Pathology

Distribution of field crop diseases in jurisdiction under RVSKVV

Wheat

During 1968-69 black stem rust was noticed in Gwalior, Indore, and Datia. Brown rust appeared late in February in Bhopal. Yellow rust was not encountered anywhere during the year, however, it appeared in the severe form during 1981-82 at Vidisha and Sehore districts. It clearly indicated that yellow rust occurs every year but does not assume severe from due to unfavourable weather conditions.

Wilt and blight complex caused by number of fungi, viz; *Sclerotium rolfsii* and a number of species of *Fusarium*. *Helminthosporium, Rhizoctonia* and *Pythium* was encountered during 1961-1981.

Chickpea (Wilt complex)

Important diseases of chickpea are wilt *(Fusarium oxysporum f* sp. *ciceri)*, collar rot *(Sclerotium rolfsii)* and dry root rot *(Rhizoctonia bataticola)*. Since these diseases are mainly soil borne in nature, emphasis was given to manage them through host resistant, cultural practices, biocontrol agents and seed treatment.

Chickpea stunt has emerged as new threat to chickpea cultivation particularly in Western Madhya Pradesh. The work on the disease was started at ZARS Khargone in collaboration with ICRISAT.

Pigeonpea

Wilt *(Fusarium udum)* is the major disease problem of pigeonpea while Phytophthora blight *(Phytophthora drechsleri f* sp *cajani)* occurs in pockets where rainfall is high and field drainage is poor.

Rapeseed-Mustard

White rust, Alternaria blight and Sclerotinia stem rot are the major diseases of rapeseed mustard in Morena region.

Sugarcane

Research work on sugarcane was started in 1960 and was concentrated on host resistance.

During survey, mainly smut was observed (5-40%) while mosaic, ratoon stunting and red rot were recorded in traces. During 1994-95 wilt was recorded in Sehore, Dewas, Bhopal, Indore, Burhanpur, Dabra and Gwalior districts ranging from 5-30 per cent.

Cotton

The diseases of cotton of common occurrence in Madhya Pradesh have been identified as Root rot *(Rhizoctonia solani, R bataticola)* Wilt *(Fusarium oxysporum f.* Sp. *vasinfectum.)* Bacterial blight *(Xanthomonas axenopodii)* Fungal leaf spots/blight/boll rot *(Alternaria* spp. *Myrothecium* spp., *Cercospora* spp., *Colletotrichum* spp.*)* Grey Mildew *(Ramularia areola)* and Physiological New Wilt.

The endemic areas for these diseases have been identified as:

Root rot – (Indore and Khargone) Wilt – (Khargone, Burhanpur, Khandwa) Bacterial blight – (Khandwa, Indore and Khargone): Grey

Mildew, (Burhanpur, Khandwa and Khargone), New Wilt – (Khandwa, Khargone, Indore, Jhabua and Ujjain).

Control measures

Seed treatment with Benlate or Vitavax @ 0.25% has been found very effective in controlling loose smut of wheat. Similarly, seed treatment with Dithane-M-45 (0.25 per cent w/w) effectively controlled seed rot and seedling blight. Zineb was found to be very effective for rust as compared to Dithane M-45, Dikar and Benlate were at per with each other.

Seed treatment with Tritisan of Thriram @ 0.3% w/w has been found effective in checking the foot-rot caused by *Sclerotium rolfsii.*

Dithane M-45 @ 0.25 per cent at an interval of ten days from the time of intial outbreak of the three rusts of wheat has proved to be effective in reducing the rust incidence Bayleton a systemic fungicide, was found to be effective in reducing the diseases intensity of black and brown rust from 13 to 100 per cent.

Seed treatment with apron 35 WS followed by a spray of mancozeb (0.2%) at DAS effectively controlled the disease and increased the grain yield by 101.9 per cent. The foliar application of ridomil MZ (0.24%) was significantly superior over mancozeb.

Both smuts of millets are externally seed borne. Seed treatment with carbendazim/ mancozeb or chlorothalonil @ 2.59 q/kg. seed was found very effective for the control of head smut of kodo and grain smut of barnyard millet. Carbendazim and Raxil (0.1%) were found to be highly effective in increasing the seed germination, seedling vigour and eliminating the seed borne mycoflora in barnyard millet.

Seed treatment with thiram @ 3 g/kg seed or bavistin and thiram in 2:1 ratio has been found effective in reducing the diseases in the initial stages of crop growth of minor millets.

Mungbean yellow mosaic virus emerged as a serious disease in recent years. A number of resistant varieties have been indentified and released for its control.

Two sprays of haxaconazole 5 EC or propiconazole 25 WP @ 0.1 per cent reduced the rust of soybean severity by 35 per cent.

The yellow mosaic of soybean is transmitted by *Bemisia tabaci* in population. To minimize its population, a schedule of insecticidal application was evolved. A basal dose of phorate 10 G @ 15 kg/ha

followed by spray of methyl demetan 0.1% at 45-65 days found most effective. Planting of maize as inter crop ckecks the flow of white fly form infested crop.

Myrothecium leaf spot it is important disease causing varying degree of losses. Its severity increased with the increase in rainfall and rainy days, higher plant population, spreading plant types and higher fertility levels but was reduced at higher phosphorus levels.

Control

Two spray of hexaconazole 5 EC or propiconazole 25 EC or triadimefan 25 WP @ 0.1 per ent reduced the disease severity by 35 per cent. Varieties JS 80-21, India soy 9, PK 1024, PK 1029, PK 1042 and PK 1162 were moderately resistant to rust of soybean.

Seed treatment with apron SD 35 @ 6 g/kg seed followed by two sprays of ridomil MZ (0.25% at 50 and 70 DAS) or three sprays of mancozeb (0.2% at45, 60 amd 75 DAS) were found most effective in reducing white rust of mustard.

Sugarcane set treatment with bavistin or dithane M-45 or moist hot air treatment of sets at 54^{o} C for 4 hours were effective in checking the set-borne enfection of smut and enhanced the germination.

Wilt of sugarcane reduced the yield, height and girth of canes to an extent of 14-21 – 42.2, 5.97 – 25-17 and 9.50 – 22.68 respectively, it also reduced the juice extraction, sucrose content and recovery percentage. Out of 43 varieties 21 were resistant to wilt. The wilt incidence was reduced by wet hot air treatment of sets at 54^{o} C for 4 hours (for with emisan-6, bavistin, venomal or thiram).

Epidemiology

Winter rains were significant in the forecast of wheat rust occurrence in central India. Rust inoculum (Uredospores) obtained in the rain samples collected in micro filters revealed the arrival of rust inoculums in the state.

For Alterrnia blight of chickpea temperature (25-27 C, with relative humidity above 80% and rains during flowering are the predisposing conditions).

Blight caused by *Colletotrichum dematium* reduced chickpea yield by 60.37 per cent.

Phytophthora blight occurs at variable extent in all the pigeonpea growing areas of M.P. causing considerable losses especially in poorly drained fields. The disease severity was found to be greatly influenced by environmental factors. It is positively correlated with number of rainy days, total rainfall, RH and least difference between maximum and minimum temperatures. The disease declines with cessation of rains. The pathogen survives in the field on infected pigeonpea stems till commencement of rains when new crop is sown in the next season.

Lentil wilt *(Fusarium oxysporum f.* sp. *lentis),* collar rot *(Sclerotium rolfsii)* and rust *(Uromyces fabae)* may become serious if winter rains occur in January-February.

Aerial blight of soybean caused by *Rhizoctonia solani* significantly influenced the pod and seed formation in soybean. Temperature 30.1 between 230 to with 82% relative humidity and total rainfall initiated disease flowering of the crop.

Data on the weather factors of kharif, 1999 and 2000 recorded from Chhindwara district showed that the predisposing factors a week before the disease appearance in 1999 (August 1st week) were temperature (21.7 to 25.8 C), relative humidity (85.2%) rainfall (182 mm), four rainy days and 7 cloudy days. From the mid of August (15 to 21) and by first week of September it became apparent in all adjoining areas of hot spots during this period, the minimum temperature ranged (21.8 to 22.4 C) and maximum (25.2 to 28.2 C) with 79 to 87.5 per cent relative humidity and 271 mm rainfall which lead to the occurrence of rust in epiphytotic form whereas, during 2000, it did not appear even in traces., Because the temperature in the first week of August, (when rust usually occurs) ranged 22.6 to 23.6^{o} C, relative humidity 75 per cent, rainfall 23.6 mm with only two rainy days and five cloudy days. Thereafter, from second week of August, the temperature ranged from 22.1 to 29.3 C, relative humidity (77.4 to 82.7 per cent) with 135 rainfall.

During first week on August when the rust normally initates the range of the predisposing factors studied was almost similar during both the years (1999 and 2000) except the high rainfall (182 mm) during 1999 as against only 23.6 mm in 2000. Therefore, lead to the occurrence of epiphytotic in 1999 and not in 2000. Thus it is concluded that heavy rain during first week of August was an important factor for inducing the rust severity.

Epidemiological and other studies on *Cercospora* leaf sport *(Cercospora sesami)* of sesame with four cultivars viz. Rewa-96, Rewa 100 and Rewa 123 alongwith two checks N-32 and JT-7 moderately

resistant exhibited thick cuticle (9.63 to 11.29 pm) epidermal layer (16.48 to 23.26 mm) positive correlation between the size of stomata with infection rate and disease index.

Purple blotch *(Alternaria porri)* is an important disease of onion the epidemiological studies revealed that initiation and development of this disease requires a warm humid weather. Age of the host determines the lesion development.

A new disease referred to as 'Ginger yellows' caused by *Fusarium oxysporum f.* sp. *zingiberi* apparently perpetuated through infected rhizomes when temperature raged between 23-29 54^{o} C accompanied with 95% RH.

Loss

Smut of pearl millet is the most important disease in Northern M.P. and its severity on cultivators field during last ten years ranged from traces to 20 per cent. The severity is more on hybrids than local.

Lentil wilt incidence has been reported to be as high as 78 per cent in some fields of Madhya Pradesh. The disease caused mortality at pre-emergence as well as at adult stage of crop.

Estimation of losses indicates that with one per cent increase in smut severity, the grain yield loss increased by 0.82 per cent.

Linseed suffers mainly from three diseases viz. Fusarium wilt, powdery mildew and rust. Past surveys indicated that losses due to Fusarium wilt are ranging from 5.25 per cent and powdery mildew 63 per cent. Rust appears at irregular interval in Western part of Madhya Pradesh but the losses are serious in Eastern part of M.P. where it appears every year.

White rust of mustard caused 15% loss in yield.

Wilt

Fusairum moniliforme and F. oxysporum in sugarcane were found associated with diseased plant. The incidence of this disease varied from 9-20 per cent in planting and 13-35 per cent in ratoon crop.

Yield losses in cowpea due to the root knot nematode can be minimized appreciably by either seed treatment with carbofuran @ 2 per cent w/w or carbosulfan @ 0.01 per cent as seed soaking.

Integrated Disease Management (IDM)

Dipping of ginger rhizomes in hot water at 45 C for three hours completely eradicated the root-knot nematode from the rhizomes. This finding has been made practically feasible for farmers by using 10 cm

deep galvanized sheet trays coated with black paint, filled with water to 8 cm level and putting them under sun from 15th May or when atmospheric temperature reaches above 40 C. The trays filled with water are exposed to sum from 8 to 11 a.m. then the temperature of water in the trays attains 45 ^{o} C.

Summer ploughing of vegetable (okra) field in second week on May an allowing it exposed for next 15 days effectively minimized the root-knot population in vegetable cropped soil.

Solarisation (ploughing and immediately covering the soil with transparent polythene sheet(1.0 mm) with margins by soil) in the month of May for 15 days was found effective in controlling the root knot nematodes. But considering the feasibility and economical point of view, summer ploughing alone is more profitable. However, the solarisation can be preferred for raising nurseries for seed production.

Nursery bed of tomato treated with dazomet gave minimum gall index of root-knot with higher yield.

Application of neem cake @ 500 kg/ha reduced nematode populations below threshold of damage. Three application of *Pecilomyces lilacinus* through oil cake @ 500 kg/split/ha was found effective in reducing root gall index and root knot nematode population in betelvine soil.

Doses of inorganic fertilizers 200 kg N/ha, 100 kg K/ha promoted the quality and quantity of betel leaves.

Application of molybdenum @ 0.1 increased the leaf yield and IBA (100 ppm) initiated early rooting of betelvine cutting.

Neem coated urea tricontanol (0.5%) and metalaxyi (0.1%) spray gave maximum yield in terms of number of leaves.

Sanitation along with one application of Bordeaux mixture at onset of monsoon and one application of *T. viride* after one month followed by second application of Bordeaux mixture after two months significantly reduced the disease incidence in betelvine.

(b) Entomology

Pest Problems in Rice

Delphacid plant hopper

The pest was found active from August to September during wet season. The severe attack in the retransplantation was unavoidable. At the lowest population (15 hoppers/hill), there was 13-17% loss after 60-120 days exposure at 15 days after transplanting. Economic threshold and injury level were found at or below 15 insects per hill for different exposure periods at different stages of the plants.

The spray formulations of monocrotophos, dimethoate, methyl demeton and dust formulation of carbaryl and methyl parathion have been found useful in controlling the pest.

Rice gall fly (Midge)

71.3% infestation in high yielding varieties in eastern part of Madhya Pradesh was recorded. The incidence was also recorded in Jabalpur district of the state. The gall midge is a serious pest of Chhatishgarh region.

In a screening test the varieties, Asha, Usha, Phalguna and Bangoli – 5 were found to be resistant and these were released in the endemic area. The carbofuran 3 G. and phorate 10 G @ 1 kg a.i./ha have been found effective. Seedling root dip by chlorpyriphos 20 EC 0.02% has also been found effective in minimizing the pest incidence before transplanting.

Army worm

Rice ear cutting caterpillar has become a regular pest of Paddy in Madhya Pradesh.

Army warm cause loss of 12.47 to 19.88 q. Grain per ha. The maximum population during the end of September to early October was observed with registered yield losses of 37.88 and 92.92% by 15 insects/hill at booting and panicle stages, respectively.

The Quinalphos 25 EC and Methyl parathion 50 EC @ 0.5 kg a.i./ha reduced the larval population significantly over malathion, phosalone and control. In another trial endosulfan 0.05% was the most effective in reducing the population of army worm.

Pest problems in Soybean

Stem fly, *Melanagromyza sojae* (Zehrit)

The maggots of this pest mines the leaves first and through leaf veins and mid-rib reaches the main stem, where it forms zigzag tunnels by feeding on the pith region of the stem. Such tunnelling leads to the withering of plants and pre-mature fall of flowers. The fly infests up to 90% of plants in kharif.

The maggot may tunnel upto 70% of the stem length and reduce the grain yield to about 33%. The fly infests up to 90% of plants during kharif.

Application of either of chlorpyriphos 20 EC @ 1.5 lit/ha, triazophos 40 EC @ 0.8 lit/ha, quinalphos 25 EC @ 1.5 lit/ha, methomyl 12.5 L @ 2 lit/ha, ethion 50 EC @ 1.5 lit/ha and ethofenprox 10 EC @ 1 lit/ha have proved effective. Field efficacy of insecticides against stem fly revealed maximum economic benefit in case of dimethoate (0.045%), 1:13, followed by endosulfan (0.07%) 1:8.6.

Girdle beetle, *Obereopsis brevis*

The adult and grub are the damaging stages of the pest. The adult females girdle the different parts of soybean plants viz. Stem, petiole and central leaflet. The part of plant above the girdle withers and dries. The girdling on stem is more detrimental than on the other parts. This beetle has become serious pest infesting 90% of plants.

Endosulfan 35 EC @ 0.07%, quinalphos 25 EC @ 0.05%, dimethoate 30 EC @ 0.04% and monocrotophos 36 SL 0.04% were found effective against girdle beetle when applied as soon as the egg laying starts in the field.

Seed maggot, *Delia platura*

The maggots feed on embryo, as a result the seeds fail to germinate. In few cases the seeds may germinate with damage symptoms on cotyledons. The maggots also feed on radical cotyledons above the soil.

The pest damages 9-13% of soybean seeds in Madhya Pradesh. Dimethoate 30 EC @ 0.03% may be sprayed if the damage has been recorded after sowing.

White grub, *Holotrichia cosanguinea*

It is found through out the country but its damages on soybean is more pronounced in some parts of Madhya Pradesh and Maharashtra.

During kharif 1991, the pest infested 20 to 43% of soybean plants and caused a reduction of 27.8% (4.39 q/ha) grain yield in Madhya Pradesh.

Green semilooper, *Chrysodeixis acuta*

The pest has been found devouring buds, flowers and young pods resulting in no podding initially and later on bud-proliferation in plants. Gray semilooper, *Gesonia (Rivula) gemma* has become a serious and regular pest of soybean in M.P.

Five Hymenopters parasites have been recorded on this pest, which include *Ecphoropsis perdistinctus, Euplectus epiplemae, Apanteles* sp., *Brachymeria* sp. and *Elasmus brevicornis* white and muscardine fungus has also been recorded on this pest. Outbreak of this pest was recorded during 1979. Though earlier it was recorded as a minor pest of soybean in Madhya Pradesh, it is now appearing regularly. Studies have revealed 35% flower, 24% pod damage and 50% grain yield reduction. Grain loss of 3.94 q/ha has been recorded due to gray semi-looper damage.

Endosulfan 4%, quinalphos 1.5% and fenvalerate 0.04% dust @ 20 kg/ha were found effective against semi-loopers.

Sucking pests

The crop is damages by various sucking pests like Jassids, *Apheliona maculosa,* aphids, *Aphis gossypii* and bean bug, *Chauliops fallax*.

Quinalphos 0.04%, monocrotophos 0.04% and dimethoate 0.04% were found highly effective in reducing the pest population.

Bihar hairy caterpillar, *Spilosoma oblique*

A reduction of 75.2% in pod number, 80.3% in pod weight, 77% in grain number and 71% grain weight was recorded in infested plants over healthy ones due to its damage.

Leaf miner, *Bilobata subsecivella*

Its out breaks were reported in 1971 and 1981 in Madhya Pradesh. The pest may cause yield reduction of 40 to 70%.

Insecticides endosulfan 35 EC @ 0.07%, quinalphos 25 EC @ 0.05%, dimethoate 30 EC @ 0.05% and monocrotophos 36 SL @ 0.04% have been found effective against soybean leaf miner.

Gram pod borer, *Helicoverpa armigera*

The gram bod borer is a polyphagous sporadic pest of soybean in Madhya Pradesh. Now it appears regularly on the vegetative stage of soybean in Kharif.

The larvae damage up to 92% pods at pod filling stage, with an average larval population of 13.9 larvae/meter row length and a reduction of 97% grain yield has recorded in Rabi soybean.

Blue beetle, *Cneorana* sp.

The blue beetle has become a potential pest of seedling of soybean. The pest was observed for the first time during kharif 1984 in Madhya Pradesh.

Pest problems in Cotton

Aphid, *Aphis gossypii* : The incidence of aphid population in Nimar region has been recorded quite high during mid July to late August and in some years up to November end. In central Narmada valley peak population of aphids, was recorded during last week of July to mid August (24.8-30.1^{o}C and >87% RH).

Jassids, *Amrasca biguttula* : In Nimar region its activity has been recorded to be higher during early July to September. In central Narmada valley its peak population has been recorded between last week of July to mid September (24.8-32.6^{o}C).

Thrips, *Thrips tabaci* : The incidence of thrips is quite during August and is favoured by prolonged dry spell. In central Narmada valley its peak activity has been recorded between second fortnight of August to first fortnight of October (30^{o}C and 74.85% R.H.).

White fly, *Bemisia tabaci* : Its activity has been recorded to be higher in the month of October and increased populatin following synthetic pyrethroid application have been observed.

Boll worm complex : Activity of boll worms has been noticed between July end and November. Peak activity of *H. armigera* has been found deviating between years. *Earias* sp. is more active in the month of October, *Helicoverpa* in September, October to December and pink boll worm in late November.

The severity of the incidence on bolls as well as locule damage, recorded at Indore and Khandwa, ranged from 10 to 70% and 32 to 65%, respectively.

Sucking pests : Disyston 5%, Temik 10%, Phorate granules 10% @ 1.5 kg a.i./ha were found to be most effective for jassids and aphids and economical under unirrigated conditions in Nimar region, while in Malwa region it is economical under irrigated conditions.

New insecticides representing neonicotinoid group like emida chloprid and thiomethoxam in the form of foliar spray exhibited excellent control 25.35 days after germination.

Neem based bio-pesticides, although gave encouraging results, but due to fast degradation more applications were needed.

Bollworm complex :

The boll worm complex including spotted boll worm and gram caterpillar are identified as the major insects of cotton. The sucking pest like jassids, aphids and white fly cause maximum damage to the cotton crop by sucking the cell sap from the different parts of the plants. Following recommendations are emerged for controlling the insect-pests in cotton.

i. Removal of alternate host plants.
ii. Avoid cotton after cotton.
iii. For sucking pest early sowing, seed treatment with Imidacloprid 70 WS @ 8 g per kg seeds.
iv. Set the pheromone trap.
v. Neem products are recommended for conrol of white fly.
vi. The insecticides viz., quinalphos 20 AF @ 500 to 700, Profenophos 50 EC 1000 1250 g a.i. per hectare during fruiting stage of the crop is recommended for controlling boll worms.
vii. After 75 days of sowing deltamethrin @ 10-12.5, alfamethrin 15-25, cypermethrin 40-60, fenvalerate 75 g a.i./ha were effective.
viii. For tobacco caterpillar and other insects, the insecticides like quinalphos 20 AF @ 500 to 700, diflubenzuron 50 WP @ 75 and Poison bait using monocrotophos 250-500 g a.i./ha were found effective control measures at early instars of the larvae of these pests.
ix. JK 35 was observed as tolerant to sucking pests and boll worm complex.

The application of pyrethroids against boll worm complex resulted in keeping the low boll as well as locule damage (%). Prefenophos 50 EC (2 lit.), quinolphos 20 EC (2 lit), endosulfan 35 EC (2.5 lit.), chlorpyriphos 25 EC (2 lit.) and triazophos 40 EC (1.5 lit.) provide satisfactory control of bollworms.

Pest problems in Sugarcane

Leaf hopper, *Pyrilla perpusilla*

Its infestation in early varieties ranged on an average between 11.17 and 25.80 hoppers/leaf while on mid late varieties its population was recorded to be 8.59 to 22.27 hoppers/leaf. Consequent to pyrilla attack there is a reduction in sucrose content and commercial cane sugar (CCS) ranging from 1.35 to 6.54% and 12.99 to 56.56%, respectively.

Early shoot borer, *Chilo infuscatellus*

It is widely distributed in the sugarcane growing areas of the state infesting the crop during early growth stages. The avoidable yield loss has been recorded up to 15.09%, while the extent of infestation has been estimated to be 11.68 to 29.21% in early and 10.9 to 28.83% in mid late sugarcane varieties.

Top shoot borer, *Scirpophaga excerptalis*

The yield loss up to 53% is reported from Sehore with reduction in sucrose and purity up to 3.68 and 13.87%, respectively.

Scale insects, *Melanapsis glomerata*

In variety CO 1305, the reduction in brix, sucrose, purity and recovery have been estimated to be 4.40, 6.70, 2.50 and 8.10%, respectively.

Decamethrin (0.0014%), quinalphos (0.05%), cypermethrin (0.01%) and malathion (0.01%) are the safest insecticides for Cotesia *flavipus* as they inflict less than 35 per cent adult mortality.

For mass multiplication of *Sturmiopsis inference*, the fourth instars larvae of *Gallaria* and parasitic inoculation exposure time of four hours were found to be the most suitable for acquiring most healthy parasite with maximum puparial recovery (23.6).

Application of granulosis virus @ 10^8 IBS at 40, 55 and 70 days after planting significantly reduced the early shoot borer population and significantly enhanced the cane yield, brix, sucrose and commercial cane sugar.

Cypermethrin + triazophos (Cyperphos) (0.04%), cypermethrin (0.005%), deltamethrin (0.002%) and azadirachtin (2 to 5 ml/l) were the least toxic insecticides (>60% adult parasite emergence) to *Tetrastichus pyrillae* Crawford, and egg parasite of pyrilla.

T. pyrillae, an egg parasite of Pyrilla was found to be of regular occurrence in sugarcane ecosystem. It parasitised up to 80 per cent eggs of the host. Its activities were recorded from second week of August till harvest of the crop, with peak activity during first week of December (74.17% egg parasitization).

Methyl parathion 50 EC @ 0.5% (42.22% yield increase) followed by malathion 50 EC @ 0.05% (30.94% yield increase) proved to be effective in controlling white fly damage on sugarcane.

Two sprays of malathion 50 EC @ 0.1% at 6^{th} and 7^{th} month old crop effectively ckecked the early shoot borer and subsequently increased the yield and NMC by 41.41 and 26.37 per cent, respectively.

Four applications of monocrotophos or malathion or endosulfan @ 0.75 kg a.i./ha reduced the pyrilla population significantly with increase in cane yield from 20.01 to 23.64 per cent.

Soil application of phorate 10 G @ 2 kg a.i./ha was observed to be effective against early shoot borer by increasing the cane yield by 41.12 per cent and number of tillers by 56.07 per cent.

Malathion (0.05%) effectively controlled the *Pyrilla* in sugarcane and it gave maximum B:C ratio of 16.54, while monocrotophos (0.04%) and quinalphos (0.07%) were some other insecticides which gave better control of the pest. The newer chemicals like prophenophos (0.05%), methomyl (0.004%) and triazophos (0.04%) gave more than 70 per cent mortality of *Pyrilla* eggs.

Number of promising genotypes/varieties were evaluated for their reaction against the key pests of sugarcane. Some of the genotypes/varieties listed below gave better performance in last decade.

Table 30: Susceptibility of different varieties of sugarcane to early shoot borer and *Pyrilla perpusilla*

S. No.	Less susceptible to early shoot borer	Less susceptible to *Pyrilla perpusilla*
1	Co 8003, Co 7902	Co 8003, Co 7902
2	Co 7381, Co 7608, Co 7808	Co 7516, Co 6507, Co 7706
3	Co 7640, Co 7906, Co 7515, Co 1305 and Co 8327	Co 7618, co 7515, Co 7543, Co 7609 and Co 1305
4	Co 7515, Co 7516, Co 62102	Co 7707, Co 7318, Co 7515
5	Co 7515, Co Jn 20	-
6	Co 89024, Co 87002 and Co 89019	Co 89019, Co 87263 and Co 8209
7	-	Co Jn 86-310 and Co Jn 86-1676
8	-	Co 89019, Co Jn 87-381, Co Jn 221, Co Jn 86-586, Co Jn 87-263

Co 1305, Co 7609, Co 7615, Co 8327, Co Jn 20, Co 7576 and Co 62102 also gave better performance with regards to yield.

Pest problems in Chickpea

Gram pod borer, *Helicoverpa armigera*

The maximum load of the larval population remains from 3rd week of December to 3rd week of February at flowering and podding stages. The outbreaks of *H. armigera* occur if rainfall in September and October exceeds 250 mm, winter rains are around 20.25 mm or more every month and winters are warm with mean daily minimum temperature exceeding 10^{o}C. The maximum and minimum temperature had negative correlation with larval population and relative humidity had positive correlation.

Two larvae/m row length of gram, at pre-flowering or at any subsequent stage causes economic injury to the crop. ETL of 1 larvae/5 plants at flowering and pod-initiation stage have been worked out. This comes to 2 larvae/m row length.

Kabuli variety L 550 was significantly more susceptible (10% pod damage) and concluded that bold seeded varieties among desi type, are more preferred as compared to small seeded ones.

Light trap can't be used as a tool for control. However, it is being used to monitor the pest population. Light and pheromone traps

successfully attracted the adults and no definite correlation could be established between the catches and the meteorological parameters.

Highest yield of 23.85 q/ha has been recorded in monocrotophos 0.04% treatment with an increase of 40.70% over control. The fenvalerate 0.02% was the most effective amongst synthetic pyrethroids in reducing the larval population, pod damage and recorded highest yield. Highest cost benefit ratio recorded with endosulfan. Among dust formulations quinalphos 1.5%, endosulfan 4% and fenvalerate 0.04% controlled the pod borer effectively (5.9 to 7.6% pod damage and 897-988 kg/ha yield) as compared to control.

Amongst the spray formulations of conventional insecticides tested from 1985-86 to 1989-90, monocrotophos 0.04%, endosulfan 0.07%, quinalphos 0.05% and fenvalerate 0.02. were found effective and economical, recording yield of 1134, 1278, 1144 and 1286 kg/ha, as compared to 911 kg/ha in control, respectively.

Pest problems in Lentil

Only few insects have been found to infest the lentil crop, namely aphid, *Aphis craccivora*, pod borer *Adisura atkinsoni*, spiny pod borer *Etiella zinkenella*, thrips *Caliothrips indicus* and jassids *Empoasca* sp. Out of the mentioned pests aphids have been recorded as important pest causing 10-15% damage. Ekalux 5% dust @ 25 kg/ha is most effective and gives highest yield.

Pest problems in Pigeonpea

In Madhya Pradesh, more than 29 species of insects are recorded attacking pigeonpea, out of which 12 foliage feeders, 11 sap suckers and 6 were pod borers. Among these pod fly, *Melanagromyza obtuse* and pod borer, *Helicoverpa armigera* are the major ones and pod bug, *Clavigrella gibbosa*, plum moth, *Exelastis atomosa* and green bug, *Nazara viridula* are the sporadic pests.

Pod fly, *Melanagromyza obtusa* : It is a serious pest of red gram in the state. The maggots bore the pods and feed on tender developing seeds. The damaged seeds are unfit for human consumption or as seed and they can't be turned into 'dal'. At Jabalpur 86.4% infestation has been recorded due to this pest. Many workers have reported the pod and grain damage ranging from 19.8 to 100 and 0.8 to 86.8%.

Pod borer, *Helicoverpa armigera* : Economic threshold/injury levels

Pest	ETL	EIL
Helicoverpa armigera	1 larva/plant	2 or more/plant
Clavigrella gibbosa	2 nymphs/plant	4 nymphs/plant
Nezara viridula	Less than 1 bug/plant	1 bug/plant

JA-4 mid maturing variety has less infestation of borer complex and higher yield as compared to other varieties. Early maturing pigeonpea varieties should be avoided as it encourage the borer complex infestation as compared to mid and late maturing varieties. Growing of same maturing group of pigeonpea in an area should be followed.

The research results done at Sehore revealed that no plant products are superior than the recommended insecticides for the control of pod borers. But, Achook 0.5% and neem seed extract 5% were better than other products in reducing the pod damage and increasing the yield. However, the cost benefit ratio was better in neem seed extract (2.72) than Achook (-0.01).

Dust formulations reduced the pod damage, gave higher yield and better cost benefit ratio. The application of dust formulation @ 20-25 kg/ha at flowering and podding stage, with fenvalerate 0.4%, quinalphos 1.5% and endosulfan 2.0% were found effective, recording 1786, 1812 and 1630 kg/ha yield as against 1330 kg/ha in control, with 1:5, 1:7 and 1:4 C:B ratio, respectively. Fenvalerate 0.4% or quinalphos 1.5% or endosulfan 2% or methyl parathion 2% or chlorpyriphos 1.5% @ 20-25 kg/ha were recommended against *H. armigera*.

Monocrotophos 0.04% and Dimethoate 0.03% were found effective not only in reducing pod damage by pod borer (4-5%) and pod fly (17.5 and 20%) but also recorded highest yield (1133 to 1205 kg/ha) as compared to control.

Green gram and Black gram

Aphids *(Aphis craccivora* Coch.), galerucid or *flea* beetle (*Madurasia obscurella* Jacoby), jassids (*Empoasca* sp.), Thrips (*Caliothrips indicus* Bagnall), Hairy caterpillar (*Diacrisia oblique* (Walk), *Amsacta moorei* Butler), leaf webers (*Cydia (Eucosna)* critica), whilte fly (*Bemasia tabaci* Genn.), blue beetle *(Cneorane sp.).*

Borers : Stem fly (*Melanogromyza sojae* Zehnt.) and girdle beetle (*Obereopsis (Oberea) brevis* Swed.). Besides these, some of the major pests may attain status of major pests in some locations under favourable conditions, they are semilooper, (*Diachrysia (Plusia) orichalcea* Feb.) and *Chrysodeixis acuta* Walker, tobacco caterpillars, *Spodoptera litura*, linseed caterpillar, *Laphygma exigua*, til hawk moth, *Acherontia styx* West. The giant hawk moth, *Agrius (Herse) convolvuli (Linn)*, Leaf miner, *Phytomyza atricornis* meign, pod borer, *Maruca testulalis, Riptorts linearis* Fabr., lygaeid bug *Chaulisps fallax* Scott., mites (*Aceria* sp.) and white grub, *Holotrichia consanguinea* (Blanch.) were recorded on green and black gram.

Losses caused by thrips, *Caliothrips indicus* are 40-50% damage, by jassids 5%, by linseed caterpillar 5-10% and by *Maruca testulalis* (10-20%). Riptortus linearis was observed on summer mung from March to June. During its total life span of 14 days, the female laid 25-33 eggs. The incubation and nymphal periods lasted 4.3 and 11.5 days, respectively, That *Oberea brevis* Swed (*Coleoptera: Lemiidae*) was recorded to be active from 26 August to 10 September and damaged 8.75% plants of black gram. A reduction of 38-58% in pods, 34.54% in pod weight and 37.45% in grain weight was observed in tunnelled plants by the *Oberea grubs.*

The blue beetle, *Cneorane* sp. (Coleoptera : Chrysomelidae) was recorded on urdbean at seedling stage feeding upon young leaves and shoots. It should be controlled even when one beetle per plant is seen. 6.75 per cent mortality of urdbean/plot due to white grub, *Holotrichia consanguinea* (Blanch.) was recorded. Outbreak of giant hawk moth, *Agrius convolvuli* (Sphingidae : Lepidoptera) was recorded at Sehore on urdbean.

Methyl parathion 2% dust @ 6.5 kg a.i./ha or endosulfan 0.07% spray @ 0.35 kg a.i./ha to control plant hock moth, *H. convolvuli* in urdbean was recorded. Under field demonstration during 1989-90 basal application of phorate 10 G @ 1 kg a.i./ha and one spray or monocrotophos 0.04% on 14 days old crop gave effective control of the pests and 25 to 30% higher yield was obtained.

Pest problems in Sorghum

The shoot fly and stem borer are the major pests of sorghum crop. The midge, bugs aphids, head worms are seen occasionally and damage the crop at low level. Recommendations for controlling shoot fly and stem borer are:

i. Dry sowing or sowing by one week before onset of monsoon is recommended to save the sorghum crop from attack of shoot fly.
ii. Higher seed rate up to 25 per cent is recommended in late sowing conditions to maintain the optimum plant population. The shoot fly attacked plants should be uprooted and destroyed.
iii. Imidacloprid 70 WS @ 10 g per kg seed was found to be effective for the control of shoot fly and higher grain yield.
iv. Early sowing and seed treatment with Endosulfan 35 EC @ 0.07 per cent + $CaCl_2$ (2 per cent) has proved an effective and most economical control measure for shoot fly. It also gave better grain yield.
v. For control of shoot fly and stem borer the intergrated pest management module i.e. early planting with normal rate (8 kg/ha) + seed soaking for 8 hours in Endosulfan 35 EC 0.07 per cent + $CaCl_2$, 2 per cent + one spray with neem leaf extract 5 per cent and whole application of Carbofuran 3 G @ 7.5 kg/ha at 30 DAE was effective.
vi. Seed treatment with Imidacloprid 600 FS @ 10 ml + 20 ml water per kg seed was also found superior and effectively control shoot fly in late sown corp.
vii. For management of sorghum shoot pest the seed should be treated with Thiomethoxam 70 WS at 3 g per kg seed followed by Endosulfan 35 EC @ 0.07 per cent at 45 days after emergence.

Pest problems in Safflower

i. The sowing of crop at 15 October recorded highest grain yield and less attack by aphids.
ii. The peripheral (1.80 m width) application of dimethoate 30 EC @ 0.05 per cent controls the aphid infestation up to 90 per cent.
iii. Some of the new chemicals such as spraying of thiomethoxam 25 WG @ 0.005 per cent, imidaclorid 17.8 per cent SL @ 0.0045 per cent and acetamiprid 25 SP @ 0.004 per cent at 50-70 days after sowing provided better control of safflower aphid in comparison to the traditional pesticides.
iv. Safflower variety JSF 1 was found tolerant to aphid infestation.

Pest problems in Wheat

Twelve insects and mite species have been recorded on wheat crop in the state. Among them termites, brown wheat mite, shoot fly and root aphid were major insect pests. A new pest *Chaetocnema cogneta* was recorded for the first time on rainfed wheat at tillering stage during 1976-

79 at Bari district of Raisen. It has attained a major status in rainfed wheat. Epidemic of *Mythimna separata* was recorded at Khandwa in 1996-97 and Bhainsadehi in 1998-99 and *Helicoverpa armigera* (1998-99) at Betul was also recorded. Wire worm, *Agriotes* sp. was recorded in un-irrigated wheat crop at Jabalpur.

Termite, Microtermes obesi, *Odontotermes obeses*

Termites are serious pests in un-irrigated, light soils, causing upto 30% crop loss. Seed treatment with Chlorpyriphos @ 400 ml diluted in 5 liter water/q seed before sowing, is effective and economical to control the pest.

Shoot fly, *Atherigona bituberculata*

It has been recorded as a serious pest of mexican wheat in M.P., infesting 8-44% seedlings. Application of nitrogen tends to increase the attack of the pest. Variety K 65, C 591, Hy 11 and Hy 65 were less susceptible than varieties Sonara-63 and Sabarmati Sonara.

Brown wheat mite, *Petrobia laten*

It is a serious but sporadic pest of rainfed wheat, most active in January and February. Varieties Raj 1385, Raj 1454, MACS 103 and Raj 1456 were found less susceptible.

Monocrotophos 36 EC @ 200 g a.i./ha, chlorpyriphos 20 EC @ 250 g a.i./ha and formothion 25 EC @ 160 g a.i./ha were found most effective against the pest.

Aphids, *Rhopalosiphum rufiabdominalis* and *R. madis*

The aphids cause a yield loss of 8.4, 28.8, 41.9, 27.3 and 3.08% in plant height, ear number, grain number, grain yield and one thousand grain weight, respectively. The application of zinc @ 5-20 kg/ha enhances the root aphid population, while phosphorus alone was found to suppress it.

Chlorpyriphos 20 EC @ 1lit/ha and aldrin 30 EC @ 1.25 lit./ha applied through irrigation water, were effective in controlling aphid population.

Flea beetle, *Phyllotreta chotania* and *Chaetocnema cognata*

It was recorded as a new pest of wheat during 1976-79 and caused serious damage at Bari district of Raisen (Average 38.6% plant infestation). Yound larvae on hatching, bored into seedlings and tillers causing dead hearts.

Phosphomidon 86 EC @ 250 ml/ha and monocrotophos 36 EC @ 750 ml/ha, followed by dimethoate 30 EC @ 750 ml/ha were found most effective in controlling the pest.

Green semi looper, *Plusia orichalcea*

Monocrotophos 0.04%, fenvalerate 0.01% and quinalphos 0.03% were found effective against the pest.

Rodentology

The survey of rodents carried out in different districts of Madhya Pradesh, denoted the presence of Larger bandicoot, *Bandicota indica* Hardwicke, lesser bandicoot, *B. Bengalensis* Gray, soft furred rat, *Millardia meltada* Gray, house rat, *Rattus rattus* Linn and house mouse, *Mus musculus*, wodgson. In poultry *Rattus rattus* Gray, *Bandicota bengalensis* Gray and *Mus musculus* urbanus Hodgson were recorded.

The population dynamics of soft furred rat, *Millardia meltada* Gray was recorded maximum at the maturity stage of ground nut crop.

Studies undertaken on food preferences to *Rattus rattus rufescens* in the laboratory revealed that jowar was the most preferred food and mustard the least. In preference test, dry and moist food of wheat and gram was tested in crop fields. The results revealed that the rats, *B. bengalensis*, *Rattus meltada* and *Mus booduga* preferred moist food over dry bait of wheat and gram.

The rodents caused annual losses to eggs in the poultry worth Rs. 3285 to Rs. 4380. The total monetary losses were amounting to Rs. 10,758.56 including damage to floor, feed and eggs.

The average loss of 44.76 kg/ha in soybean, yield loss from 3.11 to 11.31 kg/ha in gram crop in Narsinghpur district, 46 to 449 kg/ha losses in sugarcane in Madhya Pradesh, estimated grain yield losses of 54.40 and 12.80 kg/ha in semi and irrigated wheat crop and 2.33 to 12.02 g/m^2 with a mean of 6.08 g/m^2 yield loss of rice under dry farming situation were recorded in Madhya Pradesh by various workers.

The number of cut tillers caused by rats, were distributed significantly more in central area (6.40/ m^2) of the crop fields as compared to periphery (0.18/ m^2) and middle (1.75/ m^2).

The rodents are cunning animals and develop shyness to various objects. The management measures do not give consistent results. Under mechanical measures, wonder traps were found more effective over Glue trap in trapping house rats in poultry.

In a laboratory evaluation test of rodenticides against *R. rattus rufescens*, zinc phosphide 2% was found to be the most effective as compared to Bromadiolone. In a further field test the effect of three rodenticides viz. Zinc phosphide 2%, Aluminium phosphide (3g) and Bromadiolone 0.005% against *Bandicota bengalensis* was evaluated in sugarcane crop. These three rodenticides yielded 86.62, 93.13 and 99.63% reduction in the rodent population in 1, 2 and 3 days respectively.

In a field test of rodenticides against field rodents in wheat crop found that the rodenticides viz. Bromadiolone 0.005%, Flocoumafen 0.005%, zinc phosphide 2% (grain weight) and zinc phsophide 2% (semi wet bait) significantly decreased the rat damage (62.28 to 90.12%) as compared to control.

In a No choice laboratory test of Bromadiolone 0.005% using wax block @ 5, 10 and 15 g/animal of *Millardia meltada* completely fed to test species, indicated that the rodenticide caused 100% mortality at the doses of 10 and 15 g and 66.66% mortality with 5g. In a field test against *Bandicota bengalensis* Gray and *Millardia meltada* Gray in gram crop, it was found that the application of 2% zinc phosphide proved significantly effective at pod filling stage as compared to grain stage.

(5) Seed Production

Fourteen farms of Seed Production Programme contributes significantly in the contry in respect of breeder seed production of major crops. This has only been possible through extensive network of farms (Table: 31) located in 6 agro-climatic zones of the state. The total area of these farms is about 942 ha, out of which about 505 ha is cultivated area, which is used for seed production of different field, vegetable, spices, medicinal crops etc (Table). In addition, planting materials of improved varieties of fruits aromatic and ornamental plants are also produced in the orchard and the nurseries. During the period under report breeder, foundation and certified seed of various crops have been produced. In addition, the Scienticts give valueable advise to farmers on current issue on seed production and processing technologies.

Table 31: Land utilization of farms (Area in ha)

S. No.	Name of the farm	Total Area	Road & Building	Fallow (perma -nent)	Pasture	Planta -tion	Cultivated area
1	Sehore	142.90	47.38	0	1.82	2.04	91.66
2	Entkhedi	21.90	0.90	0	1.00	6.00	14.00
3	Morena	31.32	4.32	0	0	0	27.00
4	Gwalior	64.80	13.50	0	8.00	6.90	36.40
5	Bagwai	56.00	6.40	0	2.40	0	47.20
6	Mandsaur	74.15	14.45	4.33	2.02	2.50	50.85
7	Ujjain	30.80	2.80	0.40	0.60	0.40	26.60
8	Indore	126.83	46.77	0	16.52	2.50	61.04
9	Jaora	14.28	2.24	0	0	0	12.04
10	Mhow	68.62	21.58	1.27	7.22	0	38.55
11	Simrole	186.11	6.00	58.20	92.91	0	29.00
12	Khandwa	75.05	8.00	17.05	0	6.60	43.40
13	Khargone	37.37	5.50	0.74	0	5.46	25.67
14	Badwaha	12.14	2.00	4.45	0	3.69	2.00
15	Dewas	20.49	2.49	-	-	-	18.00
16	Dhar	32.43	7.43	-	-	-	25.00
17	Jhabua	24.56	0.50	1.06	-	11.00	12.00
18	Shajapur	20.18	3.18				17.00
19	Rajgarh	16.32	3.32	1.00		6.00	6.00
20	Neemuch	20.00		7.00			13.00
21	Shivpuri	21.07	3.00	3.57		0.50	14.00
22	Sheopur	15.18	3.18				12.00
23	Datia	9.18	2.18				7.00
24	Aron, Guna	20.00	1.00	2.00		5.00	12.00
25	Ashok nagar	18.38		6.38			12.00
26	Bhind	20.50	2.00				18.50
27	Lahar	20.03					20.03
Total		**1200.59**	**210.12**	**107.45**	**132.49**	**58.59**	**691.94**

(Source: Sovenir 6th Convocation, 10 April, 2001, JNKVV, Jabalpur, M.P. and Directorate of Research Services, RVSKVV, Gwalior M.P.)

Table 32: Seed and Planting material producting units

S. No.	Center	Nucleus seed	Breeder seed	Hybrid seed	Planting Material
1	Gwalior	✓	✓	✓	✓
2	Indore	✓	✓	✓	✓
3	Sehore	✓	✓	✓	✓
4	Khandwa		✓	✓	
5	Mandsaur		✓		✓
6	Morena		✓		
7	Khargone	✓	✓	✓	
8	Jhabua		✓	✓	
9	Entkhedi		✓		
10	Ujjain		✓	✓	✓
11	Bagwai		✓		
12	Jaora		✓		
13	Ashoknagar		✓		
14	Datia				
15	Sheopur		✓		
16	Aron		✓		
17	Shivpuri		✓		
18	Rajgarh		✓		
19	Shajapur		✓		✓
20	Dhar		✓		
21	Dewas		✓		
22	Badwani		✓		
23	Neemuch		✓		
24	Patan		✓		
25	Bhind		✓		
26	Lahar				

Table 33: Crop varieties / hybrids developed by different centres.

Crop	Varieties
Wheat	MP-4010
Sorghum	Vidisha 60-1, JJ 235, JJ 236, JJ 741, JJ 938, JJ 1041, CSH 18
Gram	Gwalior 2, Ujjain 21, Ujjain 24, JG 74, G-2, JG 218, JG 11, JG 130, JG 16, JG 6, JG 412, JGK 3, JAK 192-18.
Arhar	Jawahar Arhar3 (JA 3), JA 4, Gwalior 3, Khargone 2, JKM 7, JKM 189.
Mungbean	Jawahar Mung 45 (JM 45), Khargone 1, JM 131, JM 721, JM 3.
Urdbean	Gwalior 2, Khargone 3, JU 86.
Lentil	JL 1 and JL 3.
Soybean	JS 335, JS 90-41, JS 93-05.
Groundnut	Jyoti, Jawahr Moongphalli 2, Jawahar Moongphalli 3, JGN 23.
Mustard	Jawahar Mustard 1, JM 2, JM 3, JM 4
Toria	Jawahar Toria 1 (JT 1)
Safflower	Jawahar Safflower 1 (JSF 1), JSF 7, JSI 73
Cotton	Maljhari, Narmada A 51-9, Badnawar 1, Khandwa 1, Khandwa 2, Jawahar Kapas, Hybrid 1 (JKHy 1), JKHy 2, Jawahar Kapas 3 (JK 3), Vikram, Jawahar Colour Cotton 1, (JCC 1), Jawahar Tapti, JKHy 11, Jk 4
Sugarcane	COJN 86-141
Pearlmillet	JHB 1 (Hybrid), JBV 2 (variety)
Table pea	Jawahar Matar 1 (GC 141), JM 2 (GC 466),JM3(GC 66).
Coriander	Jawahar Dhania 1(JD 1)
Opium	Jawahar Afeem 16, Jawahar Afeem 539
Asgandh	Jawahar Asgandh 20, JA 134
Isabgol	Jawahar Isabgol 4

(Source: Sovenir 6th Convocation, 10 April, 2001, JNKVV, Jabalpur, M.P. and Directorate of Research Services, RVSKVV, Gwalior M.P.)

III. Infrastructure and Achievements of Extension

It is important to disseminate information about new technologies so that the farmer is able to make use of the latest agricultural developments. There also exists a gap between research findings and the needs of farmers. For technology to be successful, it is important that it should serve a useful purpose to the end user. The institution that bridges the gap between farmers and agricultural research scientists is the Agricultural Extension Service. The main objective of Agriculture Extension Services or AES's is to transmit latest technical know-how to farmers. The new technologies of crop production, plant protection, livestock husbandry, farm machinery and resource management generated at Zonal/ regional research stations are being transferred to farmers through demonstrations, training programmes, print and electronic media maintaining a close linkage with various agencies related to agriculture. Upto 70s, transfer of technology was mainly programme based, financed by ICAR and other agencies in which the main emphasis was on high yielding varieties of cereals, popularization of chemical fertilizers and controlling of insects and pests. The scientists of various centres initiated such programmes on limited scale which created awareness amongst the farmers for development of their farm business. These programmes were mainly on top down approach.

In early 80's, Training & Visits (T&V) Programme was implemented under IERP to systematise research and extension activities on regional/zonal basis. Agro-climatic zones were identified and research stations were established in each zone. The research and extension activities were planned considering the bottom up approach. An Agronomist was posted in each selected district. The new technologies were transferred to farmers through adaptive trials on various crops representing specified problems. These trials were laid out on farmers fields by the scientists in each district in collaboration with the State Department of Agriculture. Fortnightly and monthly training programmes for field level workers of the Department of Agriculture were orgainised to develop lesson plans for the use of extension personnel.

Diagonistic team consitituted at the zonal staionss, visited the problem areas for on the spot verification of problems and solutions there of. Each district in the state is linked with the research centres for interaction with extension agencies, farmers and scientists. This was the

period during which infrastructural facilities for research and extension were created and equipped with multidisciplinary manpower.

The infrastructure created under T&V programme was further strengthened through National Agricultural Research Project (NARP) sactioned by the ICAR to bridge the gap between location specific problems and multidisciplinary technical output for minimising research and extension gaps revealed by productivity levels of crops. The qualitative improvement in technological feedback appeared visible during the NARP tenure. The ICAR launched the 'Lab to Land' programme throughout the country. Scientists transferred the technologies to small, marginal and resource poor farmers of the state. Skill upgradation of extension agencies through training programmes on various aspects of agriculture were organised at all research stations and agriculture colleges in the state. The state sponsored demand driven training programmes periodically for skill upgradation of field workers.

In the year 1985, Krishi Vigyan Kendra was established at Jhabua with 100% grant of the ICAR for testing and refinement of technologies to be popularized among the farmers. Additional KVKs were sanctioned at Rajgarh, Guna and Khandwa in mid ninetees. The specific mandates of KVKs were demonstrations, organisation of training programmes for farmers, farm women and school drop outs to enable them to establish their own sources of earning at the village level. The multidisciplinary teams of scientists were provided to KVKs for executing the mandatory and other extension activities. During the year 1999 one additional KVK was sactioned for Gwalior. In the year 2000 KVK for Morena was sanctioned, in the year 2002 KVK for Dhar was established. In the year 2004 KVKs for Khargone, Mandsaur, Shajapur and Ujjain were sanctioned. During the year 2005 KVKs for Dewas and Shivpuri were established. In the year 2006 KVKs for Badwani, Neemuch and Sheopur were sanctioned. During the year 2007 KVKs for Ashoknagar and Datia were established. Each KVK is in direct contact of the farmers maintaining close linkages with district officials (Table: 34).

Table 34: Year of establishment and address of different KVKs

S. No.	Name of KVK	Address of KVK	Year of Establi-shment	Programme Coordinator*
1.	Aron (Guna)	Krishi Vigyan Kendra, Raghogarh Naka, Post – Aron Guna - 473101 (M. P.)	1994	Dr. L. S. Tomar
2.	Ashok nagar	Krishi Vigyan Kendra, Palkatori Road Village Awari, Post - Ashok Nagar -473331 (M.P.)	2007	Dr. A. K. Mishra
3.	Badwani	Krishi Vigyan Kendra, Bajatta Khurd Farm Badwani - 451 551(M. P.)	2006	Dr. (Mrs.) Sunita Mishra
4.	Datia	Krishi Vigyan Kendra, HIG-4, Karn kunj colony (Housing Board), Jhansi Road, Datia - 475 686 (M. P.)	2007	Dr. P. Sharma
5.	Dewas	Krishi Vigyan Kendra, Balgarh Farm, Dewas - 455001 (M. P.)	2005	Dr. R. P. Sharma
6.	Dhar	Krishi Vigyan Kendra Post Box No. 18, Dhar - 454001 (M. P.)	2002	Dr. K. P. Asati
7.	Gwalior	Krishi Vigyan Kendra, College of Agriculture, Race Course Road, Gwalior (M.P.) PIN-474002	1999	Dr. R. S. Kushwah
8.	Jhabua	Krishi Vigyan Kendra, Rajgarh Naka, Jhabua, District – Jhabua (M.P.) PIN-457661 (M.P.)	1985	Dr. I. S. Tomar

9.	Khandwa	Krishi Vigyan Kendra, B.M. College of Agriculture, Jaswadi Road, Post- Khandwa (M.P.) PIN-450001	1994	Dr. Surendra Singh Tomar
10.	Khargone	Krishi Vigyan Kendra, Zonal Agri. Research Station, Khargone - 451 001 (M. P.)	2004	Dr. Y. K. Mishra
11.	Lahar (Bhind)	Krishi Vigyan Kendra, Bhind (Lahar) - 477 445 (M. P.)	2003	was not in operation
12.	Mandsaur	Krishi Vigyan Kendra, College of Horticulture, Mandsaur - 458 001 (M.P.)	2004	Dr. B. S. Gupta
13.	Morena	Krishi Vigyan Kendra, P.O. Joura Khurd, A. B. Road, Morena (M.P.) PIN – 476001	2000	Dr. Y. P. Singh
14.	Neemuch	Krishi Vigyan Kendra, 56-14/2, Vikas Nagar, Neemuch (M.P.) PIN - 458441	2006	Dr. C. P. Pachauri
15.	Rajgarh	Krishi Vigyan Kendra, Biaora, Post - Rajgarh (M.P.) PIN - 465661	1994	Dr. M. K. Shrivastava
16.	Shajapur	Krishi Vigyan Kendra, Girwar Farm, Post- Shajapur PIN- 465001	2004	Dr. R. Umat
17.	Sheopur	Krishi Vigyan Kendra, M.P. Seed and Farm Dev. Corp., Seed Processing Centre Campus, Baroda, District- Sheopur PIN - 476339 (M.P.)	2006	Er. S. K. Tiwari

18.	Shivpuri	Krishi Vigyan Kendra, Piparsama Road Shivpuri (M.P.) PIN - 473551	2005	Dr. R. K. Sharma
19.	Ujjain	Krishi Vigyan Kendra, Near Vikram Nagar Railway Station, Ujjain (M.P.) PIN – 456010	2004	Dr. A. K. Dixit
20.	Bhopal	CIAE, Krishi Vigyan Kendra, Navibagh Berasia Road Bhopal, Distt. Bhopal (M.P.) PIN - 462001	1979 ICAR	Dr. P. M. Nimje
21.	Burhanpur	Krishi Vigyan Kendra, Bhadarpur Road, Near Indian oil Petrol pump, Burhanpur (M.P.) PIN – 450331	2007 NGO	Dr. Ishwar Singh
22.	Indore	Krishi Vigyan Kendra, Kasturba Gandhi National Memorial Trust, Kasturbagram Distt.: Indore (M.P.) PIN - 452020	1996 NGO	Dr. A. Deshwal
23.	Ratlam	Krishi Vigyan Kendra,Village Post Kalukheda, Teh.- Piploda, Ratlam (M.P.) PIN-457340	1995 NGO	Dr. M. K. Shrivastava
24.	Sehore	CRDE- Krishi Vigyan Kedra,Village- Sewania, The- Ichhawar, Distt- Sehore PIN- 466115	1999 NGO	Dr. J. K. Kanaujia

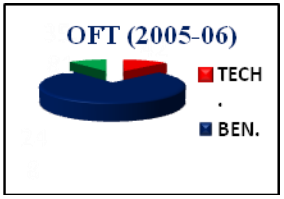
(Source: QRT Report, 2005-06 to 2009-10, Directorate of Extension Services, RVSKVV Gwalior)

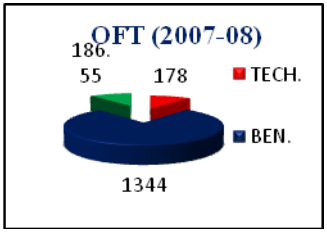
* As on August 18, 2008 (Pre RVSKVV establishment)

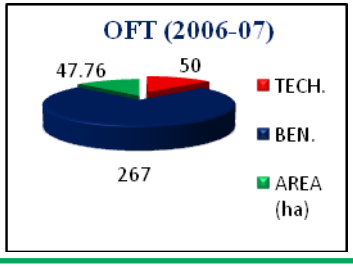
Summary of Achievement of KVKs

(a) On Farm Trials conducted by KVKs

OFT										
S. No.	Kvk	2005-06			2006-07			2007-08		
		Tech.	Ben.	Area (Ha)	Tech.	Ben.	Area (Ha)	Tech.	Ben.	Area (Ha)
1	Ashoknagar	0	0	0	0	0	0	0	10	4
2	Badwani	0	0	0	4	20	4	4	20	4
3	Bhind	6	30	6	0	0	0	0	0	0
4	Datia	0	0	0	0	0	0	4	22	1
5	Dewas	2	12	0.3	2	12	1.8	17	142	10.8
6	Dhar	3	32	3.2	1	10	1	4	35	3.5
7	Guna	3	15	3	4	20	4	6	30	6
8	Gwalior	7	44	1.61	5	31	1.84	11	100	10
9	Jhabua	4	16	6.4	4	16	5.6	13	52	4.6
10	Khandwa	3	15	3	3	15	3	7	35	7
11	Khargone	2	12	0.9	2	12	5	15	105	35
12	Mandsaur	0	0	0	3	17	0.37	12	93	7.75
13	Morena	6	40	6	7	35	7	22	378	22
14	Neemuch	0	0	0	0	0	0	6	30	6
15	Rajgarh	2	12	0.6	3	19	0.95	7	35	1.5
16	Shajapur	2	10	2	2	10	2	16	80	16
17	Sheopur	0	0	0	0	0	0	7	42	8.4
18	Shivpuri	0	0	0	7	35	7	19	95	19
19	Ujjain	2	10	2.8	3	15	4.2	8	40	20
	Total	**42**	**248**	**35.81**	**50**	**267**	**47.76**	**178**	**1344**	**186.55**

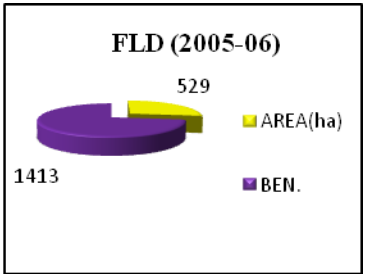


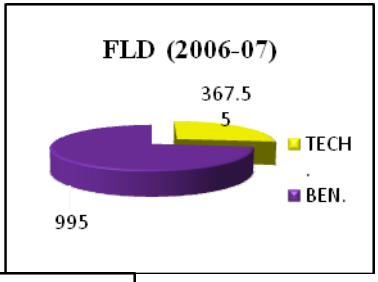


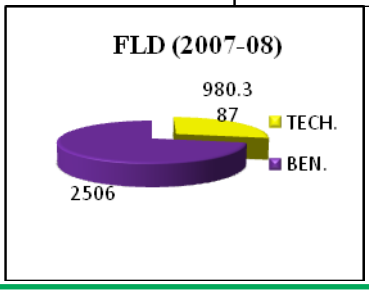


(b) Front Line Demonstrations conducted by KVKs

FLD							
S. No.	KVK	2005-06		2006-07		2007-08	
		Area (Ha)	Ben.	Area (Ha)	Ben.	Area (Ha)	Ben.
1	Ashoknagar	0	0	0	0	15	36
2	Badwani	0	0	36.05	119	71.05	183
3	Bhind	50	104	0	0	0	0
4	Datia	0	0	0	0	2	20
5	Dewas	27.6	67	41.2	90	130.137	186
6	Dhar	10	28	9.2	24	25.6	67
7	Guna	171.56	454	20.8	52	26	65
8	Gwalior	38.6	130	28	81	36.4	96
9	Jhabua	100.44	275	77.8	213	299	879
10	Khandwa	27	68	26	66	42	146
11	Khargone	18.6	46	41.3	124	82	211
12	Mandsaur	0	0	0	0	40	104
13	Morena	20	76	14	46	25	101
14	Neemuch	0	0	0	0	25	50
15	Rajgarh	30.8	79	16	41	10	25
16	Shajapur	19.4	51	25.4	62	42	102
17	Sheopur	0	0	0	0	28.2	63
18	Shivpuri	0	0	0	0	42.5	93
19	Ujjain	15	35	31.8	77	38.5	79
	TOTAL	**529**	**1413**	**367.55**	**995**	**980.387**	**2506**

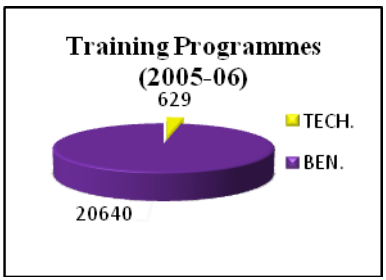


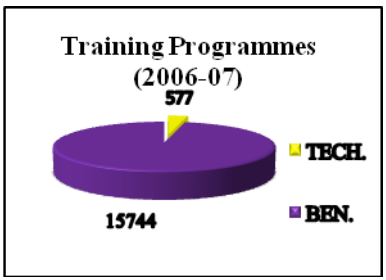


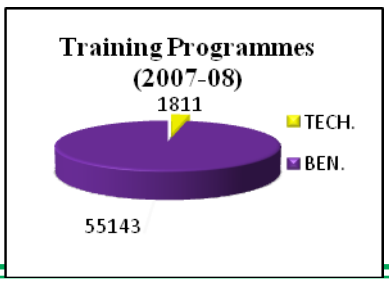


(c) Trainings Conducted by KVKs

KVK	2005-06		2006-07		2007-08	
	No. Trg	Ben.	No. Trg	Ben.	No. Trg	Ben.
Ashoknagar	0	0	0	0	8	231
Badwani	0	0	27	557	82	1849
Bhind	71	1850	0	0	0	0
Datia	0	0	0	0	20	325
Dewas	20	400	27	775	83	1920
Dhar	70	1608	33	1451	220	8297
Guna	29	956	32	713	66	1427
Gwalior	13	2021	54	984	121	2801
Jhabua	147	5641	70	2074	161	4878
Khandwa	25	536	12	210	92	2249
Khargone	61	2820	39	1598	145	5081
Mandsaur	0	0	49	1063	88	1832
Morena	85	2112	88	2410	151	5607
Neemuch	0	0	5	123	60	1400
Rajgarh	61	1612	72	1828	87	2377
Shajapur	14	294	16	322	96	2057
Sheopur	0	0	0	0	90	4327
Shivpuri	0	0	7	222	125	5069
Ujjain	33	790	46	1414	116	3416
Total	**629**	**20640**	**577**	**15744**	**1811**	**55143**







(c) Extension Activities Conducted by KVKs

S. No.	KVK	2005-06		2006-07		2007-08	
		NO. ACT	BEN.	NO. ACT	BEN.	NO. ACT	BEN.
1	Ashoknagar	-	-	-	-	1	65
2	Badwani	-	-	13	260	798	1540
3	Bhind	260	Mass	-	-	-	-
4	Datia	-	-	-	-	33	490 (Mass)
5	Dewas	12	108	18	139	288	6432
6	Dhar	72	596	46	2054	342	1473
7	Guna	33	6600	41	8200	40	8000
8	Gwalior	163	1657	279	9922	1209	6364
9	Jhabua	47	29825	32	3432	280	8272
10	Khandwa	21	Mass	14	Mass	68	Mass
11	Khargone	76	1215	75	2208	121	9601
12	Mandsaur	94	2208	120	8615	896	27831
13	Morena	341	16913	311	13160	515	20071
14	Neemuch	-	-	-	-	198	3781
15	Rajgarh	31	701 (Mass)	40	749 (Mass)	50	832 (Mass)
16	Shajapur	73	1460	82	1722	142	3124
17	Sheopur	-	-	-	-	157	1709
18	Shivpuri	-	-	-	-	452	2966
19	Ujjain	64	748 (Mass)	132	1908 (Mass)	440	4998 (Mass)
	Total	**1287**	**62031**	**1203**	**52369**	**6030**	**107549**

Major accomplishments and impact of Krishi Vigyan Kendras

KVK wise major accomplishments are detailed below:

KVK – Ashoknagar

- Introduction of JU -3, PU- 35 and PDU -1 varieties of Urad in the district with the seed treatment of Thiomithoxam.
  Introduction of TM -33 variety of moong.
- KVK introduced high yielding varieties of wheat MP 4010, GW 322, GW 273 and GW- 366, which are suitable for the district for irrigated and partial irrigated condition.

KVK – Badwani

- Productivity of cotton, maize, soybean, pigeon pea, wheat, gram, Chilli, Banana, Papaya, Sapota, Guava, Acid lime, Kharif Onion, Cole crops and tomato crops is increased by 20-60%.

KVK – Datia

- Introduction of Kharif onion.

KVK – Dewas

- Formation of micro finance societies at village level.
- Promotion of integrated farming systems.

KVK – Gwalior

- Increase in cropping intensity by 16 per cent in 5 years.
- Increase in crop productivity by on average 20 per cent.
- Increase in farm net income of Rs. 6000.00 / ha / year.

KVK – Mandsaur

- Introduction of JS 93-05 and JS 95-60 varieties of soybean.
- Introduction of G-1 and G-282 varieties of garlic.

KVK – Morena

- Sulphur Nutrition in Rapeseed –Mustard.
  Capsicum cultivation by ridge furrow technique.
- Low cost Zero tillage technology.

- Beekeeping an agri based business for income generation of rural people.

KVK – Neemuch

- Farmers from the whole district are coming forward to adopt the technologies like Improved Varieties, IPNM, IPM, IDM, Integrated Weed Management and Improved Farm Implements and Machinery. The productivity of various crops has increased significantly in the district over a short span of period.

KVK – Rajgarh

Introduction of Kharif Onion.

- Ridge and furrow system in Soybean.
- Introduction of Garlic variety G-282.
- Mandarin Production.

Coriander production.

KVK – Shajapur

- Introduction of JS-9560 and JS-9305 varieties of soybean. JG-11, JG-130and KAK-2 varieties of Gram, JWS-17 and HW-2004 varieties of wheat.
- Area expansion of oilseed specially mustard (8% area of district) and use of sulphur in oilseed.
- Use of K, Zinc, S increased in almost all crops (27%).

Use of Micro nutrient like Boron in vegetables and Cu in citrus, Orange (12%).

KVK – Shivpuri

- Introduction of JS-95-60 variety of soybean.
- Adoption of TM 99-37 variety of moong.
- Introduction of groundnut varieties GG20
- Introduction of Bt Cotton in the district.
- Ridge & furrow technique of sowing.
- Zero tillage in wheat and chickpea.

KVK – Jhabua

- Control of Red Hairy caterpillar *(Amsecta moorai)* popularly known as kamaliya kit with collective oppeoach of KVK, Farmers and line department.
- Conservation and Popularization of local poultry bird kadaknath for livelihood security of tribal farmers.
- Introduction and replacement of local maize. Variety JVM – 421

KVK – Khandwa

- Popularization of IPM in cotton
- Introduction of JS 9560 short duration varietiy of Soybean.

KVK – Guna

- Coriader production
- Introduction of JS 93-05 & JS 95-60 varieties of Soybean
- Weed management thsough Imazethapyr 10 SL @ 100 gm / ha

KVK – Ujjain

- Introduction of soybean variety JS 95-60.
- The 20 kg/ha sulphur application was applied on OFTs and FLDs in soybean and the maximum yield was achieved 19.1 q/ha as compared to control (13.9 q/ha).
- Introduction of marigold cultivation.

Farmers visit at KVK Guna

Farmers visit at KVK Khargone

Scientists visit at Farmer Field at KVK, Jhabua

Scientists visit at Farmer Field at KVK, Neemuch

Farmers / Scientists Visit to KVKs

References

AICAES, 1971. Results of the experiments conducted under All India Coordinated Agronomic Experiments Scheme during 1970-71, Directorate of Agriculture, Gwalior Division, Gwalior, M.P.

AICCIP, 2008. Annual Reports-AIC Cotton Improvement Project for the years 1967-08, JNKVV, College of Agriculture, Indore (M.P.).

AICCIP, 2008. Annual Reports-AIC Cotton Improvement Project for the years 1967-08, JNKVV, College of Agriculture, Khandwa (M.P.).

AICMIP, 1976. Progress Report of the All India Coordinated Millet Improvement Programme (1975-76). ICAR & Cooperating Agencies for the year 1975-76.

AICRPAL, 2008. Annual Reports-AICRP on Arid Legumes (Guar) for the years 1987-08, JNKVV, College of Agriculture, Gwalior (M.P.).

AICRPC, 2008. Annual Reports-AICRP on Chickpea for the years 1982-08, JNKVV, College of Agriculture, Sehore (M.P.).

AICRPCSR, 2008. AICRP on Cropping System Research for the years 1969-08, JNKVV, College of Agriculture, Indore (M.P.).

AICRPDA, 2008. Annual Reports-AICRP on Dryland Agriculture Research (ORP for the years 1980-08, JNKVV, College of Agriculture, Indore (M.P.).

AICRPDA, 2008. Annual Reports-AICRP on Dryland Agricutlure for the years 1969-08, JNKVV, College of Agriculture, Indore (M.P.).

AICRPG, 2008. Annual Reports-AICRP on Oilseeds (Groundnut) for the years 1967-08, JNKVV, ZARS, Khargone (M.P.).

AICRPMAP, 2008. Annual Reports-AICRP on Medicinal & Aromatic Plants for the years 1978-08, JNKVV, College of Horticulture, Mandsaur (M.P.).

AICRPMSAS, 2008. Annual Reports-AICRP on Management of Salt Affected Soils for the years 2000-08, JNKVV, College of Agriculture, Indore (M.P.).

AICRPMULLaRP, 2008. Annual Reports-AICRP on MULLaRP for the years 2001-08, JNKVV, College of Agriculture, Sehore (M.P.).

AICRPP, 2008. Annual Reports-AICRP on Pigeonpea for the years 2001-08, JNKVV, College of Agriculture, Sehore (M.P.).

AICRPP, 2008. Annual Reports-AICRP on Pigeonpea for the years 1982-08, JNKVV, ZARS, Khargone (M.P.).

AICRPPM, 2008. Annual Reports-AICRP on Pearl Millets for the years 1986-08, JNKVV, College of Agriculture, Gwalior (M.P.)

AICRPRM, 2008. Annual Reports-AICRP on Oilseed (Rapeseed & Mustard) for the years 1987-2008, JNKVV, ZARS, Morena (M.P.).

AICRPS, 2008. Annual Reports-AICRP on Soybean for the years 1983-08, JNKVV, College of Agriculture, Sehore (M.P.).

AICRPS, 2008. Annual Reports-AICRP on Sugarcane for the years 1970-08, JNKVV,College of Agriculture, Sehore and ZARS, Pawarkheda(M.P.)

AICRPSF, 2008. Annual Reports-AICRP on Oilseed (Safflower) for the years 1986-08, JNKVV, College of Agriculture, Indore (M.P.).

AICRPSI, 2008. Annual Reports-AICRP on Sorghum Improvement for the years 1969-08, JNKVV, College of Agriculture, Indore (M.P.).

AICRPSSWM, 2008. Annual Reports-AICRP on Soil Salinity & Water Management for the years 1969-99, JNKVV, College of Agriculture, Indore (M.P.).

AICRPW, 2008. Annual Reports-AICRP on Wheat Improvement for the years 1987-08, JNKVV, College of Agriculture, Gwalior (M.P.).

AICRPWC, 2008. Annual Reports-AICRP on Weed Control for the years 2000-08, JNKVV, College of Agriculture, Gwalior (M.P.).

AICRPWM, 2008. Annual Reports-AICRP on Water Management for the years 1981-08, JNKVV, ZARS, Morena (M.P.).

AICCIP, 1983. Annual Progress Report on AIC Cotton Improvement Project for the years 1972-83, Morena.

AICCIP,1986. Annual Progress Report of AIC Cotton Improvement Project, for the year 1985-86, Morena.

AICCIP,1987. Annual Progress Report of AIC Cotton Improvement Project, for the year 1986-87, Morena.

COAGWL, 1964. Report-Fifteen Years of College of Agriculture Gwalior, 1950-64. pp. 1-28.

COAGWL, 1965. Journal of College of Agriculture, Gwalior Campus, JNKVV, Volume VII, 1964-68, pp. 17.

COAGWL, 1968. Journal of College of Agriculture, Gwalior, JNKVV, Volume VIII, pp.

COAGWL, 1977. Souvenir, Silver Jubillee Celebration (1950-1976), College of Agriculture, Gwalior, January 8-10, 1977. pp. 69.

COAGWL, 1993. Final report of the Research Project "On Mustard" Sponsored by MAPCOST, Bhopal during 1989-90 to 1992-93 College of Agriculture, Gwalior.

COAGWL, 2000. Souvenir, Golden Junbilee. College of Agriculture for the year 1950-2000, Gwalior, JNKVV (M.P.). pp. 114.

COAIND, 2006. Krishi Kalp, College of Agriculture, Indore, JNKVV, (M.P.) pp. 113.

COAIND, 2009. Glimpses, A triumphant journey of five decades towards prosperity.

Deshpande, W. R., 1973. A Handbook of Agriculture. Directorate of Extension, JNKVV, Jabalpur (M.P.).

Gadkari, P. D. & Singh, Laxman, 1979. Pulse Crops of Madhya Pradesh, Communication Centre, Directorate of Extension, JNKVV, Jabalpur (M.P.).

JNKVV, 1973. Draft, Package of Practices For discussion and Finalization at the State Level Workshop of the Officers of the Agriculture Department and the JNKVV, April 17-20, 1972, pp. 198.

JNKVV, 1974. Draft, Package of Practices For discussion and Finalization at the State Level Workshop of the Officers of the Agriculture Department and the JNKVV, April 07-09, 1973, pp. 136.

JNKVV, 1988. Project Completion Report-National Agricultural Research Project 1982-87, JNKVV, RARS, Morena (M.P.). pp. 74.

JNKVV, 1995. Bulletin-Present Status, Constraints & Strategies, Gird Zone-VII, National Agricultural Research Project and its Impact on Agricultural Production, JNKVV, ZARS, Morena (M.P.). pp. 46.

JNKVV, 1995. Status Report : Volume I-III, National Agricultural Research Project, Madhya Pradesh-Gird Zone, JNKVV, ZARS, Morena, (M.P.). pp. 217.

JNKVV, 1995. Yearly Progress Report of Research Project on Augmenting Oil Seed Production in M. P. (Soybean-Mustard Cropping Seqence for Chambal Command Area) Sponsered by M. P. Council of Science & Technology,Bhopal(1994-95). JNKVV, ZARS, Morena (M. P.).

JNKVV, 1996. Research Digest of Gird Zone. JNKVV, ZARS, Morena (M.P.). pp. 32.

JNKVV, 1998. Annual Report. Introduction of Soybean as kharif crop in mustard mono crop irrigated area of Madhya Pradesh for the year 1997-98, College of Agriculture, Gwalior, JNKVV (M.P.)

JNKVV, 2001. Souvenir 6th Convocation, 10 April, 2001, JNKVV, Jabalpur, M.P.

JNKVV, 2005. Achievements, Department of Agronomy. A profile of 50 years; Golden Jubilee of Agriculture College, (1955-2005), JNKVV, Jabalpur (M.P.) pp. 64.

JNKVV, 2008. Annual Reports for the years 2005-08, JNKVV, College of Agriculture, Indore (M.P.).

Mishra, V. K., Saleem, H. I., Sharma, S. G. & Verma, R. S., 1980. Report on Post-Irrigation Detailed Reconnaissance Soil Survey of Harsi Command Area Tehsil Dabra, District Gwalior. JNKVV, Department of Soil Science and Agricultural Chemistry, Agriculture Reseach Institute and College Gwalior (M.P.)

Nene, Y. L., 2000. Key Note Address on Agriculture-Our Heritage. National Seminar on Agriculture Scenario-Challenges and Opportunities November 11, 2000, Golden Jubilee, College of Agriculture, Gwalior (M.P.) pp. 15.

Purohit, M. L., Pawar, J. G., Sood, N. K. & Patel, R. K., 1971. Guide Lines for Plant Protection Workers, Technical Bulletin No. 4, Directorate of Extension, JNKVV, Jabalpur (M.P.).

QRT, 2010. Quinquennial Review Team Report (2005-06 to 2009-10), Directorate of Extension Services, RVSKVV, Gwalior (M. P.).

Rathore, G. S., Khamparia, R. S., Gupta. G. P., Dubey S. B., Sharma B. L., and Tomar V. S., 1995. Twenty five years of Micronutrients Research in Soils and Crops of Madhya Pradesh (1967-92), Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur (M.P.)

Sharma, R.A. Jain, M.P. and Holkar, Sunil, 2008. Compendium on abstracts of research publication from AICRPDA. Indore for the year 1971-2008 pp.132.

Shastry, P.P., Mishra, P.K., Sharma, R.A. and Tomar, V.S., 2006. Cotton Production Technology for Madhya Pradesh.

Tomar, S. S., Arora, A., Joulkar, A. M. and Yadav, K. S., 2007. Weed Control at a glance, Department of Agronomy, College of Agriculture, Gwalior (M.P.)

Tomar, V.S., 2005. JNKVV Research Achievements of four decades (1964-2005), Directorate of Research Services, JNKVV, Jabalpur (M.P.)

Upadyay, Y. M. & Singh, S. P., 1965. Two Decades of Wheat Improvement Work in Madhya Pradesh for the year 1964-65, College of Agriculture, Journal, Gwalior Campus, JNKVV, Vol-VII, pp. 08.

कृशिवाणी (1973). कृशि महाविद्यालय, सीहोर का मुख्य पत्र, 1972-73.

चौहान, दिग्विजय सिंह (1991) खरपतवार नियंत्रण बैज्ञानिक तकनीकी भाब्दावली आयोग द्वारा प्रायोजित मध्य प्रदे ा हिन्दी ग्रंथ अकादमी, भोपाल।

ढमढेरे, एस. व्ही. (1987). फसलों के हानिकारक कीट वैज्ञानिक तथा तकनीकी भाब्दावली आयोग (मानव संसाधन विकास मंत्रालय) हरियाणा साहित्य अकादमी, चन्डीगढ़।

ढमढेरे, एस. व्ही., चौहान, डी. व्ही. एस., कि ाोर प्रेम, बरतरिया, ए. एम. (1993) पौध संरक्षण मार्ग दि ाका (Plant Protection Guide) वैज्ञानिक तथा तकनीकी भाब्दावली आयोग द्वारा प्रायोजित, मध्य प्रदे ा हिन्दी ग्रंथ अकादमी, भोपाल।

सृजन, 1992. कृशि महाविद्यालय, ग्वालियर।

श्रीवास्तव, व्ही. के., भार्मा, आर. ए., परसाई, जी. एस., सिंह, सी.वी. (2006). निमाड़ में कपास की उन्नत खेती, कृशि विज्ञान केन्द्र, खण्ड़वा (म.प्र.)।

Appendices

Appendix -I

Recommended varieties of Pulses for Gwalior Division

Arhar (Pigeonpea)

Type 21: Early maturing (130-140 days). Seed light red, flower yellow, long erect primary branches with very few secondaries. Average yield 1200-1500 kg/ha found suitable for double-cropping under irrigated conditions. (Introduced from U.P.)

Gwalior-3: Late maturing (250 days). Seed light red, flowers yellow, average yield 1000-1200 kg/ha recommended for northern alluvial plains of M. P. (Selection from local bulk in Ambah Tehsil, Morena District)

Mung

Kopargaon: Early maturing (60 days). Seed shining green, protein content 24.4 per cent, average yield 600-1000 kg/ ha. Suitable for double-cropping and as summer catch-crop. Recommended for whole of M. P.

Krishna-11: Early maturing (60 days). Seeds small, dull green, yield 800-1100 kg/ha. Suitable for double-cropping Recommended for Gwalior Division of M.P.

Jawahar 45: Medium maturing (75-80 days), seeds medium size, shining green (weight of 100 seeds-3 gms), plants tall, semi erect with light green leaves, having the tendency of producing 5 leaflets at some nodes instead of 3, ears profusely in bunches of medium size (7 cm) black pods, Average yield 1000-1500 kg/ha. Suitable for Kharif season. Recommended for whole of M.P. (Selection from a cross Madira x U.P. local).

Urdbean

Type-9: Early maturing (70-80 days). Seeds medium sized, black plants small, erect and with good bearing of pods. Yields potential 1000-1200 kg/ha at higher plant population by keeping 10 cm. distance between plants and 30 cm in rows, Suitable for double-cropping. Recommended for whole M.P. (Introduction from U.P.).

Gwalior-2: Late maturity (105 days). Seeds medium size, black. Average yield 1000-1200 kg/ha. Recommended for northern M.P. (Selection from local material.)

Mash-48: Medium maturing (100 days). Seeds medium sized, black, (100 seeds weight 3.4 gms). Plants semi-erect, mean plant height 50 to 60 cm. Tolerant, to yellow mosaic virus even in area of wide-spread infection of the disease. Yield potential over 1000 kg/ha area of adoption may be Gwalior and Rewa Division where heavy incidence of yellow mosaic virus, disease is generally noticed. (Introduced from Punjab, a selection from Gurdaspur local)

Cowpea

K-11: Medium maturing (75-80 days). Seeds small (100 seeds weight 7 gms), white with brown hilum, Pods medium size, green. Plants erect. Yield 12-15 quintal/ha.

K-4: As K-11, but has bold seeds (100 seeds weight 12 gms) and have black hilum.

Philippine early: Early maturing, good for vegetable purpose. Plants dwarf with long tender pods. Yield of green pods vary from 15 to 20 Qt/ha and mature seeds 5 Qt/ha.

Gram

Gwalior-2: Medium maturing (125 days). Seeds small, dark brown, average yield 1000-1500 kg/ha. Suitable for Northern alluvial plains of M.P. (Selection from local bulk in Gwalior).

JG 62 (G. 62 404): Matures in 120-125 days. Seeds light yellowish brown with test weight of 16 gms per 100 seeds. Main distiquishing feature is double podded bearing, dark-green foliage and erect plants, which permit the advantage of easy maintenance. Average yield on experimental basis-2200-2300 kg/ha. A cosmopolitan variety with wider adaptability. (selection from local bulk collected from Rajpur village, West Nimar in 1962.)

3: Bold seeded (100 seeds weight 19 gm). Profuse branching plants and good pod-bearing habit. Suitable for Northern alluvial plains of M.P. (Introduction from U.P.)

Ujjain-24: Matures in 120 days. Seeds yellow brown. Protein percentage 19.4 average yield 1000-1250 kg/ha.

Pea

Early December: Earliest in maturity (90 days). A quality table pea with sweet, wrinkled seeds. Pods are ready for picking after 55 days of sowing. Average yield of green pods 800 kg/ha. (It is a cross between T-19 and Early Badger).

T-163: Seeds white, round and attractive. It is a field pea for dal purpose. Average yield dry seed 1000 to 1500 kg/ha. It is taken as irrigated crop.

GC 65: Matures in 80 days. Average yield 1320 kg/ha. (Cross of variety Ruby-2 and Greater Progress). Table pea with sweet, wrinkled seeds.

GC 141: Matures in 90 days. Average yield of green pods 16090 kg/ha between T-19 and Greater Progress. Table pea with sweet, wrinkled seeds.

GC 477: Matures in 90 days. Average yields of green pods 16090 kg/ha. (Evolved by crossing Rusi-2 and Greater Progress). It is table purpose variety.

Bonville: Similar to T-19 Green pods are good for edible purpose. A popular variety.

Masur (Lentil)

B-17, NP-48 and HY-1-1: These improved varieties give 20 to 30 per cent higher yield than the local ones.

Appendix-II

Package of Practices of crops (1972-73)

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
1.	Pearl millet	PHB-10 (HB-6), PHB-14 (HB-7), Vijay Composite, BJ-104, BK-560,	upto second week of July	2.00	45x15	16.00	16.00	-	• Hand weeding 20-30 DAS • Propazin or Atrazin@ 200g/acre before sowing
2.	Maize	Ganga-5, Decan, Ganga Safed-2, Vijay, Chandan Makka, Chandan Makka-1, Chandan Makka-3, JMAU-1, Chandan Safed Makka-2,	with the onset of monsoon	6.5 -7.5	75x25	60.00	25.00	15.00	• simazin@600g ai/ acre pre emergence • Hand weeding 15-20 DAS • 2,4-D@ 400-600g/ acre 45 DAS

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
3.	Sorghum	302(6212), 604(771), CSH-5, CSH-1, Vidisha 60-1,	-	4.0-5.0	45x15	32-40	16-24	16	• 1-2 hand weeding at early stage of the crop. • Atrazin 400g/ acre as Pre-emergence
4.	Soybean	Brag, JS-2	with the onset of monsoon	30.0-40.0	30-45 x 5-7	-	32	16	• 1-2 hand weeding • Lasso 50%@8ml/ acre as pre-emergence

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
5.	Cotton	Badnavar-1, Khandwa-2, Maljari, Sankar-4, Narmada, L-147, C59-228, J-34	Rainfed: Dry sowing just before or onset of monsoon or after 75 to 80 mm precipitation Irrigated: Sowing by 15th to 29th May	American Cotton 3.5-10kg, Desi Cotton 3-8kg, Hybrid 1-1.5	Amrican type: 45x20 Desi type: 30x15-20	48	24	16	• Hand weeding at early stage of the crop. • Diuron@ 400g/ acre as pre-emergence or @ 600g/ acre at 15 DAS

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
6.	Paddy	Jagnath, Pankaj, Safari-17, Kali moonch-64, Narvad, Pandry Lunchi-16, Cross-51, IR-20, GMR-2, GMR-11, GMR-28, IR-8, Jaya, Ratna, IIT, Anupama, Bala, Kaveri	with the onset of monsoon	Transplanting 12-15 kg, Direct sowing 35-50kg	20x15	40-50	20	20	• 1 hand weeding 20-30 DAT • 2, 4-D@ 500g
7.	Groundnut	AK 12-24, Jyoti, Gangapuri, Chandori	with the onset of monsoon	50 (Kernel)	37x8	8	32	8	• Two hand weeding
8.	Sesame	No. 128, Gwalior-5, G-35, T-4, N-32	upto 15 July	2.5	30x3-4	6	12	-	• Two hand weeding

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
9.	Castor	Gujarat Hybrid-3, Aruna, HC-6	July	5-6	90x45	8	16	8	• Two or three weeding
10.	Pigonpea	Khargone-2, Type-21, No.148, NP-15, Gwalior-3		6	75-100x 20-30	8	20	-	• Two hand weeding at 15 and 45 DAS • Lasso or Tok-E25@ 800g/ acre as Pre-mergence
11.	Green gram	Krishna-11, Kopergaon, Khargone-1, Jawahar-45	End of June or 1st week of July	6-8	37x10	6-8	12-20		• Two hand weeding • Lasso or Tok-E25@1kg/ acre as Pre-emergence

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
12.	Blackgram	No. 55, Khargone-3, Gwalior-2, T-9, Mash-48		5-6	30x10	6-8	12-20		• One hand weeding at 6" height • Lasso or Tok-E25@ 800g/ acre as Pre-mergence
13.	Sunflower	EC-68415, EC-68414	Kharif -Last week of June to first week July Rabi- Oct to first week of Nov	15-20	45x20	25	60		• Thinning at 10-15 DAS

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
14	Sugarcane	CO-527, CO-775, CO-954, CO-1101, CO-1169, CO-678, CO-421, CO-1307, CO-779, CO-617, CO-419	Oct - Nov and mid Jan to mid Feb	30-35qtl	Row to Row 85-90	50-90	34	25	• 6 Hand weeding. • Tafapan and Tafazin @1.52kg/ acre
15	Wheat	NP-404, Hybrid-633, Narmada-4, Hybrid-65, Hybrid-34, NP-89, Kalayan Sona, Sonalika, Choti larma - S331, Safed Larma - S307, UP301, Heera	Rainfed-15 Oct to Last Oct, Irrigated-Second week of Nov to last week of Nov	40-50	Row to Row 20-30	Rainfed 12, Irrigated - 40	12 24	- 16	• 2, 4-D@400-600g/ acre

S. No.	Crop	Recommended varieties	Optimum Time/ Date of sowing	Optimum Seed Rate (kg/ acre)	Row to Row x Plant to Plant Spacing (cm)	Fertilization (kg/ acre)			Weed Management
						N	P_2O_5	K_2O	
16.	Gram	Gwalior-2, Ujjain-21, Ujjain-24, Gulabi-2, JG-62	15 Oct to 15 Nov	30.0	30x10-13	Rainfed 4-6, Irrigated - 8-10	12 24		• One hand weeding
17.	Linseed	T-397, R-17, NP-9, R-7	first week of Oct to first week of Nov	10-12	Row to Row 20-30	Rainfed-12, Irrigated - 30	6 15		• One hand weeding
18.	Lentil	B-77, NP-48, Hybrid 1-1	Last week of Oct to mid Nov	12	30x6-10				

(Source: JNKVV, 1973 & 1974)

Appendix-III

Major Recommendations of National Agricultural Research Project for Gird Zone on the basis of experiments conducted at ZARS, Morena during 1982-95*

(1) Crop Improvement

The following crop varieties identified/ tested and found promising in the zone.

1.	Moong	K-851
2.	Early pigeonpea	ICPL-151 & ICPL-81 for pigeonpea-wheat crop sequence
	Later maturing	ICPL-87 and for ratoon crop of pigeonpea
3.	Bajra	wcc-75 & ICTP-8203
4.	Rice	Purwa, Ratna, Kranti and IR-36
5.	Sesame	Kanchan, N-32 & TKG-22
6.	Soybean	Punjab-1 & Gaurav (Soybean-Wheat seq.)
	Early Soybean	JS 71-05 & PK-472 (Soybean-Mustard seq.)
7.	Mustard and Toria	Pusabold, Kranti, Rohini and Varuna and Toria T-9, Bhawani and JMT-1
8.	Urid	JU-2, PU-19, PU-30 & T-9
9.	Cotton	Bikanari Narma
10.	Groundnut	Jyoti & TG-17
11.	Guar	HG-75
12.	Jowar	CSH-5 and CSH-9
13.	Tomato	Pusa Ruby, Pusa gaurav and Pusha sheetal
14.	Mirch	Pusa sadabahar, JM-218 & Pant C-2
15.	Karela	Coimbatore long
16.	Brinjal	Hy. Long & Pusa purple-round

*JNKVV (1995)

(2) Production Technology

Optimum & economic fertilizer doses of different crops and sowing dates recommended for including in pachage & practices.

1.	Rice	60+40+15+25 kg/ha NPK Zn
2.	Bajra	80+40+20+20 kg/ha NPK Zn
3.	i. Toria (Irrig.)	60+30+20 NPK kg/ha
	ii. Mustard (Irrig.)	80+40+20+20 NPKS kg/ha
	iii. Mustard (Rainfed)	40+20+10+10 NPKS kg/ha
	iv. Taramira (Rainfed)	30 N kg/ha
4.	Irrigation	
	i. IW/CPE ration	1.0 was found beneficial to wheat crop
	ii. For Mustard	One irrigation at 40-45 DAS is sown under pre irrigated fields
		One irrigatior at 30-35 DAS, if sown at residual moisture.

5. Two irrigation in gram at 45-50 and 85-90 DAS.
6. Strip border (6m width) method of irrigation in wheat and furrow method in sugarcane registered more yield and water use efficiency.
7. In wheat application of 2, 4-D or Isoproturon @ 1 kg ai/ha 30-35 DAS recommended for effective control of weeds.
8. Basalin as preplant or Isoproturon as preemergence application @ 1 kg ai/ha recommended for control of weeds in mustard.
9. The seed treatment of PSB 10 gm/kg seed increase an additional yield (1.25 q/ha) of gram over no PSB.
10. Foliar spray (0.5%) and soil drench (1.0) of bodeaus mixture gave the best stand of betelvines (275).

(3) Cropping Pattern

The increase cropping intensity, high remunerative and risk coverage double or multiple cropping pattern were developed, tested and recommended to farmers of the zone.

1. Irrigated or semi irrigated conditions

   i. Toria-wheat/ mustard

   ii. Soybean-wheat/ mustard

   iii. Early variety of soybean-mustard/ gram
   iv. Guar-wheat
   v. Bajra-wheat/ mustard
   vi. Moong/ urud-wheat/ mustard
   vii. Bajra-gram
   viii. Early soybean-mustard

2. Rainfed conditions

   i. Cowpea (fodder+green pods)- mustard
   ii. Bajra-gram
   iii. Greengram-mustard

(4) Intercropping

i. Nine rows of wheat & 1 row of mustard was found remunerative (9:1) for irrigated conditions.
ii. Four/ six rows of gram and one row of mustard (4/6:1) recommended under restricted irrigation or rainfed condition.
iii. Safflower+toria (1:1) found remunerative over pure mustard inter rainfed conditions.
iv. Intercropping of toria+gobhi sarson (1:1) alternate rows was more remunerative than monocrop of mustard.
v. Long duration pigeonpea intercropped with til/ urid /guar was recommended as more remunerative than pure pigeonpea under rainfed conditions.

(5) Plant Protection

i. For control of while rust and alternaria blight disease of mustard seed treatment with apron S. D. 35 (@ 6 g / kg seed) followed by

spraying of Ridomil MZ-72 (0.25%) or Dithane M-45 (0.25%) at 50 & 70 DAS was found most effective.

ii. For control of mango mal formation tha following spraying schedule has been recommended-

Planofix-50ml+ Demecron-7ml+ Sulflex-50ml in 20 litre of water should be sprayed at preflowering stage followed by spraying at 50% flowering stage.

iii. For control of attack of painted bug in rapseed (Toria) & mustard dusting with carbonyl dust @ 20-25 kg/ha or spraying the crop with Melathion 50 EC or Endosulphan 35 EC @ 500 ml/ha was recommended.

(6) For control of termite in wheat seed treatment with Aldrin 30 EC @ 400 ml/ 100 kg seed was found most effective and economical.

Appendix-IV

Golden Jubilee Celebration
of
College of Agriculture, Gwalior (1950-2000)

National Seminar on
"Agriculture Scenario-Challenges and Opportunities"
(November 11-12, 2000)

ADDRESS

Dr. A. S. Tiwari
Vice Chancellor
JNKVV, Jabalpur (M.P.)

I feel extremely privileged and proud to welcome all the dignitaries from ICAR, State Govt., Development Agencies, Members of BOM JNKVV, my teachers and alumni of the Colleges. We are glad and feel elevated by the gracious presence of Dr. S. L. Mehta, DDG (Education), Dr. Y. L. Nene, Ex DDG ICRISAT and a old student of this College as well all the Ex Teachers/ Scientists of this College.

On this glorious momentous occasion, I recall the glourious services/ sacrifices of the Principals/ Deans and Teachers, the supporting staff and all others who participated in the development of this great College. We pay tribute to Rai Bahadur K. I. Thadani, founder Principal for providing a vision for the College. Rai Bahadur established this College on a very firm footing within a short period of two years. In 1952, Dr. R. Shankaran took over as Principal and College progressed very well. In the beginning of 1955 Dr. T. R. Mehta, a well known scientist, teacher and administrator, became the Principal and Jt. Director of Research of College and Research Institute. The dedicated efforts and dynamic leadership of Dr. Mehta resulted in the elevation of the status from UG to PG College and integration of teaching, research and extension which brought name and fame to the College within and outside the then Stae of Madhya Bharat. Thereafter, College continued to march ahead in the worthy leadership of Dr. P. S. Lamba, Dr. M. L. Purohit and others. We also remember the dedication and devotion of great teachers like Dr. D. P. Motiramani, Dr. L. K. Joshi, Prof. S. K. Singh Gour, Prof. M. P.

Singh, Dr. S. P. Pant and others, who worked untiringly for the over-all development of the College.

The College became a constituent College of JNKVV in 1964.

After 50 years of its existence, it enjoys the status of oldest Agriculture College of JNKVV. We have made every effort to improve the over-all academic, social and cultural environment of this great College. We compliment ICAR and particularly our Chief Guest DDG (Ed.) who has provided financial and technical support through catch-up grant and accreditation. I request him for an enhaced support to JNKVV and in particular to College of Agriculture, Gwalior.

National Seminar as a part of Golden Jubille celebration gives us an excellent opportunity to deliberate on the changing Agriculture Scenario – Challenges and Opportunities.

The achievements of 20th century on the food front remain greatest human achievements. Despite these achievements, a sizable population continues to be poor, malnourished and lack resources and skills. Besides these inequities, there is an enormous pressure on our natural resource base, because of several factors. In addition, recurrence of droughts and other climate change poses a great threat to livelihood prospects.

The present scenario of declining total factor productivity growth, depleting natural resource base, increasing biotic and abiotic stresses and adverse impact of climate change poses a great challenge for the accomplishment of 5 million tons of additional foodgrains annually to feed the nation.

However, we now have uncommon opportunities of an adequate trained manpower, big and growing market, low productivity level, low input use and emerging private sector provide future scope for improving efficiency, productivity, quality, value addition, diversification and trade. In addition, we have wide diversity of bioresources and production environment, availability of irrigation network and resource base for agriculture and industrial growth. We are fortunate in having abundant sunshine, high precipitation and rich traditional knowledge and wisdom. The advanced technologies, in different fields have enabled us to tackle the emerging challenges with new options.

Our vision of poverty, hunger and malnutrition free and environmentally safe India can only be realised by harnessing modern science blended with indigenous knowledge and with fullest participation of our masses, particularly in rural areas.

On the auspicious occasion of the Golden Jubille of College of Agriculture, Gwalior, I extend my warm greetings and felicitations to the alumni, students, faculty, supporting staff and distinguished guests. I am sure that the college will continue to be the light house of the modern knowledge of agricultural science and technology and will serve to fulfil the mission of bringing agricultural prosperity in the country, particularly in northern Madhya Pradesh.

I wish the students and staff a great success in their endeavours in the service of farming community.

JAI HIND

Appendix-V

(a) Critical limits of Zn in Crop plants of different districts of RVSKVV *

Crop	Variety	No. of soils/ experiments	Plant part	Age (days)	Critical limit (ppm)	Location	Soil type
Wheat	Kalyansona	52	Third leaf	45	20.0	Indore, Ujjain	Medium black
	Kalyansona	25	Top half	30	20.5	Guna	Medium black
	Kalyansona	20	Top half	30	15.3	Khargone	Medium black
	Kalyansona	29	Third leaf	35	18.0	Morena	Alluvial
	Kalyansona	24	Top half	30	19.0	Gwalior	Alluvial
	Kalyansona	24	Third leaf	30	14.3	Shivpuri	Mixed Red & black
Rice	Garima	25	Top half	30	15.5	Guna	Medium black
	NSPR-2	20	Top half	35	11.4	Khargone	Medium black
	Jaya	32	Third leaf	50	11.5	Morena	Alluvial
	Jaya	24	Top half	30	15.5	Gwalior	Alluvial
	Jaya	24	Third leaf	30	21.1	Shivpuri	Mixed Red & black
Coriander	Moraccan	18	Top half	40	19.0	Guna	Medium

(b) Critical limits of zinc in divergent soils of different districts under RVSKVV *

District	Soil classification (suborders)	Soil type	test crop	Method	Critical limit (ppm)	Reference
Sehore	Usterts and Ochrepts	Med. black	Wheat	Dithizone	0.65	AR(1970-71)
Indore, Ujjain, Dewas & handwa	Usterts and Ochrepts	Med. black	Wheat	DTPA	0.50	AR (1971-72)
Guna	Usterts and Ochrepts	Med. black	Wheat	DTPA	0.54	AR (1983-84)
Khargone	Usterts and Ochrepts	Med. black	Wheat	DTPA	0.60	AR (1986-87)
Morena	Ochrepts, fluvents & Orthents	Alluvial	Wheat	DTPA	0.46	Rathore et. al. (1978)
Shivpuri	Ochrepts, Orthents & Usterts	Mixed Red & black	Wheat	DTPA	0.45	AR(1980-81)
Gwalior	Ochrepts, fluvents & Orthents	Alluvial	Wheat	0.1 HCI	2.8	Khamparia at al. (1982)
Guna	Usterts & Ochrepts	Med black	Rice	DTPA	0.64	AR(1983-84)

Khargone	Usterts & Ochrepts	Med black	Med black	DTPA	0.64	AR(1986-87)
Morena	Orchrepts, fluvents & Orthents	Alluvial	Rice	DTPA	0.45	AR (1976-77)
Shivpuri	Ochrepts, Orthents & Usterts	Mixed Red & black	Rice	DTPA	0.50	AR (1980-81)
Gwalior	Ochrepts, fluvents & Orthents	Alluvial	Rice	0.1N HCI	3.5	AR (1977-78)
Guna	Usterts & Ochrepts	Med black	Coriander	DTPA	0.52	AR (1983-84)
Gwalior	Ochrepts, fluvents & Orthents	Alluvial	Soybean	0.1N HCI	3.0	AR (1977-78)

(c) Boron deficiency in some soils of Morena district *

District	Soil	No. of sample	Avail. nutrients (ppm)		% deficient samples
			Range	Mean	
Morena	Alluvial	Boron 521	0.10-3.82	0.76	0

(d) Distribution of Available Sulphur in different districts of RVSKVV *

S. No.	Name of district	No. of samples analysed	Range (ppm)	Mean (ppm)	Per cent deficiency
1.	Bhind	40	3.5-110.5	26.8	27.5
2.	Dewas	96	0.6-178.1	39.0	43.7
3.	Dhar	115	0.7-192.4	26.6	49.5
4.	Guna	400	3.5-36.8	15.4	30.0
5.	Gwalior	40	1.0-14.5	12.6	60.0
6.	Indore	96	0.6-23.6	11.8	66.7
7.	Khandwa	97	0.6-25.0	12.6	80.4
8.	Mandsaur	149	0.9-65.0	43.0	45.6
9.	Morena	330	1.5-88.6	15.8	49.7
10.	Ratlam	92	0.7-42.6	21.3	35.9
11.	Ujjain	94	1.5-28.2	13.0	44.7

* Rathore *et. al* (1995)

Appendix-VI

All India Coordinated Research Projects (Pre RVSKVV, Gwalior)

S. No.	Name of Scheme/ Project	Centre	Year of Start	Project I/C*
1	AIC Cotton Improvement Project (Sub Centre)	Indore	1967	Dr. P. D. Gaikwad
2	AICRP on Oilseeds (Groundnut)	Khargone	1967	Dr. J. P. Dixit
3	AIC Cotton Improvement Project (Main Centre)	Khandwa	1982	Dr. P. P. Shashtri
4	AICRP on Sorghum Improvement	Indore	1969	Dr. S. N. Upadhyay
5	AICRP on Dryland Agriculture	Indore	1969	Dr. M. P. Jain
6	AICRP on Management of Salt Affected Soils	Indore	2000	Dr. S. K. Verma
7	AICRP on Cropping System Research	Indore	1969	Dr. V. S. Gautam
8	AICRP on Medicinal & Aromatic Plant (Main Centre)	Mandsaur	1978	Dr. H. Patidar
9	AICRP on Dryland Agriculture Research (ORP)	Indore	1980	Dr. D. H. Ranade
10	AICRP on Water Management	Morena	1981	Dr. Y. M. Kool
11	AICRP on Chickpea	Sehore	2001	Dr. H. S. Yadav
12	AICRP on Pigeonpea	Khargone	1982	Dr. V. S. Kandalkar

S. No.	Name of Scheme/ Project	Centre	Year of Start	Project I/C*
13	AICRP on Soybean	Sehore	1983	Dr. S. R. Ramgiry
14	AICRP on Pearl Millets	Gwalior	1986	Dr. A. K. Singh
15	AICRP on Oilseed (Safflower)	Indore	1986	Dr. Jagdish Singh
16	AICRP on Arid Legumes (Guar)	Gwalior	1987	Dr. G. S. Rawat
17	AICRP on Oilseed (Rapeseed & Mustard)	Morena	1987	Dr. G. S. Lal
18	AICRP on Wheat Improvement	Gwalior	1987	Dr. K. P. S. Malik
19	AICRP on Weed Control	Gwalior	2000	Dr. S. S. Tomar
20	AICRP on MULLaRP	Sehore	2001	Dr. R. P. Singh
21	AICRP on Pigeonpea	Sehore	2001	Dr. A. N. Tikle

* As on August 18, 2008 (Pre RVSKVV establishment)