Working Group Report on Productivity Enhancement of Crops in Haryana

Haryana Kisan Ayog

Government of Haryana

Working Group Report
on
Productivity Enhancement of
Crops in Haryana

2013

HARYANA KISAN AYOG
Government of Haryana

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Haryana Agriculture
-Leading a Way Forward

CHAIRMAN
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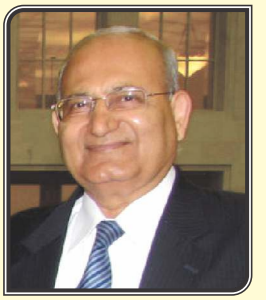
Government of Haryana



FOREWORD

Increasing productivity and profitability of farmers has always been the focus of Haryana agriculture. The Government is also keen to provide the required technical and policy support. These initiatives have helped in achieving almost seven fold increase in food grains production since the Green Revolution period. In recent past, Haryana has achieved the highest productivity in the country in case of wheat, pearlmillet, rapeseed and mustard. The State has also received the national "KRISHI KARMAN AWARD" from Prime Minister of India for the last two consecutive years for outstanding performance in wheat productivity. As a result, Haryana has emerged as one of the most important food bowls of the country being the second largest contributor to our national food reserves. Development in agriculture has also triggered fast growth of agro-industries in the State.

Despite above achievements, it is being increasingly felt that full potential of State agriculture has not been harnessed. Moreover, factor productivity is decreasing and concerns of soil health, water shortage and climate change are becoming real. Hence, efforts are needed to address the second generation problems of Green Revolution. Also there is need a to further improve the productivity of all crops by improved efficiency, timely operations, resilience and much needed crop diversification, including promotion of secondary agriculture. As total cultivable land is limited, only option left is to go vertical by out scaling farm innovation and by adopting well planned strategy in a "Mission Mode" approach.

Haryana Kisan Ayog (HKA), has suggested various measures including technology-led effective management of natural resources, sectoral development like horticulture, livestock, fishery etc. and appropriate policy interventions in its previous reports to sustain and accelerate agricultural growth in the State. In continuation, the Ayog also constituted a Working Group on Productivity Enhancement of Crops under the able leadership of Dr. P. L. Gautam. The Working Group has now submitted a comprehensive report. The valuable suggestions made by the Group such as: strengthening of research, particularly on export oriented crops like *basmati* rice and *guar*, launching of "State Seed Mission" and "State Mission on Mechanization of Small Farms", establishment of "Hybrid Seed Cell" and "Gene Bank at CCSHAU", skill development of farm women, promotion of agri-entrepreneurship etc. will ensure enhancement of overall crop productivity in the State.

I appreciate the valuable efforts of Dr. P. L. Gautam, Chairman of Working Group and other members namely, Dr. M. S. Kairon, Dr. Sain Dass and Dr. S. S. Singh, beside the strenuous contribution of Dr. R. S. Dalal and Dr. R. B. Srivastava as Nodal Officers. It is my considered view that this report would be of immense use to the planners, administrators, scientists and field functionaries for further increasing crop productivity in Haryana and improve livelihood opportunities of farmers in the State.

(R.S. Paroda)

Ex. Chairperson,
PPV & FRA, Government of India,
Vice Chancellor,
Career Point University, Hamirpur, (H.P)

PREFACE

There has been a significant gain in agricultural production and productivity in Haryana that can be attributed to the development of irrigation net work in the State, availability of quality seeds of high yielding varieties/hybrids, enhanced accessibility to inputs, development of matching production and protection technologies and, above all, the implementation of farmers' friendly policies by the government.

The process of growth has been technologically highly dynamic in the State. Adoption of improved varieties/hybrids of wheat, rice, *bajra* and oilseeds and associated production technologies in late 1960s & 1970s onwards and Bt cotton after 2002-03 have changed the landscape of Haryana agriculture. Further, it is quite visible that transformation in State agriculture has also boosted the growth of agro-industries. The significance of agriculture sector is not restricted to its contribution to GDP but it has far reaching impact on poverty alleviation and rural development. It is estimated that "GDP growth originating through agriculture is at least twice as effective in reducing poverty as GDP growth originating outside agriculture."

To accelerate growth in agricultural productivity, there is a need for focus on farming system approach benefiting small farmers and entrepreneurs as well, besides moving towards value chains establishment, and policy reforms to attract investments. Hence the State Government is appropriately focusing on the sustainability of agriculture and making it globally competitive, and strengthening the economic well-being of the farmers. Accordingly, Government constituted Haryana Kisan Ayog to suggest measures for boosting growth in agriculture. The Working Group on "Productivity Enhancement of Crops in Haryana", constituted by the Haryana Kisan Ayog, has critically analyzed the problems and prospects of Haryana agriculture and come-out with key recommendations to accelerate sustainable and inclusive growth in the agriculture sector in the State.

I trust and believe that this document will be of immense use of planners and scientific community for making short-term and long-term strategies to accelerate growth in crop productivity.

(P. L. Gautam)
Chairman, Working Group

Member Secretary
Haryana Kisan Ayog
Government of Haryana

ACKNOWLEDGEMENT

The Working Group on "Productivity Enhancement of Crops in Haryana" has assessed the present status of Haryana Agriculture in terms of infrastructural and policy support; technology back-up provided to the farmers; accomplishments; emerging challenges; and gaps in productivity and research. The Group has made concrete recommendations to make Haryana agriculture a buoyant and employment oriented occupation.

The Chairman, members and nodal officers of the Working Group are grateful to Padam Bhushan, Dr R. S. Paroda, Chairman, Haryana Kisan Ayog, for providing an opportunity to be the part of this important endeavor. His generous guidance and encouragement helped the Working Group in timely preparation of this inclusive and exhaustive report. We also owe a great deal to his dedication and determination to uplift the agriculture sector in the country. His concerted efforts has encouraged farmers of Haryana to make agriculture a technology driven occupation.

I record my sincere gratitude to Dr P. L. Gautam, Ex. Chairperson, PPV & FRA, Government of India and presently, Vice Chancellor, Career Point University, Hamirpur, (H.P) for chairing this Working Group , though he was too busy and pre-occupied. The task given to this Working Group was extremely large. However, his determined efforts and able leadership in steering the work made the report possible in time. I am indeed thankful to members of Working Group namely; Dr M.S. Kairon, Ex Director, CICR, Nagpur, Dr Sain Dass, Ex Director, DMR, New Delhi, Dr S.S. Singh, Ex Director, DWR, Karnal and Dr R. B. Srivastava, Consultant, HKA & Nodal Officer of this group for their untiring and commendable efforts to prepare this precious report.

I duly acknowledge the generous and valuable support given by Dr K. S. Khokhar, Vice Chancellor, CCSHAU, during the course of preparation of this report by allowing the HODs and senior scientists to participate in discussions with the group and offering their inputs and suggestions.

My special thanks are also due to Dr J. C. Katyal, EX. Vice Chancellor, CCSHAU for his valuable suggestions which helped in making this report more informative and focused.

I am thankful to the scientists/HODs from CCSHAU, IARI, DWR, CICR, and RRS, Sirsa, for their participation in discussion and offering valuable suggestions. I also thank Dr Sandeep Kumar, Research Fellow, HKA and other staff members for their precious assistance in preparation of this document.

Finally, I thank the farmers of the State who put forward their views and offered suggestions.

Dated : November, 2013

(R.S. Dalal)

CONTENTS

Sr.No.	Title	Page No.
	Foreword	
	Preface	
	Acknowledgement	
	Executive Summary	i-v
1.	**Introduction**	1
	1.1 Agricultural Heritage of Haryana	1
	1.2 Agricultural Zones in the State	1
	1.3 Infrastructure Development	2
	1.4 Policy Support	4
	1.5 Technology Back-up to Farmers	5
	1.6 Technology Dissemination	6
	1.7 Impact of Initiatives on Agricultural Production - Success Story	6
	1.8 Constitution of Working Group on "Productivity Enhancement of Crops in Haryana"	7
2.	**Review of Productivity Status**	9
3.	**Changing Scenario of State Agriculture**	13
	3.1 Employment Generation	13
	3.2 Change in Cropping Pattern	13
	3.3 Up-coming Entrepreneurship	16
	3.4 Change in Energy Use	16
4.	**Emerging Challenges to Agriculture**	17
	4.1 Climate Change	17
	4.2 Natural Resource Degradation	18
	4.3 Effect of Sewage Water and Industrial Effluents	19
	4.4 Declining Size of Holdings	19
	4.5 Imbalanced Input and Energy Use	20
	4.6 Yield Gaps	21
	4.7 Crop Losses	21
	4.8 Profitability Issues	23
	4.9 Supply of Inputs	24

4.10 Post- harvest/Value Addition 24
4.11 Crop Residue Management 24
4.12 National Food Security Act, 2013 25

5. SWOT Analysis 26
5.1 General SWOT Analysis of the State 26
5.2 Zone-wise SWOT Analysis 28

6. Attainable Potential and Strategies to Enhance Productivity of Major Crops 32
6.1 Rice 32
6.2 Wheat 36
6.3 Barley 40
6.4 Maize 43
6.5 Bajra *45*
6.6 Oilseeds 48
6.7 Pulses 52
6.8 Guar *55*
6.9 Cotton 57
6.10 Sugarcane 60
6.11 Additional production 64
6.12 Drivers of achieving attainable and potential yield 65

7. Seed Production Plan 66

8. Farm Mechanization 70

9. Conservation Agriculture 72

10. Diversification in State Agriculture 73
10.1 Crop Diversification Plan 74
10.2 Input Diversification 75
10.3 Inter Cropping Approach 75
10.4 Horticulture, Fisheries, Animal Husbandry 75

11. Marketing 77

12. Biodiversity Conservation 78

13. Education, Extension And Entrepreneurship Development 79
13.1 Agriculture Education 79
13.2 Agriculture Extension 79
13.2.1 Stimulus to Extension System 80
13.2.2 KVKs as Incubator Centres 80
13.2.3 Knowledge Sharing 80
13.2.4 Building Cadre of Technology Agents 80
13.2.5 Extension Kiosk 80
13.3 Entrepreneurship Development 80
13.3.1 High Value Agriculture 81
13.3.2 Seed Business 81
13.3.3 Development of Farmer Relevant Machines and Tools 81
13.3.4 Food Processing 81

14. Research Gaps 83
14.1 Technology for Small Farmers 83
14.2 Climate Resilient Varieties and Hybrids 83
14.3 Natural Resources and CA 83
14.4 Scaling-up of IPM 84
14.5 Post Harvest/Value Addition Technologies, Packaging and Branding 84
14.6 Diversification in Agriculture 84
14.7 Technology for Organic/Speciality and Peri-urban Farming 85
14.8 Out-scaling Farm-led Innovations 85
14.9 Strengthening Decision Support System 85

15. Recommendations 86

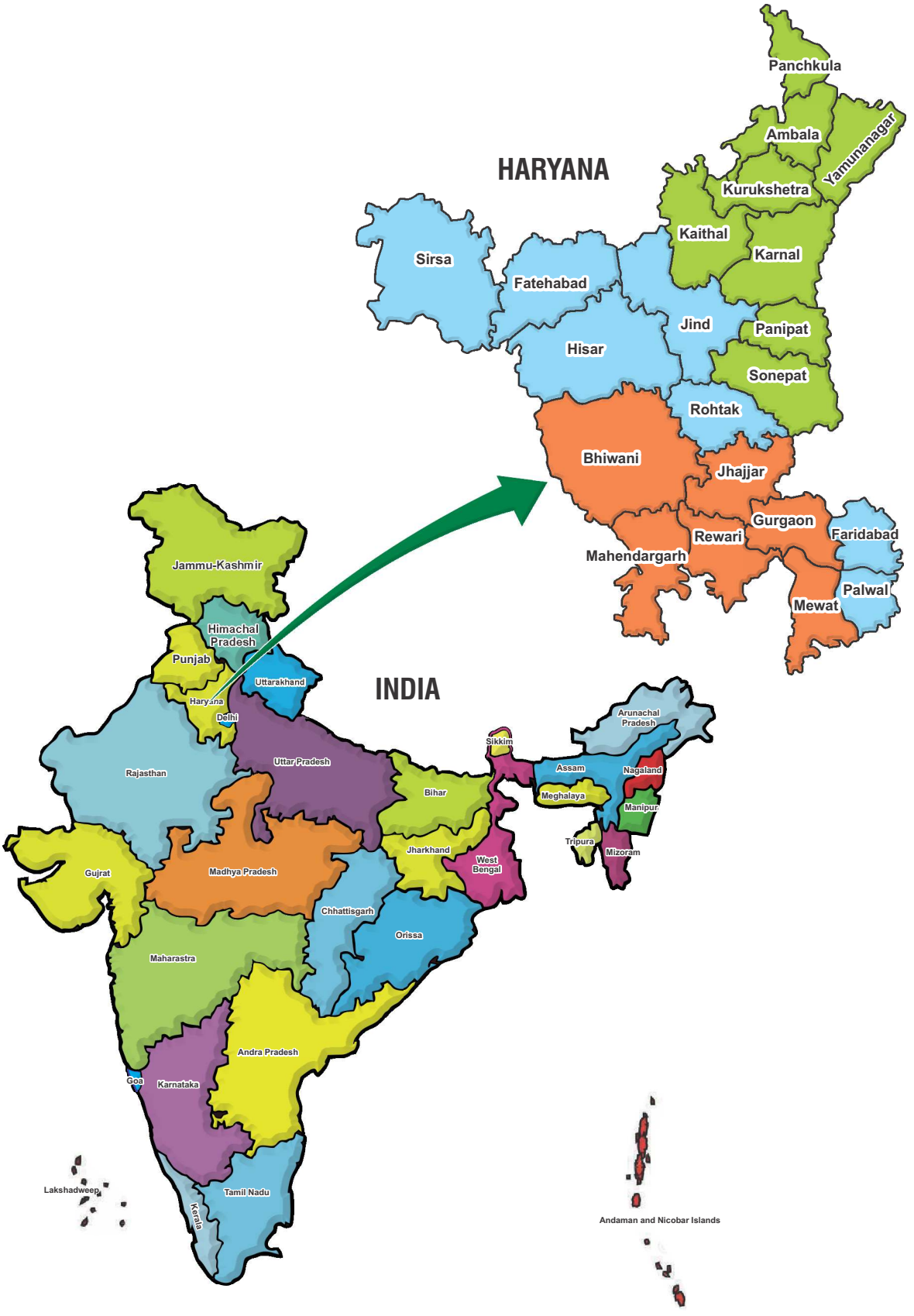
References 91

List of Tables 94

List of Figures 96

Annexure - I 97

Acronyms 98


HARYANA
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Sonepat
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Jhajjar
Gurgaon
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Andra Pradesh
Goa
Karnataka
Tamil Nadu
Kerala
Lakshadweep
Andaman and Nicobar Islands

Executive Summary

Haryana has 44.2 lakh hectares of land which is 1.34% of the total geographical area of the country. Agriculture contributes 16.7% to State GDP and is the mainstay of more than 51% population. The major cropping systems are: rice-wheat, *bajra*-wheat, cotton-wheat, and sugarcane-wheat and the cropping intensity is over 184%. The average productivity of total food grains has reached 35.27q/ha in the State as against 19.2 q/ha at National level. The annual growth rate of agriculture and allied sectors during 11th Plan in Haryana was 3.9%, whereas at all India level it was 3.7%. The State has attained quantum jump in food grains production which is mainly due to the contribution of principal crops *viz*., rice, wheat and *bajra*. The State enjoys first position in the production of *basmati* rice and also in productivity of wheat (51.8 q/ha), pearl millet (20.4 q/ha)and rapeseed & mustard (18.8q/ha). This could be possible due to development and adoption of improved technologies, expansion of infrastructure and farmers' friendly policies of the Government.

2. The contribution of State in "Green Revolution" is widely recognized and admired. Haryana is the second largest contributor to national food grains reserves and has 60% share in *basmati* rice export from India. All these achievements are heartening considering the challenges related to soil health and availability of irrigation water. However, annual fluctuations in agricultural growth of the State are quite visible. The Government is concerned for the sustainability of agriculture and therefore, minimum 4% growth in this sector has been targeted in future through technological and policy interventions.

3. Haryana Kisan Ayog (established by the Government of Haryana in July, 2010) has been given the responsibility to suggest measures for productivity enhancement through technology-led farming, capacity building to compete in domestic and international markets, and generating rural employment. For this purpose, the Ayog had constituted ten working groups to study various issues related to agriculture and prepare comprehensive reports. The working group on "Productivity Enhancement of Crops in Haryana" has assessed the present status of Haryana Agriculture in terms of infrastructural and policy support, technology back-up provided to the farmers, accomplishments, emerging challenges, and gaps in productivity and research. The Working Group has come out with recommendations.

4. The State has undergone a rapid change in cropping pattern with the increase in irrigation facilities. In 1966-67, The pearl millet was the major *kharif* crop in the state occupying nearly 54% of area under major *kharif* crops, whereas paddy occupied only 12% area. Similarly, in *rabi* season gram occupied 48% of area under major *rabi* crops followed by wheat (33%). The scenario has now significantly changed. Now, paddy occupies 49% of the cultivated area in *kharif* reducing area mainly under pearl-millet, sorghum and pulses. In *rabi* season, wheat crop now occupies maximum area (79%) reducing the area of gram, barley and other crops. About 58% area has come under R-W cropping system.

5. In this era of change, several second generation problems particularly depletion of soil and water resources have cropped-up. The problems like low organic carbon in soils, deficiency of various major and micro-nutrients, declining water table in rice-wheat cropping areas, decreasing availability of good

quality water for irrigation, disposal of raw sewer water into agricultural fields, climate change and pests & diseases are posing serious challenge in agriculture. Decline in TFP, size of holdings and capacity of employment are also important problems of this sector.

6. The analysis of yield gaps and attainable potential for major crops indicates that there are wide variations in productivity of crops among the blocks and districts. In order to bridge these gaps, efficient micro-management of resources, appropriate technology interventions and policy support are required. By bridging these gaps through technological interventions and timely delivery of inputs, additional 11.6 lakh tons of food grains, 1.4 lakh tons oil seeds, 4.2 lakh tons sugarcane, 7.1 thousand tons of gram and 25.4 thousand tons of cotton production can be achieved.

7. Now, Haryana agriculture has to rapidly diversify to function in a rural-urban continuum with rapid developments of agri-business, employment generation and economic growth. Therefore, farmers will have to adopt new innovations, best practices and diversification of agriculture, including secondary agriculture, for both enhanced production and profitability. The farmers will, however, require technology and policy support.

8. The National Food Security Act, 2013, passed by the Parliament and implemented by Government of Haryana, is an ambitious and rather bold social scheme. This would necessitate increased food production by making our agriculture more efficient and resilient. Obviously, the responsibility lies on the planners, scientists and farmers of Haryana to produce more food grains.

Keeping in view the prevailing problems and needs in agriculture for enhancing productivity, the Working Group has come out with salient recommendations as under:

- Special attention to strengthen research on *basmati* rice and *guar* is essential because Haryana has major share in export of these two commodities. The alternate use of *bajra* for the production of alcohol, poultry feed, animal feed and value added food products is increasing. Therefore, *bajra* crop also requires attention of researchers as it is emerging as an industrial crop. Strengthening of research on oats and barley crops is also required as both are in demand of industry.

- Low water requiring high yielding and climate resilient varieties/hybrids of crops particularly of wheat, rice, cotton and sugarcane need to be developed. Attention is also required to develop rice varieties suitable for DSR and wheat varieties for zero tillage conditions.

- The rice-wheat cropping system in the State, which has covered 58% cultivated area, is now seen as major cause of soil health deterioration. Researches on maize, soybean, castor, sunflower, groundnut, rapeseed mustard, autumn sugarcane, gram, *arhar, and* moong bean etc. need to be strengthened to promote diversification in R-W cropping areas. Haryana has high potential for oilseeds production that needs to be harnessed. Sufficient data on crops likely to be promoted under diversification is to be generated particularly on agronomy, feasibility, profitability, total factor productivity and market demand as it will help in motivating the farmers for diversification.

- Scaling-up the research to develop the efficient technologies for soil and water management and enhancing fertilizer and water use efficiency are urgently required. Crop residue management technologies and green manuring need to be promoted. The technologies for micro-management of natural resources in agriculture at block level should be developed and made available to the farmers.

- New pests and diseases are emerging in the State. The emergence of yellow rust in wheat and *orobanche* weed in mustard are some of the examples. Accordingly, the trans-boundary survey and surveillance programmes need to be strengthened and the appropriate technology development programmes may be initiated to tackle the emerging problems of out-breaks of diseases and pests.

- Establishment of "Gene Bank at CCSHAU" should be considered as it will strengthen the crop breeding programme. Under the technical guidance of the Universities, the seed and fodder banks may be created by the concerned departments of the State.

- Launching of "State Seed Mission" and establishment of "Hybrid Seed Production Cell" have been proposed to enhance the availability of quality seed in the State. The newly released varieties should be brought in seed chain without delay. Seed production programme on *guar* need to be strengthened.

- The "State Mission on Mechanization of Small Farms" needs to be launched to make farming efficient and remunerative.

- Branding of products should be initiated. The competition for the development of class products can be created. CCSHAU and other research institutions should have a mission to create unique products meeting the international standards.

- The research on the development of viable decision support system (DSS) is critical in revamping agriculture production in Haryana. The data bank will help in risk management by accurate planning, forecasting and early warning. The information generation system on natural resources, new diseases and pests, market fluctuations and demands need to be strengthened at block level for micro-planning.

- The knowledge and technology sharing are considered important instruments for solving the problems associated with productivity enhancement. The research programmes need to be formulated by sharing knowledge and experiences of agri- entrepreneurs and innovator farmers. There should be mechanism to identify farm led innovations and use them for larger benefits of the society.

- Development of innovative extension models and application of ICT are required for improving adoption, technology dissemination & assessment of socio-economic constraints. For the capacity building of rural youth and scaling-up of skills of innovator farmers, the KVKs need to work as incubators and commodity specific extension kiosks also.

- Promotion of precision farming, which includes timely sowing, use of treated quality seed, maintenance of optimum plant population, balanced use of fertilizers and irrigation at critical stage of crop growth, is crucial to enhance productivity. Besides the farmers need to be made aware of benefits and importance of adoption of IPM, INM, CA, bio-fertilizer, water saving technologies, application of green manuring, and balanced use of fertilizers. Creation of awareness about crop residue management and harms of burning of dung, rice/wheat straw and sugarcane trash etc. is also important.

- Creating enabling environment for promoting industries and market support for the promotion of secondary agriculture and crops like maize, *guar*, *bajra*, soybean, sunflower, castor, oats, barley etc. under diversification would help farmers in getting remunerative prices.

- Women in Haryana need to be empowered with knowledge as they are major work force in agriculture and involved in almost every activity of farming. They have little or no exposure to new ideas and technologies. Their skill improvement would have direct impact on technology adoption and enhancing agricultural production and productivity.

- Entrepreneurship development and self-employment orientation in agricultural education should receive high priority. Vocational courses should be introduced at diploma/certificate level for rural youth including women. There are several areas like seed production, hybrid seed production, dairying, food processing, bee keeping, peri-urban farming, organic farming, protected cultivation, nursery raising, machines & tools manufacturing, mass multiplications of planting material, value added agriculture etc., where enormous opportunities are emerging for income generation and therefore, the capacity building of farmers and rural youth is urgently required.

- The students and faculty should be exposed to the domestic and international developments related to agriculture such as WTO, Agreement on Agriculture, TRIPS, PPV &FRA, SPS, Geographical Indications (GI), CBD, trade needs etc.

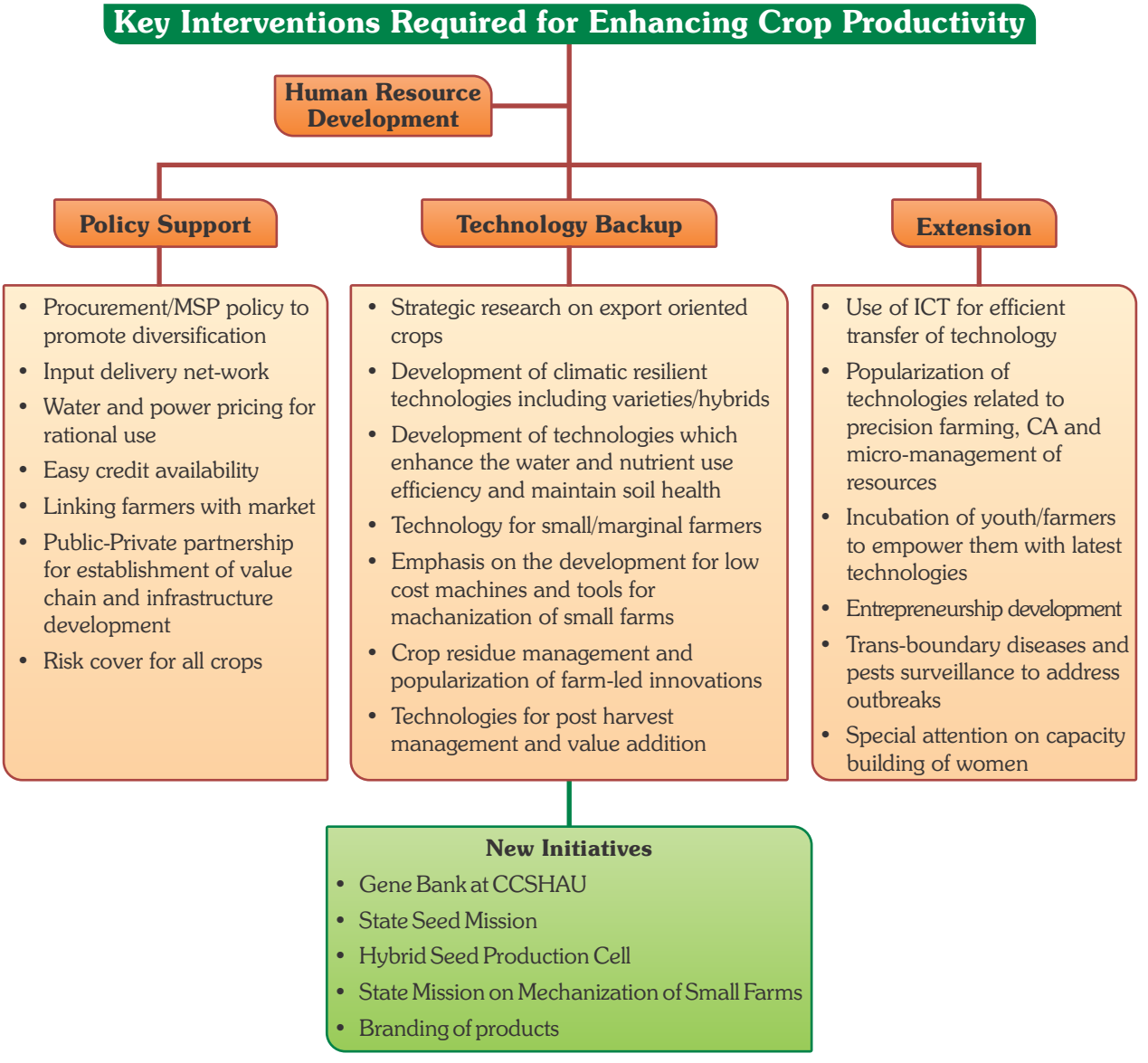
- The policy for risk management like insurance cover and procurement/MSP need to be considered to extend to all crops including the crops to be promoted under diversification.

- Promotion of solar, bio-mass and wind power in agriculture through viable policy interventions needs special attention and consideration to reduce the cost on energy use.

- The collaboration with private sector needs to be seriously assessed for partnerships to solve the core problems like water management, processing and packaging, supply chain establishment, storage, marketing etc. The partnership may also help in promoting secondary agriculture.

- Automation of operations in agriculture marketing such as primary processing and grading, storage etc need to be introduced so that farmers get better return on investment.

- The input delivery network needs to be refined, strengthened and made efficient. The agricultural graduates may be given opportunity for having license for inputs sale.



The report of the Working Group provides an insight into the magnitude of efforts needed to achieve balanced, sustainable, competitive and employment oriented growth for ensuring enhanced farm income and sustainable food and nutritional security.

"Everything else can wait but not agriculture."

- Jawahar Lal Nehru

1. Introduction

1.1 Agricultural Heritage of Haryana

Haryana, as a State, emerged on the political map of India on 1st November, 1966. The region has been playing a vital role in the economic growth and agricultural development of the country. Geographically, Haryana is bounded by the Shiwalik Hills in the North, the Aravali Hills in the South, Yamuna River in the East and the Thar-desert in the West. It has 44.2 lakh hectares of land, which is 1.34% of the total geographical area of the country. The average height ranges from 700 to 950 feet above sea-level. The climate of the State varies from arid, semi-arid and humid with annual average rainfall of 617 mm (http:www.rainwaterharvesting. org/urban/rainfall.htm). Major rainfall is received during July to September.

A comprehensive review of history of agriculture has been encoded in Haryana State Gazetteer Volume II. Agriculture and animal husbandry have always been the mainstay of its economy through the ages, infact since the Aryans inhabited this region in the second millennium B.C. Archaeological evidences reveal that agriculture was being practised in this region even earlier than the Harappan civilization, but the earliest literary reference is found in the Vaman-Purana.

Historical facts

- *Agriculture was in practice in this part of the country earlier than Harappan civilization*
- *People of this region experienced horrible distress due to recurrent famines and droughts* but continued efforts to overcome the problems

The excavations and explorations of important sites in Haryana like Siswal, Mitathal, Rakhigarhi, Banawali and others indicate towards agricultural base of this region during Harappan culture. Haryana region, the land of the Kurus, reached the pinnacle of glory during the Mahabharata times as agriculture was given much importance. It was then known as the land of plentiful grains and immense riches (Bahudhanya). The literature also reveals that the enhancement of productivity of agriculture was always in serious consideration of the kings and the rulers. Harshavardhan's reign (606-647 A.D.) is considered a significant epoch in the agricultural history of Haryana. Under Firojshah Tughlaq (1351 to 1388 A.D.), determined efforts were made for strengthening agriculture in the region as people experienced horrible distress and great loss of human, animal and vegetation due to recurrent famines and droughts. This hampered progress in agriculture. There was hardly any progress in science and technology related to agriculture during medieval period. However, there were some land reforms, and initiatives for irrigation facilities, as well as introduction of some horticultural crops.

The prosperity to the farmers was accorded high priority by the Government right from the inception of Haryana in 1966. Therefore, several short-and long term policy based reform processes were initiated to triggering growth and sustainability in agricultural production and productivity.

1.2 Agricultural Zones in the State

The State surrounds National Capital from three sides. Over 35% of the State's area falls in National Capital Region. It is located near to international air port, which is an additional advantage, as it

"The discovery of agriculture was the first big step toward a civilized life." *– Arthur Keith*

enhances the reach to domestic and global markets. Based on ecology and cropping pattern, the state is delineated (Table 1.1, Fig. 1.1) into the following three zones. These zones have their own strength and weaknesses. Accordingly, the farming systems and cropping systems have emerged.

Table 1.1 : Agricultural Zones of the State

Zone	Districts	Area %	Agricultural options
I	Panchkula, Ambala, Kurukshetra, Yamunanagar, Karnal, Kaithal, Panipat and Sonepat	32	Wheat, rice, sugarcane, maize, cows, buffaloes, and poultry
II	Sirsa, Fatehabad, Hisar, Jind, Rohtak, Faridabad and Palwal	39	Wheat, cotton, rice, sugarcane, bajra, buffaloes, cows and poultry
III	Bhiwani, Mahendergarh, Rewari, Jhajjar, Gurgaon and Mewat	29	Pearl millet, rapeseed & mustard. Mewat area is also suitable for agro-forestry, sheep and goat rearing

Note: Zone I and II have better irrigation facilities and overall infrastructure

Fig1.1: Map showing ecology and cropping pattern zones

The major cropping systems followed in the State are rice-wheat, *bajra*-wheat, cotton-wheat, and sugarcane-wheat. The gross cropped area in the State was 65.05 lakh hectare in 2011-12. About 3.069 m ha (84 % of cultivated area) was irrigated and the cropping intensity had been over 184 %. The State is second largest contributor to the central food grains pool and largest exporter of *basmati* rice.

1.3 Infrastructure Development

Government took decisive and speedy policy initiatives to transform the rural economy through infrastructural and technology support to agriculture sector. Strengthening of basic infrastructure for the development of agriculture was the first priority. In this endeavour, manifold expansion such as facilities for irrigation, land reclamation, soil & water testing, electricity availability, input supply, quality testing laboratories for farm inputs, post harvest processing, transportation, storage, and marketing was done to build the capacity of this sector.

The State Government created facilities for human resource development and established research institutions including CCS Haryana Agricultural University for the development of improved technologies required for crop and animal husbandry. Besides imparting agricultural education, research and extension education are the integral parts of objectives of the University. The ICAR and Central Government Institutions located in the State also helped in strengthening technology

development and extension programmes. A vibrant technology transfer system, which is considered a model for other States of India, was also nurtured. This system has inbuilt mechanism of research institutions working closely with the State Departments of Agriculture, Animal Husbandry, Horticulture and other line departments, agricultural field functionaries, planners, administrators, farmers and other stakeholders. The major institutions established in the State to strengthen agriculture are:

- Chaudhary Charan Singh Haryana Agricultural University, Hisar
    - ➢ College of Agriculture
    - ➢ College of Agricultural Engineering and Technology
    - ➢ College of Basic Sciences & Humanities
    - ➢ Indira Chakravarty College of Home Science
    - ➢ College of Agriculture, Kaul
    - ➢ Krishi Vigyan Kendra (KVK) in each district namely Ambala, Bhiwani, Bhopani (Faridabad), Bawal (Rewari), Damla (Yamunanagar), Fatehabad, Jhajjar, Jagdishpur (Sonepat), Kaithal, Kurukshetra, Mahendergarh, Mandkola (Mewat), Pinjor (Panchkula), Uchani (Karnal), Ujha (Panipat), Pandu Pindara (Jind), Rohtak, Sadalpur (Hisar), Sirsa except in newly created district Palwal. Besides, two NGO run KVKs and one KVK under IARI are also in Haryana.
    - ➢ Extension and Training Institute, Nilokheri
- Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar comprising of a college and six disease investigation laboratories
- Haryana Agriculture Management and Extension Training Institute, Jind
- ICAR Institutes Located in The State:
    - ➢ Central Soil Salinity Research Institute, Karnal
    - ➢ Directorate of Wheat Research, Karnal
    - ➢ IARI Regional Station, Karnal
    - ➢ Sugarcane Breeding Institute, Regional Research Station, Karnal
    - ➢ Central Institute for Cotton Research, Regional Station, Sirsa
    - ➢ Central Soil and Water Conservation Research and Training Institute, Research Centre, Panchkula / Chandigarh
    - ➢ National Dairy Research Institute, Karnal
    - ➢ Central Institute for Research on Buffaloes, Hisar
    - ➢ National Bureau of Animal Genetic Resources, Karnal
    - ➢ National Research Centre on Equines, Hisar
    - ➢ Central Institute of Fisheries Education, Rohtak
- Central Government Institutions:

- Regional Station for Forage Seed Production & Demonstration, Govt. of India, Ministry of Agriculture, Department of Animal Husbandry Dairying & Fisheries, Hisar
- Central State Farm, Hisar
- Tractor Training Centre, Govt. of India, Ministry of Agriculture, Hisar

The Government also established irrigation network, State Seed Development Corporations (HSDC), Haryana State Seed Certification Agency (HSSCA), Haryana State Agriculture Marketing Board (HSAMB), Haryana State Cooperative Supply and Marketing Federation Limited (HAFED), Haryana Land Reclamation and Development Corporation (HLRDC), Agro-Industries Corporation, Agriculture and Rural Development Bank, Dairy Development Board, Dairy Development Cooperative Federation, Haryana State Federation of Cooperative Sugar mills etc. to support agriculture sector in the State.

1.4 Policy Support

Haryana Government attaches high priority to formulate and implement farmers' friendly policies and schemes. The Government has vigorously pursued implementation of land and water management schemes, farm mechanization plan, credit availability schemes and risk management measures. In order to provide better risk management in agriculture, National Agricultural Insurance Scheme (NAIS) and Modified NAIS covering maize, cotton, *arhar,*, *bajra*, mustard, gram and barley have been implemented, Weather based crop insurance scheme (WBCIS) covering primarily rice and wheat besides cotton and *bajra* has also been implemented. The "Toll Free Agricultural Help-Lines" have been established in the Agricultural University and line departments. Kisan Clubs have been constituted in every district for discussing problems and planning strategies for issues relating to agriculture and allied sectors.

Initiatives

- *Agricultural revolution was triggered in Haryana due to pro-farmers' policies of State Government* with infrastructural and technology support

The State has successfully implemented national schemes such as Rashtriya Krishi Vikas Yojana (RKVY), which was designed to give flexibility to spend more on agriculture on the basis of State plan. Integrated Scheme of Oilseeds, pulses, oil palm and maize (ISOPOM) and the National Food Security Mission (NFSM Rice, NFSM-Wheat and NFSM-Pulses) have also been effectively implemented to increase production of rice, wheat, oilseeds and pulses through area expansion and productivity enhancement in a sustainable manner. The State has formulated its draft State water policy to address major issues relating to the water sector. Schemes for enhancing productivity of degraded lands in the catchment of Flood Prone River and Scheme for Reclamation of Alkali Soils (*USAR* land) are being undertaken. Integrated Wasteland Development Programmes, governed by the common guidelines issued by the Ministry of Rural Development, Government of India for Watersheds and Horticulture Mission, have been implemented.

The reforms in making easy credit availability to farmers have been brought out and Kisan Credit Cards (KCC) are being issued. In Haryana, wheat, paddy, barley, gram, *bajra* and mustard are covered under

the Minimum Support Price Scheme (http://haryanafood.gov.in/ profile_procurement.aspx). The wheat and leviable paddy are purchased by the six procurement agencies namely; Food and Supplies Department (33%), Hafed (30%), Haryana Agro Industries (10%), Haryana Warehousing Corporation (10%), Confed (5%) and Food Corporation of India (12%). Mustard is purchased by Hafed. *Bajra* is purchased by the State Procurement Agencies (excluding FCI) and its disposal is made by FCI. About 99% of *mandi* arrivals of paddy and wheat are procured by the government. Government has implemented several other schemes for the benefit of the farmers. To make farmers aware about these schemes, a booklet "**हरियाणा के किसानों से सम्बन्धित योजनाएं**" has been brought out and distributed by Haryana Kisan Ayog.

1.5 Technology Back-up to Farmers

The infrastructural, technological and policy support helped in bringing a sea change in agricultural productivity in the State. CCS Haryana Agricultural University (CCSHAU) has been the main contributor on technological front for helping farmers and other stake holders. In a very short period, the farmers developed their faith in technologies and crop varieties/hybrids developed by the University and adopted them. Over 254 high yielding, disease resistant varieties/hybrids of various crops have been developed by the University which are benefiting not only the farmers of Haryana but also the neighbouring States. The landmark varieties/ hybrids developed by the University include, C306, WH147, WH711 and WH912 (*durum*) of wheat; BH393 of barley; RH30 and RH8812 (Laxmi) of Indian mustard; C235 and HC5 of chickpea; HK2 of *kabuli* chickpea; HFP4 of fieldpea; HHB67 of *bajra*; HM4 of baby corn, HM8, HM9, HM10, HM11 (single cross hybrids) and HQPM4, HQPM5 and HQPM7 (quality protein) maize hybrids; HG365 and HG563 of *guar*; H777, H1098 and H1226 of American cotton; AAH1 first hybrid of *desi* cotton; *Taraori Basmati* and HKR47 of paddy; SSG593 of sorghum; CoH119 of sugarcane, DH1 of *dhaincha* and HM1 of *mulahti*. The University also provided cost-effective and efficient technologies in crop production and protection. Besides, University has contributed significantly in the areas of production of bio-fertilizers & bio-agents, food & nutrition, PHT, soil & water management, dryland agriculture, agricultural engineering, animal husbandry and bio-technology. The sustained efforts have been put to promote resource efficient technologies like Conservation Agriculture (CA), Good Agricultural Practices (GAP), Integrated Pest Management (IPM), Integrated Nutrient Management (INM), water management etc.

Technology support

- *CCSHAU developed and released over 250 varieties & hybrids along with production & protection technologies*
- *Haryana is considered as model State in technology transfer*
- *IP management and partnership with private sector have been initiated*

The University has taken lead in management of intellectual property and technology commercialization. Policy and Regulations for IIntellectual Property Management are in place. Several technologies including hybrids of maize, *bajra* and rice, varieties of wheat & *dhaincha,* bio-fertilizers etc have been commercialized. Public-Public and Public-Private partnerships have been encouraged to strengthen human resource development, research and technology transfer programmes. These steps

may help in creating competition among the scientists for innovations and accelerating the transfer of technology.

The ICAR institutes and other agencies located in the State also help the farmers by providing technology for soil & water management, crop production and animal husbandry.

1.6 Technology Dissemination

Haryana has emerged as model State in technology transfer which is jointly managed by State Department of Agriculture and CCSHAU through its net-work spread down to village level. The dissemination of farm technology in the State is also being effectively done through Krishi Vigyan Kendras located in different districts. Other R&D institutions located in the State also collaborate in this endeavour. Promotion of ICT is a priority to strengthen technology transfer programme. In addition, Community Radio Stations, front line demonstrations, field days, interface among farmers-scientists-field functionaries, trainings etc are being employed as instruments of technology transfer and up-skilling the farmers. In fact, the primary concern of the government has always been to insulate the farmers of Haryana from fluctuations in agricultural production, rise of cost of cultivation and vagaries of weather/climate. To cope with the situation, the farmers are trained and empowered with efficient technologies to make farming remunerative.

1.7 Impact of Initiatives on Agricultural Production- A Success Story

The initiatives on agricultural development in the State have not only brought rich economic benefits to farmers and subsequently helped to trim down rural poverty but have also helped India to achieve self-sufficiency in food production. In fact, Haryana's agricultural development is one of the lead success stories of post independence which contributed in ushering the Green Revolution in India.

The impact of initiatives of the Government can be viewed in terms of quantum jump in food grains production, which was merely 25.92 lakh tons at the time of inception of the State. It touched 183.42 lakh tons during 2011-12. The average productivity of total food grains has reached 35.27q/ha as against 19.2 q/ha at country level. This increase in production is mainly due to the contribution of principal crops *viz*., rice, wheat and *bajra*. The State enjoys first position in the production of *basmati* rice and also in productivity of wheat (51.8 q/ha), pearl millet (20.4 q/ha) and rapeseed & mustard (18.8 q/ha). The State has achieved high productivity/production of fish (5,500kg/ha), mushroom (6.07 kg/tray productivity or 8000 tons production), honey (2500 tons production with 15% growth/annum), fruits (3.5 tons/ha), vegetables (13.42 q/ha), etc. Similarly, livestock productivity has increased several times. Haryana can legitimately claim to be the pioneer in adoption of sprinkler irrigation technology. Area under irrigation is estimated at 84%.

Haryana is second largest contributor of food grains to

Achievements

- *Seven times increase in food grains production over the year 1966-67*
- *Average productivity of food grains in Haryana reached 35.27q/ha against 19.20q/ha of the country.*
- *Second largest contributor to national food grains reserves.*
- *State contributes 60% of total basmati rice export*

the Central Pool. About 60% of the total export of *basmati* rice is contributed by the State alone. The farmers have harnessed benefits of advanced technologies in the State. All these achievements are highly satisfying considering the various challenges related to soil health and water availability being faced by the State. However, there is ample scope to make agriculture a buoyant occupation for both small/marginal farm holders and the farmers of rainfed areas.

1.8 Constitution of Working Group on "Productivity Enhancement of Crops in Haryana"

Agriculture plays a vital role in economic development as it still contributes 16.7% to State GDP and employs 51% of workforce. Therefore, strengthening agricultural research, education and extension as well as ensuring adequate availability of irrigation water, timely supply of essential inputs and dissemination of improved technologies to the farmers and other stakeholders have always been the major concern of the State. The strenuous pursuits of the Government to support farmers resulted in an agricultural revolution in the State. However, up-coming second generation problems like depletion of natural resources, decreasing TFP and globalization of agri-business are forcing the planners and scientists to reassess and fine-tune the current research and extension programmes in order to address the new challenges. Besides achieving the 4% annual growth in the agriculture sector as envisaged in National Policy on Farmers (2007), the Haryana Government is now precisely focussing on the sustainability of agriculture and making it globally competitive, and strengthening the economic well-being of the farmers.

Considering the recommendations of National Policy on Farmers, the State Government had notified the constitution of Haryana Kisan Ayog (Haryana State Farmers' Commission) vide No. 1919-Agri.II (1)-2010/9677 dated July 15, 2010 to address the issues in agriculture and suggest measures to improve overall agriculture and livelihood of farmers of the State. The Ayog has constituted the following technical working groups to address important issues of agriculture, highlight strengths, constraints and suggest needs, strategies and priorities to trigger another agricultural revolution in the State.

- Conservation Agriculture
- Development of Animal Husbandry
- Draft Agricultural Policy
- Fisheries Development
- Horticulture Development
- Linking Farmers to the Market
- Natural Resource Management
- Productivity Enhancement of Crops
- Protected Cultivation
- Rainfed Area Development

The Chairman, Haryana Kisan Ayog, had constituted the following "Working Group on Productivity Enhancement of Crops in Haryana" vide notification of Haryana Kisan Ayog, Hisar No. HKA/ 12/ WG-09/8125 Dated, January 6, 2012.

1.	PL Gautam	Former Chairperson, Protection of Plant Varieties & Farmers' Rights Authority, Ministry of Agriculture, NASC Complex, New Delhi Presently Vice Chancellor, Career Point University, Hamirpur (HP)	Chairman
2.	MS Kairon	Former Director, Central Institute of Cotton Research, Nagpur	Member
3.	SS Singh	Former Director, Directorate of Wheat Research, Karnal	Member
4.	Sain Dass	Former Director, Directorate of Maize Research, New Delhi	Member
5.	RS Dalal	Former Registrar, CCSH/AU, Hisar and Presently Member Secretary, Haryana Kisan Ayog, Hisar	Nodal Officer
6.	RB Srivastava	Former Associate Dirctor (Planning) CCSHAU Hisar and Presenly Consultant, Haryana Kisan Ayog	Nodal Officer

Terms of Reference of the Working Group

- To make SWOT analysis and review the productivity status, yield gaps and attainable potential yield of major crops viz., wheat, barley, rice, cotton, rapeseed-mustard, pearl millet, maize, *guar* and sugarcane
- To analyse present status of seed production of released and notified varieties/hybrids and to review the seed replacement rates and gaps in availability of quality seeds and suggest measures to overcome such gaps, including seed rolling plans for replacement of old varieties/hybrids
- To suggest research gaps that need to be bridged regarding development of new varieties, production and protection strategies for different crops by reorientation of research, education and extension in order to meet the emerging challenges associated with agriculture
- To suggest suitable measures for implementation of improved agro-techniques such as Conservation Agriculture (CA), Integrated Nutrient Management (INM), Integrated Water Management (IWM), Integrated Pest Management (IPM), diversification, farm mechanization and precision farming keeping in view the needs of agro-climatic zones and farming system

This Working Group has prepared its report after wide consultations with different stake holders and has made recommendations to make Haryana farming more inclusive, remunerative and globally competitive. The report provides an insight into the magnitude of efforts needed to achieve balanced, sustainable, competitive and employment oriented growth for ensuring enhanced farm income and sustainable food and nutritional security.

2. Review of Productivity Status

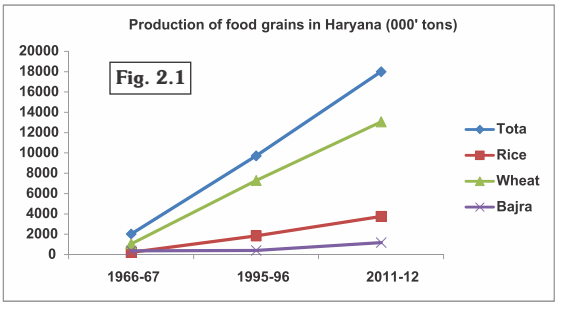
The success achieved by the State in enhancing crop productivity has been acclaimed at various fora. The total food grains productivity in the State is 1.8 times higher than the average at country level. The crop-wise review of productivity (Table 2.1) showed that the infrastructural, technical and policy support have paid rich dividends for enhancement in total production. During 2011-12, the increase in productivity of paddy, wheat, barley, maize, *bajra*, *rabi* oilseeds, gram, cotton and sugarcane was achieved by 2.6, 3.5, 2.7, 2.6, 4.8, 3.4, 1.8, 2.7, and 21.4 times, respectively over the year 1966-67.

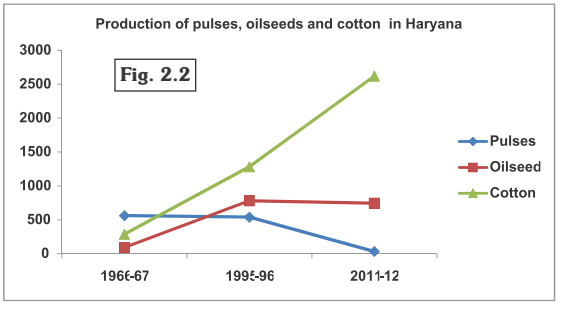
Table 2.1: Productivity status of major crops

Crops	Productivity Status (Kg/ha)		Increase	
	1966-67	2011-12	%	Fold over
Paddy	1161	3044	262	2.6
Wheat	1459	5182	355	3.5
Bareley	1313	3633	276	2.7
Maize	988	2666	269	2.6
Bajra (pearlmillet)	418	2040	488	4.8
Rabi oilseeds	404	1396	345	3.4
Gram (chickpea)	500	911	182	1.8
Cotton	268	739	275	2.7
Sugarcane	3408	73253	2149	21.4

Source: agriharyana.nic.in/Stat_Info/Nine%20Patti.doc

The total production of major crops such as wheat, paddy, *bajra* and cotton has continuously improved (Fig. 2.1 and 2.2), whereas, production of oilseeds stagnated after 1995-96. The pulse production always showed declining trend, especially after 1995-96 (Fig. 2.2).





Source: Based on data - agriharyana.nic.in/Stat_Info/Nine%20Patti.doc

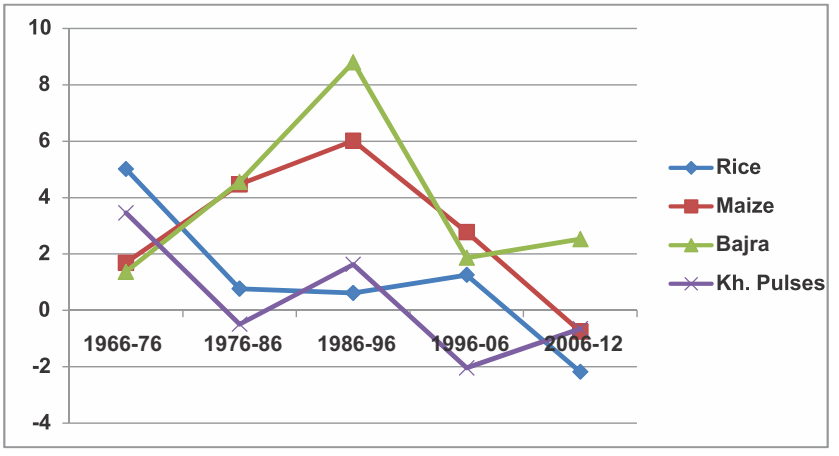
The decadal analysis of productivity growth of major crops of *kharif** and *rabi*** seasons showed considerably high fluctuation (Fig. 2.3, 2.4, 2.5). Most of the *kharif* crops showed sharp decline in

productivity growth after the decade 1986-96 (Fig. 2.3). *Bajra* and pulses showed improvement in growth after 1996-06.

* *Kharif : It refers to the planting, cultivation and harvesting of any domesticated plant sown in the rainy (monsoon) season in the Asian subcontinent. Such crops are planted for autumn harvest and may also be called the summer or monsoon crop in India. The term has been derived from Urdu-Punjabi.*

** *Rabi: The word rabi refers to agricultural crops sown in winter and harvested in the spring season. The term has been derived from the Arabic word for "spring",*

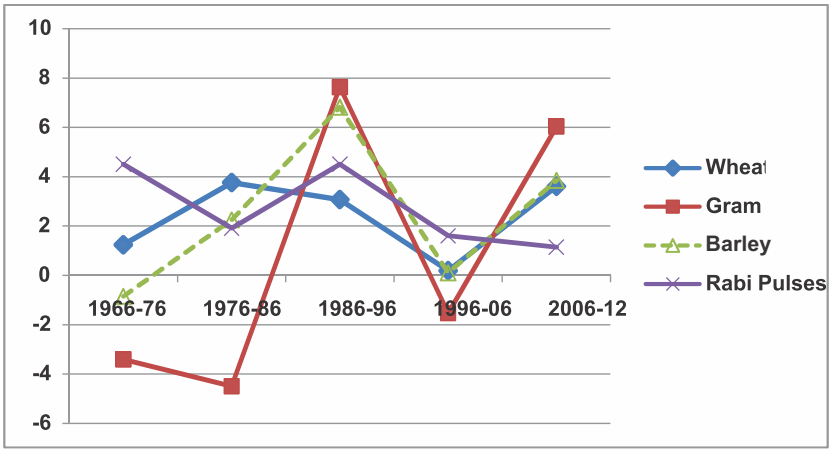
Fig. 2.3: Decadal growth (%) of productivity of major *kharif* crops in Haryana



Source: Based on data - agriharyana.nic.in/Stat_Info/Nine%20Patti.doc

Similarly, sharp decline in decadal growth of productivity (Fig. 2.4) was also observed in major *rabi* crops after 1986-96 decade. However, it is satisfying that during 2006-12, all the rabi crops including wheat, barley and gram (chickpea) showed increase in decadal growth in productivity whereas there was decline in case of pulses.

Fig. 2.4: Decadal growth (%) of productivity of major *rabi* crops in Haryana

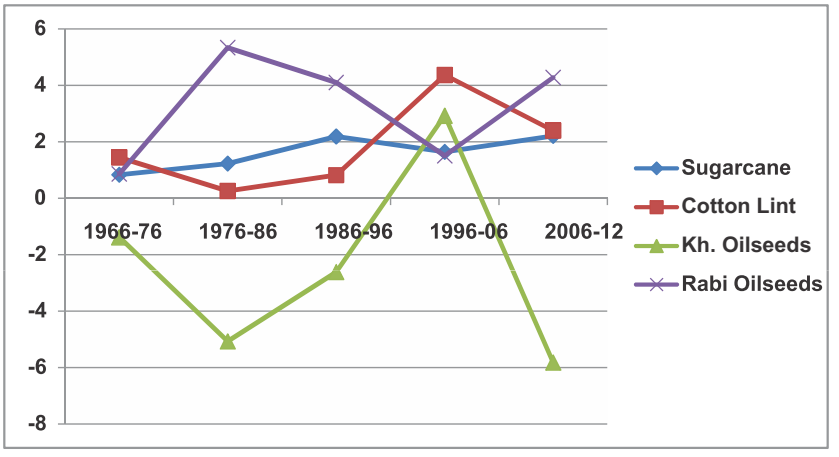


Source: Based on data - agriharyana.nic.in/Stat_Info/Nine%20Patti.doc

Among the major commercial crops also, there was no consistency in decadal productivity growth except for sugarcane (Fig. 2.5). There is decline in growth of cotton productivity after the decade 1996-

06, whereas *rabi* oilseeds showed increasing growth. *Kharif* oilseeds showed sharp decline in growth. Consistency in productivity growth of all major crops is required for sustainability of Haryana agriculture.

Fig. 2.5: Decadal growth (%) of productivity of major commercial crops in Haryana



Source: Based on data - agriharyana.nic.in/Stat_Info/Nine%20Patti.doc

The fluctuation in decadal growth is clearly alarming and indicates that factors affecting the growth have to be critically identified to take appropriate measures for enhancing the growth in productivity.

The annual growth rate of agriculture and allied sectors during 11th Plan in Haryana was 3.9% whereas, at national level it was 3.7%. During the last five year plan, a high fluctuation in agricultural growth from -0.3% in 2007-08 to 8.6% in 2010-11 was observed (Table 2.2). It shows that agriculture in the State is vulnerable to various biotic and abiotic stresses. In fact, this kind of fluctuation is alarming and poses threat to sustainability of this occupation.

Agricultural growth situation

- *Considerable fluctuation has been observed in productivity growth*
- *High GDP growth without consistent agricultural growth likely to accelerate inflation in State. Therefore, minimum 4% growth rate in agriculture is essential*

Table 2.2: Growth in Haryana agriculture (at 2004-05 prices)

Year	% Growth	Reasons
2007-08	-0.3	Decline in production of oilseeds, sugarcane, gram, vegetables and low increase in wheat & milk production
2008-09	7.4	Increase in production of wheat, *rabi* oilseeds, gram, fruits, vegetables
2009-10	-1.7	Sharp decline in production of all crops
2010-11	5.6	Sharp rise in production of wheat and all other crops
2011-12*	8.6	Sharp rise in production of paddy (8.5%), wheat (12.9%), cotton (50 %), sugarcane (15.2%), maize (26.3%), barley (17.7 %) and fruits (32.5 %)

**Quick Estimates (Source: Economic Survey of Haryana, 2012-13)*

The instability in agricultural growth in the State is a worrisome situation. The State has to maintain growth rate at-least at the level of 4% per annum for its long term sustainability. The economic survey of Haryana (2012-13) suggests that high GDP growth without consistent and rapid agricultural growth is likely to accelerate inflation in the State which may jeopardize the larger growth process.The revitalization of agriculture through enhancing productivity and profitability by pushing comprehensive plan has become crucial as summarized below:

- Land productivity enhancement with focus on efficient management of natural resources
- Development of climate resilient and input efficient improved hybrids/varieties
- Enhancement of labour productivity through mechanization complimented by new searches and surges on alternate employment via value addition and protected agriculture)
- Increasing energy efficiency by use of alternate energy sources and use of energy efficient machinery.

"You can't build a peaceful world on empty stomachs and human misery."
- Norman Borlaug

3. Changing Scenario of State Agriculture

3.1 Employment Generation

The agriculture sector in the State has undergone significant structural changes in the form of decrease in share of GDP from 56% in 1966-67 to 16.7 % in 2011-12, indicating a shift from the traditional agrarian economy. In Haryana, the decline in share of agriculture in GDP is due to faster development of services sector and manufacturing industries around the national capital, Delhi. The decrease in agriculture's contribution to GDP in the State has not been accompanied by a matching reduction in the share of agriculture in providing employment. Agriculture is still the single largest source of employment in the State. It continues to provide employment to 51 % workforce as compared to 66 %at the time of inception of the State. It is estimated that "GDP growth originating through agriculture is at least twice as effective in reducing poverty as GDP growth originating outside agriculture." This reflects that capacity of Haryana agriculture should continue to be strengthened to employ its dependents in farming and related sectors. There is a strong feeling among the farmers that the rural youth is losing interest in farming due to low profitability and decreasing employment avenues. This trend has to be checked. Therefore, fostering rapid, sustained and broad-based growth in agriculture remains key priority for the Government. The most favourable situation in the State is that the farmers are always inclined to adopt new technologies.

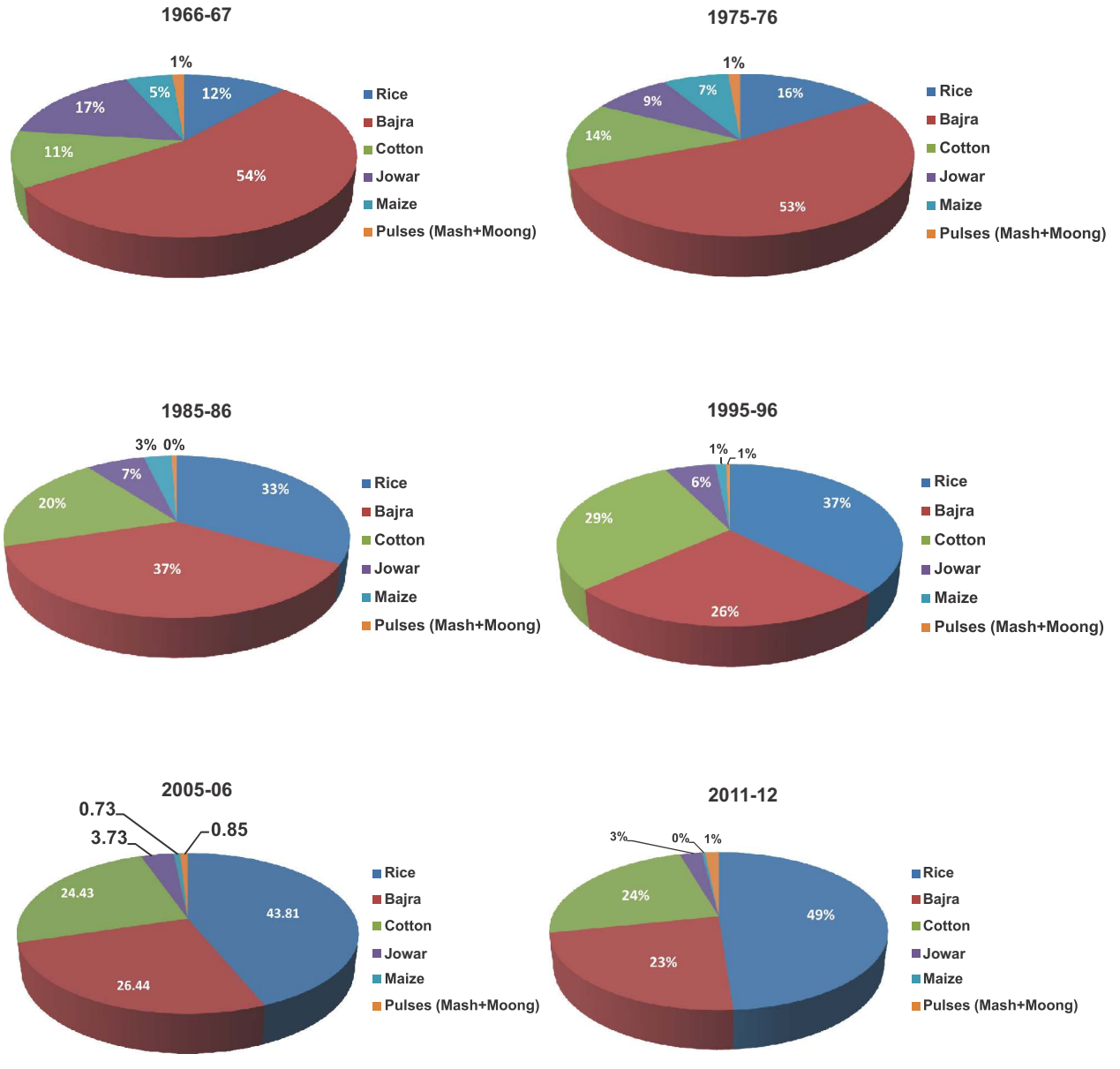
Size of agriculture sector

- *Agriculture still contributes 16.7% to State GDP*
- *It is a single largest source of employment*
- *51% workforce depends on agriculture*
- *Youth is leaning towards self-employment and commercial agriculture*

3.2 Change in Cropping Pattern

With the advent of modern agriculture in the State, there is continuous change in cropping pattern primarily influenced by economic considerations. The sharp shift was observed after 1975-76 in both *kharif* and *rabi* seasons (fig. 3.1 and 3.2). The increase in irrigation facilities, availability of inputs particularly high yielding varieties and procurement policy influenced the change in cropping pattern. In 1966-67, the major *kharif* crops like *bajra, jowar* (sorghum), paddy, maize, *urad* bean, *moong* bean and oilseeds occupied 1659.30 thousand hectare area. As indicated in Fig. 3.1, *bajra* was the major *kharif* crop in the State occupying nearly 54% area followed by *jowar* (17%), paddy (12%), cotton (11%), maize (5%) and pulses (1 %). This pattern has drastically changed now. In 20011-12, the paddy occupied 49% of the cultivated area under major *kharif* crops followed by *bajra* (23%), cotton (24%), *jowar* (3%) and *kharif* pulses (1%). The area under maize, *jowar*, oilseeds and pulses has been drastically reduced to negligible level. The area under *bajra* also reduced to less than half.

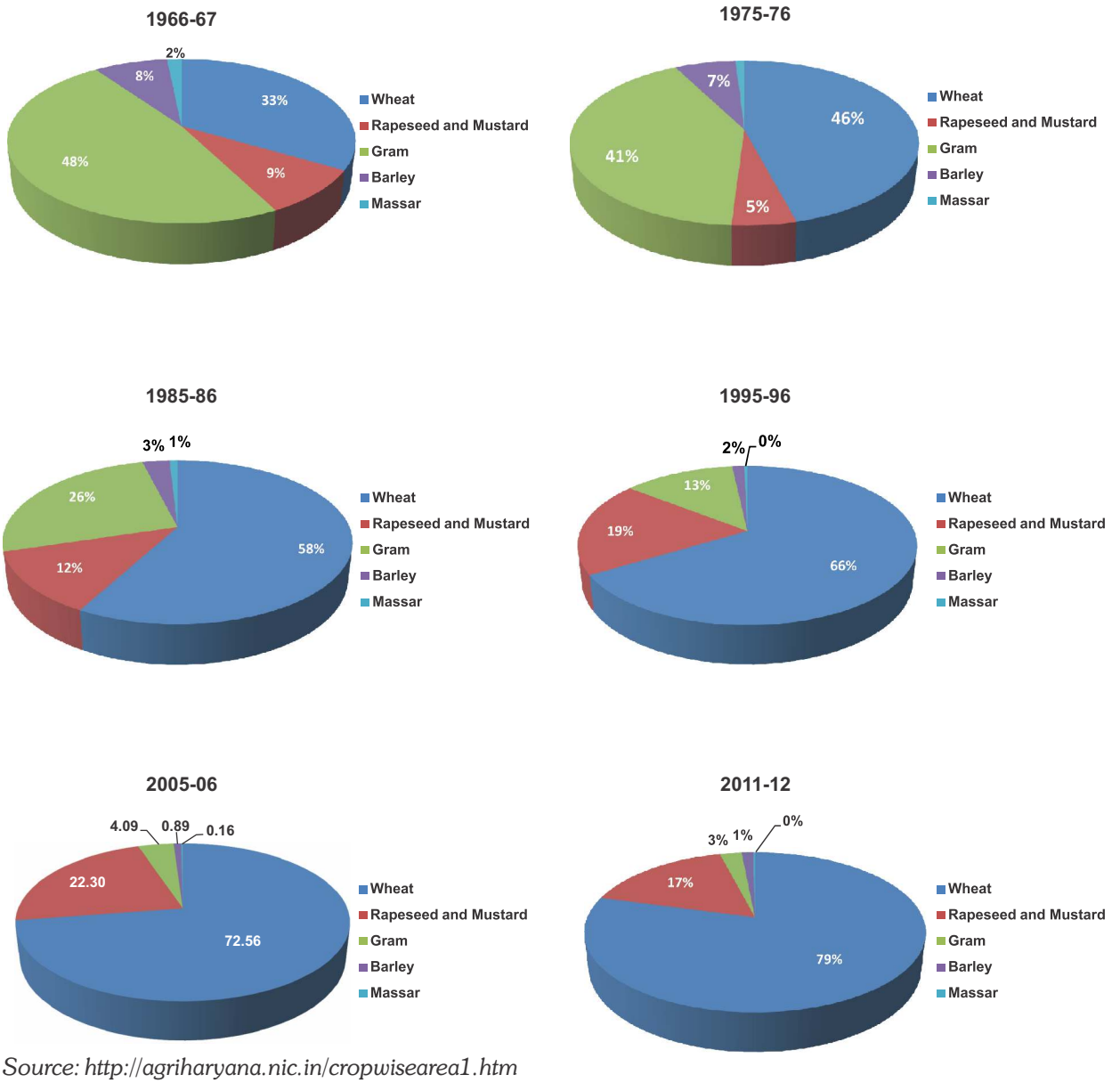
Fig. 3.1 Change in area (%) under major *kharif* crops in Haryana



Source: http://agriharyana.nic.in/cropwisearea1.htm

Such shift has also been observed in *rabi* cropping pattern (Fig. 3.2). In 1966-67, gram (Chickpea) occupied 48% area of *rabi* crops followed by 33% wheat, 9% rapeseed & mustard, 8% barley and 2% lentil (massar). In 2011-12, wheat (79%) occupied maximum area followed by rapeseed & mustard (17%), gram (3%), barley (1%) and lentil (0.13%). Drastic reduction in area under sugarcane (47%) and total pulses (88%) has also been observed. The area under oilseeds has shown significant increase (146.6%). In the year 2009-10, the area of *guar* increased by 80% over the year 1997-98. The overall review indicates that the area has been diverted more towards assured and income generating crops, especially rice and wheat.

Fig. 3.2 Change in area (%) under major *rabi* crops in Haryana



Source: http://agriharyana.nic.in/cropwisearea1.htm

Significant shift in the cropped area include increase in area under wheat, rice and cotton (Fig. 3.1, 3.2). All these are high water demanding crops. On the contrary, area under low water requiring crops like *bajra,* gram, barley and *jowar* has drastically declined. Maize cultivation has yet not become popular in the State despite its high potential. The crops such as *guar,* soybean, *arhar,* castor, sunflower, groundnut and maize have potential to break rice-wheat cropping

Change in cropping pattern and energy use

- *Steep increase in area under rice, wheat and cotton after 1975-76*
- *Area under low water requiring crops like gram, bajra, maize, sorghum and pulses drastically reduced*
- *Energy requirement in agriculture increased several times*

pattern. A suitable production technology with procurement policy and crop insurance may help in the promotion of cultivation of these crops.

3.3 Up-coming Entrepreneurship

A visible and encouraging change which is being noticed in rural youth of the State is that they are leaning towards self-employment and commercial agriculture. Several success stories of entrepreneurs have emerged in different districts. Aterna and Mandoli villages of Sonepat districts have been converted into hybrid maize villages due to the efforts of entrepreneurs and technology back-stopping. Dairying, poultry farming, bee keeping, mushroom cultivation, nursery raising, tissue culture, production of value added products of maize, *bajra* and *guar*, production of machines and tools, protected cultivation etc have been opted as enterprises by several youth successfully.

3.4 Change in Energy Use

The requirement of energy for agriculture in the State is rapidly increasing due to the use of energy operated machines, implements, tube wells etc. Energy use is expected to rise in near future as there is emphasis on farm mechanization and processing. Haryana State Action Plan on Climate Change (2011) indicates that Haryana represents about 3% of national fossil fuel consumption and 2% of national electricity utilization. Alternate arrangements for energy (solar and bio-fuel) and adoption of efficient machines may help in reducing the dependence on fossil fuel.

"Haryana Agriculture is to be Transformed as Science & Technology Driven Occupation"

- Anonymous

4. Emerging Challenges to Agriculture

4.1 Climate Change

Climatic variability directly impacts yields of crops besides affecting soil quality, water availability and increasing vulnerability to pests and diseases. For instance, a short period of exposure of wheat crop to high temperatures results in sharp decrease in productivity, ranging from 10-20%. As per report published by CRIDA (http://www.crida.in/Climate%20 change/network.htm), high thermal stress during post-flowering duration manifested 18, 60 and 12% reduction in economic yield of wheat, mustard and potato, respectively.

Unpredictable moisture stress during critical crop growth stages is major factor in reducing productivity of crops. According to Haryana State Action Plan on Climate Change (2011) the mean maximum temperature is likely to increase by 1.3°C and mean minimum temperature by 2.1°C by 2050. The increase in mean maximum temperature is projected to be 4.2°C and mean minimum temperature 4.7°C by 2100. Mean annual rainfall is projected to decrease marginally by about 63 mm (3%) by mid century and increase by about 347 mm (17%) by the end of century. The parts of Bhiwani, Faridabad, Fatehabad, Gurgaon, Jhajjar, Jind, Karnal, Kurukshetra, Mahendragarh, Rohtak, Sirsa and Sonipat showed decreasing trend in the monsoon rainfall. Evapo-transpiration and Green House Gases (GHG) are projected to increase, whereas, negligible changes, in ground water recharge have been anticipated.

The weather data of different stations of past 35 years (1980 to 2012) was evaluated by Department of Agri-Meteorology, CCSHAU (as communicated through e-mail) and it was found that the maximum temperature is decreasing and minimum temperature is rising. The warming rate for minimum temperature is 0.198°C/decade and cooling rate for maximum temperature is 0.046°C. The mean temperature is rising with rate of 0.075°C/decade. The average annual rainfall is increasing with rate of 22.5 mm/decade in Haryana. There is a climatic shift of 50 to 60 km towards SW Haryana.

The scientists and planners are concerned about the erratic rainfall pattern in the State. For example, of the last four seasons, three received deficit rainfall (Table: 4.1). This adversely affected the production and productivity of various crops in the State.

Table 4.1: Erratic rainfall in Haryana impacting agriculture

S.No.	Rainfall (mm)	2011-12		2012-13	
		April-Sept. (mm)	Oct.-March (mm)	April-Sept (mm)	Oct.-March (mm)
1.	Acutal	426.8	9.4	340.0	111.8
2.	Normal	531.0	67.1	532.1	67.1
3.	Departure %	-19.6	-86.0	-36.1	66.6

Source: http://agriharyana.nic.in/

4.2 Natural Resource Degradation

The total factor productivity (TFP) is declining due to resource degradation, high cost of inputs & labour, natural calamities and gaps in technology. The continuous degradation of natural resources and intensive cultivation is affecting the sustainability of agriculture. The soils of the State are low in various major and micro-nutrients (Table 4.2). About 70% soils have low (<0.4%) Organic Carbon Matter (OCM) and large scale deficiency of nutrients. The organic carbon and nutrient deficient soils cannot afford pressure of intensive agriculture for longer time.

Table 4.2: Soils showing macro and micro-nutrients deficiency

Sr. No.	Macro nutrients	Soils (%) showing low nutrient status
1.	Nitrogen	94
2.	Phosphorus	89
3.	Potash	6 low
		46 medium
		48 high
4.	Sulphur	9
Micronutrients		
1.	Zinc	20
2.	Iron	26
3.	Manganese	7.2

Source: http://agriharyana.nic.in/

About 15% (2.2 lakh ha) of the net sown area of the State is now salt affected. The rice-wheat rotation is disturbing the balance of available nutrients in the soil and also causing micronutrients deficiency (http://elmu.umm.ac.id/file.php/1/jurnal/A/Agriulture,%20 Ecosystems%20and%20Environment/Vol82.Issue13.Dec2000/1637.pdf).

Water is becoming a scarce commodity in Haryana. Agriculture's share in water is declining at a faster rate due to increasing competition for good quality water from urban and industrial sector. Underground water quality map of the State prepared by CCSHAU reveals that 55, 8 and 37% of the sub-soil waters are of poor, marginal and good quality, respectively. Amongst poor quality water 18% is sodic, 11% saline and 26% saline-sodic in nature. Underground water in Panipat, Kaithal, Karnal, Kurukshetra, Yamuna Nagar and Ambala districts is generally of good quality. However, in the remaining districts: Sonepat, Jind, Rohtak, Hisar, Sirsa, Bhiwani, Mohindergrah, Rewari, Gurgaon and Faridabad, water is predominantly of poor quality. In the southern zone

Resource Situation

- *Soils of the State are low in various major and micro-nutrients*
- *About 70% soils have low (<0.4%) Organic Carbon Matter (OCM)*
- *55, 8 and 37% of the sub-soil waters are of poor, marginal and good quality, respectively*
- *Marginal farmers represent 65% of the total farming families and have 21% of total holdings*
- *About 19% area is rainfed in the State*

of Haryana comprising Rewari, Mohindergarh, Bhiwani and Gurgaon districts, the ground water is predominantly saline, sodic or saline-sodic. In this area, the ground water is the only source of irrigation covering more than 70% of net irrigated area. Indiscriminate use of canal irrigation water and lack of natural drainage has led to the rise in water table accelerating water-logging and secondary soil salinization problems. A separate comprehensive report prepared by "Working Group on NRM" constituted by Haryana Kisan Ayog, was submitted to State government in 2012 suggesting measures to manage these natural resources effectively.

4.3 Effect of Sewage Water and Industrial Effluents

According to the work done at CCSHAU, the toxic metals like Cd, Cr and Ni were found to be accumulated in the soil and plant due to long-term use of sewage irrigation. The elements Cd, Cr and Ni are more likely to become health hazards for consumers of the crops grown in sewage irrigated soils (http://cdn.intechopen.com/pdfs/30857/InTechimpact_of_sewage_and_industrial_effluents_on_soil_plant_health.pdf). With the rapid urbanization and industrialization, the amount of sewer water is increasing substantially. The disposal of raw sewer water in to agricultural fields is becoming a serious problem. It is adversely affecting soil, plants and animal/human health. It has been found that about 60% sewer water in Haryana is unsafe for irrigation and requires treatment before use. To avoid such problems, continuous monitoring of quality of sewage and industrial effluents available in the Sate and impact on soil plant health is required in order to make use of sewage water as a cheap potential alternative source of plant nutrients in agriculture.

4.4 Declining Size of Holdings

In Haryana, the size of holdings is reducing continuously. The average of operational holdings is 2.25 ha. About 65% of the totals farming families are small and marginal, owning 21% area of operational holdings. The farmers of rainfed area also own about 19% of the total cultivated area and they have harnessed comparatively fewer benefits of advanced technologies. Farmers of ten districts in the State have less than 2 ha holdings (Table: 4.3). The small size of holdings hinders in farm mechanization and adoption of new and potential technologies due to lack of economic and technological viability (http://agricoop.nic.in/Farm%20Mech.%20PDF/05024-03.pdf). Hence, increasing the productivity and profitability of these farms is a challenge and needs to be addressed appropriately.

Table 4.3: Average size of holdings (ha) 2011-12 in different zones of Haryana

District	Holdings (ha)	District	Holdings (ha)	District	Holdings (ha)
Panchkula	1.76	Sirsa	2.80	Bhiwani	3.05
Ambala	1.73	Fatehabad	2.44	Mahendergarh	1.82
Kurukshetra	2.67	Hisar	3.25	Rewari	1.81
Yamuna Nagar	2.73	Jindal	2.61	Jhajjar	2.09
Karnal	2.47	Rohtak	2.58	Gurgoan	1.62
Kaithal	2.75	Faridabad	1.88	Mewat	1.48
Panipat	1.49	Palwal	1.67		
Sonepat	1.35				
State	2.25				

Source: Statistical Abstract of Haryana, 2011-12

4.5 Imbalanced Input and Energy Use

The energy use is fast increasing (Fig 4.1 & 4.2) in agriculture sector. The increase is mainly due to intensification of agriculture. Therefore, there is a need to develop energy efficient technology and cost-effective machines and tools to effectively use energy in order to reduce the cost of cultivation. It has been observed that there is over use or injudicious use of agro-chemicals and fertilizers in the State which adds to the cost of cultivation.

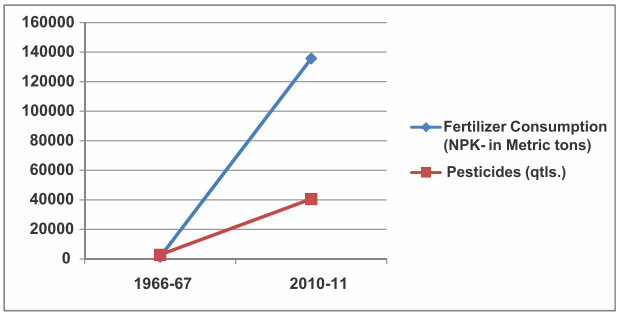


Fig.4.1: Increasing use of fertilizers and pesticides

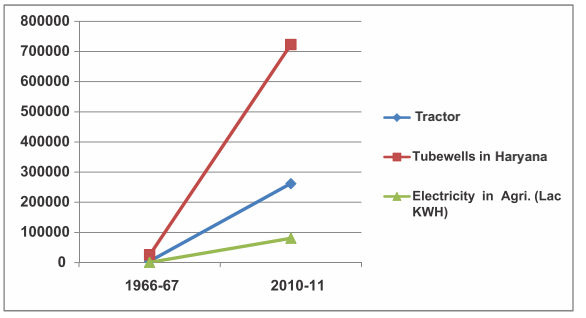


Fig.4.2: Increasing use of tractors, tubewells & Electricity

Source : Statistical Abstract of Haryana, 2011-12

The districts of Sirsa, Karnal, Hisar and Fatehabad, are the highest users of fertilizers, whereas Mahendergarh, Mewat, Gurgaon, Faridabad, Jhajjar and Panchkula are the lowest consumers. Application of NPK and micro-nutrients like Zn, S, Mn etc is not balanced which adversely affects the crop yields. Rohtak, Jhajjar, Gurgaon, Mewat, Rewari and Mahendergarh use the least quantity of pesticides. Karnal followed by Hisar, Panipat, Sirsa, Kaithal, Bhiwani and Sonipat are using pesticides on higher side. The use of herbicides need to be minimized with the adoption of appropriate technology keeping in view the trade and health concerns. Haryana is well placed for targeting global market. Hence, it has to ensure that its products meet the SPS and Codex *alimentarius* standards.

Major challenges

- *Climate change*
- *Decreasing total factor productivity*
- *Natural resource degradation*
- *Declining size of holdings*
- *Crop residue management*
- *Yield gaps among the district/ blocks*
- *Losses due to insect–pest, diseases and weeds*
- *"National Food Security Act, 2013."*

Similarly, it appears that the growth in farm power is due to fast increase in number of tractors and tube wells. The increase in tractors and tubewells has enhanced the consumption of diesel and electricity. Agriculture consumes the highest KWH electricity of total consumption followed by industry, domestic sector, commercial establishment etc. To meet the demand of energy and also to reduce the energy cost, new options of energy like solar energy, bio-fuel and efficient machines and tools will have to be explored and exploited. Further, the growth in farm machinery needs to be rationalised.

4.6 Yield Gaps

The area/block specific data on resources for agriculture would be of great help for both long term as well as short term planning for crop production. There are wide gaps in productivity of various crops among the districts (Table 4.4) and also across the blocks (Table 4.5) of the various districts. As many as 11 districts in rice, 12 in wheat, 4 in barley, 8 each in *bajra* and gram, 18 in cotton, 13 in sugarcane and 3 districts in oilseeds are performing below the State average.

Table 4.4: Number of districts in different zones performing below the State average in productivity based on data 2011-12

Sr. No.	Crops	State average productivity t/ha	Number of districts below state average			
			Zone-I	Zone-II	Zone-III	Total
1.	Rice	3.04	4	5	2	11
2.	Wheat	5.18	2	4	6	12
3.	Barley	3.63	-	2	2	4
4.	Maize	2.67	1	-	-	1
5.	Bajra	2.04	2	3	3	8
6.	Oilseeds	1.39	0	1	2	3
7.	Gram	0.9	-	4	4	8
8.	Cotton	0.74	7	5	6	18
9.	Sugarane	73.25	3	5	5	13

Source:http://agriharyana.nic.in/cropwisearea1.htm

4.7 Crop Losses

In monetary terms, the Indian agriculture currently suffers heavy losses due to insect pests. The proportionate losses, which could be too high in Haryana, may be extrapolated from the trend of losses in the country. The changing scenario of insect pest problems in agriculture as a consequence of green revolution technology has also been well documented by the scientists. There has been further shift in the status of several insect pests due to climate change and introduction of transgenics in cotton. Adoption of Bt cotton has enhanced production and profitability, but encouraged new pests (xa.yimg.com/kq/groups/14164994/…/Dr%2B Dhaliwal%2Barticle.PDF). There is a decline in the pest status of bollworms. However, the sap feeders, viz. aphids, jassids, mirids and mealy bugs are emerging as serious pests (http://www.ncipm.org.in/NCIPMPDFs/Publication/Cotton%20Mealybug %20Bulletin.pdf). The use pattern of pesticides shows that cotton crop alone consumes 44.5% pesticides followed by rice, which accounts for 22.8% of pesticide consumption. These two crops consume more than two thirds of the total quantity of the pesticides used in the country. The composition and competition by weeds are dynamic and dependent on soil, climate, cropping and management factors.

Pests and disease scenario

- *Shift in the status of several insect pests due to climate change and introduction of transgenics*
- *Yellow rust in wheat, orobanche weed in mustard and nematodes in wheat & other crops are emerging problems*

Table 4.5 : Productivity (kg/ha) gaps at block level in different districts (kg/ha)

S. No.	District	No. of Block	Rice	*Bajra*	Barely	Gram	*Rabi* oilseeds	Cotton	Sugarcane	Maize
1.	Hisar	9	574	1068	885	415	861	447	49000	0
2.	Fatehabad	6	1533	1900	1401	620	732	117	0	0
3.	Sirsa	7	1261	580	1903	207	573	101	0	0
4.	Bhiwani	10	1086	965	1645	770	1045	301	108050	0
5.	Rohtak	5	562	380	1355	406	163	208	7280	0
6.	Jhajjar	5	2286	555	407	1290	639	0	43229	0
7.	Sonepat	7	440	828	0	0	1426	863	15427	0
8.	Gurgaon	4	0	492	545	0	133	0	0	0
9.	Mewat	5	0	577	2161	0	265	0	0	0
10.	Faridabad	2	487	14	668	0	134	739	77650	0
11.	Palwal	4	526	721	2210	0	438	0	6724	0
12.	Panipat	5	318	0	0	0	0	0	21429	0
13.	Karnal	6	1043	0	0	0	0	0	87883	0
14.	Kurukshetra	5	1159	0	0	0	0	0	22400	0
15.	Kaithal	6	1474	534	0	0	0	183	14000	0
16.	Ambala	6	1544	0	0	0	0	0	10483	477
17.	Panchkula	4	1448	0	0	911	0	0	5250	920
18.	Yanunanagar	6	1278	0	0	0	0	0	21403	204
19.	Jind	7	785	638	290	0	437	278	21200	0
20	Mahendergarh	5	0	559	0	893	880	0	0	0
21.	Rewari	5	0	743	0	0	63	179	0	0
		119								

Source: http://agriharyana.nic.in/cropwisearea1.htm

Note : '0' indicates no gaps in productivity or no cultivation

New problems like yellow rust in wheat, orobanche weed in mustard and nematodes in wheat & other crops are emerging. The problem of control of *P. minor* weed continues to be a challenge as it has developed resistance against herbicides. These problems have to be managed with the technological interventions. The changing scenario of insects and pests suggests that pesticide use will increase in future. Major diseases and insect pests of various crops in Haryana are given in the table 4.6. To reduce the pesticide application, the use of IPM technology and adoption of resistant varieties need to be accelerated.

Table 4.6: Important insect pests and diseases of major crops in Haryana.

Crops	Insect pests	Diseases
Rice	Root weevil, leaf folder, plant hopper, stem borer, gandhi bug	Blast, bacterial leaf blight, false smut, stem rot
Cotton	Thirps, jassid, leaf hopper, mealybug, spotted bollworm, american bollworm, pink bollworm, hairy caterpillar, smiloopers, white fly and other leaf eating insects.	Leaf spot anthracnose, root rot, leaf curl virus
Surgarcane	Termite, stem borer, root borer black bug, redmite, shoot borer, pyrilla. White fly, tarai borer, gurdaspur shoot borer, Scale pest	Red rot, wilt, smut
Bajra	White grubs, hairy caterphillar, grey weevil, grass hopper	Downy mildew, ergot, smut
Maize	Maize borer, grass hopper and army worm, hairy caterpillar, grey weevil maize thrips and jassids	Maydis leaf blight, banded leaf and sheath blight, post flowering stalk rot, common rust
Kharif Pulses	Hairy caterpillar, flea beetle, jassids, white fly, termite, leaf folder, pod borer	Cercospora leaf spot, bacterial leaf spot, root rot, yellow mosaic
Wheat	Termites, aphids, surface hopper	Yellow rust, brown rust, karnal bunt, black rust, loose smut leaf smut, black point powdery mildew
Rapeseeds and mustard	Mustard sawfly, red hairy caterpillar, aphids/jassids	Alternaria blight, downy mildew, white rust
Sunflower	Cut worm, hairy caterpillar, flower borer	Alternaria blight, root rot and stem rot
Gram	Termite, cut worm, pod borer, black aphid, semi-looper	Wilt, blight, alternaria blight, Escocyta blight, grey mould
Barley	Termite	Covered smut, loose smut, yellow rust, black rust, brown rust

Source: http://agriharyana.nic.in/variouscrops.htm

4.8 Profitability Issues

The rice-wheat rotation has emerged as the most preferred cropping system across Haryana eliminating many of the cropping patterns due to its comparative economic advantages, assured marketing and comparatively stable productivity levels. As a result, rice-wheat cropping system continues to occupy

more than 58% of gross area sown in 2011-12 in the State. Rice-wheat cropping system led to benefits in the initial days of the Green Revolution. These crops are labour intensive and require more water and other inputs. Keeping in view the sustainability aspects, diversification in cropping system needs emphasis. The farmers are hesitant to adopt diversification in agriculture because of marketing problems and therefore, the options are limited to enhance profitability. The sharp decline in net farm profitability is due to increase in the cost of cultivation particularly due to increased cost of inputs, machines and shortage of labor. During the last ten years the cost of production per quintal of major crops has increased by over 2.5 times (Table 4.7). Obviously, cost-cutting technologies will have to be developed.

Table 4.7: Increase in cost of production of major crops (Rs Q/ha)

S. No.	Crop	2002-03	2011-12	Times increase
1.	Paddy (non-*basmati*)	464.32	1206.00	2.6
2.	Paddy (*basmati*)	1033.82	2580.00	2.5
3.	Wheat	464.36	974.00	2.1
4.	Cotton (American)	1242.58	3036.00	2.4
5.	Rapeseed & mustard	850.09	2313.00	2.7
6.	*Bajra*	615.49	-	-

Source: Report Department of Agricultural Economics, CCSHAU

The profitability can be enhanced by adoption of technologies which enhance the input use efficiency and value of the products.

4.9 Supply of Inputs

Farmers have complaints about non-availability of various inputs in time and some times supply of spurious inputs i.e. seed; fertilizers, pesticides etc. These factors adversely affect the productivity of crops.

4.10 Post Harvest/Value Additions

PHT facilities have not been established in the commodity production areas and therefore, most of the produce of the farmers is sold as raw material. This directly reduces the return on investment and also does not generate employment for rural youth.

4.11 Crop Residue Management

A huge quantity of residue of crops in various cropping systems is left unutilized, particularly in rice-wheat system. The farmers are not aware of benefits of its recycling. Unutilized residue causes several problems including insect, disease etc. The crop residues are good sources of plant nutrients and are important components for the stability of agricultural ecosystems. In areas where mechanical harvesting is practised, a large quantity of crop residues is left in the field, which can be recycled for nutrient supply. About 25% of nitrogen (N) and phosphorus (P), 50% of sulphur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources. Traditionally, wheat straw is removed from the fields for use as cattle feed and for other purposes. The rice straw is left

un-utilized. With the advent of mechanized harvesting, farmers have been burning large quantities of crop residues left in the field. As crop residues interfere with tillage and seeding operations for the next crop, farmers often prefer to burn the residue *in situ*, causing loss of nutrients and organic matter in the soil. The Government of Haryana has banned the burning of crop residues, which is a welcome initiative.

4.12 National Food Security Act, 2013

The "National Food Security Act, 2013", passed recently by the Parliament and implemented by Government of Haryana, is an ambitious and rather bold social scheme aiming at both physical and economic access ensuring food and nutrition security. It has placed extra responsibility on the planners, and scientists to enable farmers of Haryana to produce more food grains. This would necessitate making our agriculture more efficient and resilient. Obviously, more attention will have to be paid on development and adoption of cost-effective efficient technologies resilient to climate change, resource management and infrastructure development to enhance productivity and production.

"A nation that is alert should be sensitive to the changes that take place in the technological fabric of the world and prepare itself for the arrival of newer changes on the horizon"

- A.P.J. Abdul Kalam
Ex. President of India

5. SWOT Analysis

In order to tackle the emerging problems, it is necessary to analyse strength, weakness, opportunities and threats (SWOT) of the system as it helps in effective planning and implementation of appropriate strategies. The SWOT analysis for the State, zones and districts suggest that besides some common problems, there are some specific problems of the zones and districts. The over all review indicated that major problems are related to NRM in all the zones besides climatic factors.

5.1 General SWOT Analysis of the State

Strengths

General

- Pro-farmer policies and programmes of the government
- Developed allied sectors like dairying, poultry, fishery, horticulture, mushroom farming, apiary, agro-industry, agro-forestry *etc*.
- Potential for protected cultivation and urban/peri-urban agriculture
- Constitution of Haryana Farmers' Commission to consistently advise the government on issues of farmers and farming
- Scope for agricultural diversification and off-farm job opportunities
- An effective technology transfer system in the State

Specific

- Institutions of repute for agricultural research, human resource development, extension and marketing
- Leading State in adoption of conservation agriculture and farm mechanization
- Integrated farming systems for livelihood security
- Harbours important niche for *basmati* cultivation and is its major exporter
- Pioneer in establishing "State Agriculture Innovation Fund" to promote farmers innovations including good agricultural practices
- Availability of hybrids of maize, *bajra*, cotton and rice from public and private sectors

Weakness

General

- Fragmented and small land holdings with little scope for expansion of area in agriculture
- Shortage of labour at peak crop seasons

- Lack of proper storage, primary processing and cold chain facilities
- Inadequate investment in agricultural R&D
- Weak coordination between different developmental agencies in public and private sector
- Unorganised dairy, farm machinery and horticulture sectors

Specific

- Declining soil health, increasing salinity / sodicity / alkalinity, depleting water table and its quality, rising water table in the arid areas, release of untreated industrial effluent and sewage water in fresh water canals, low soil organic carbon and declining total factor productivity, low level of recycling of organic matter
- Gaps in adoption of recommended package of practices such as balanced nutrient application, use of micro nutrients, weed control, water management, green manuring, bio-fertilizers, vermi-composting, conservation agriculture, IPM approach for plant protection, crop rotation and farm mechanisation
- Problems related to availability of quality inputs, credit, irrigation and power supply in time
- Problems associated with implementation of crop insurance for all commodities and rationalisation of MSP
- Lack of efficient forecasting systems for weather, emergence of diseases and pests and lack of contingent planning to address the vagaries of nature.

Opportunities

General

- Scope for value addition through agro-processing industries with the availability of adequate raw materials and market facilities due to increasing purchasing power and rapid urbanisation
- Scope for promoting minor and micro irrigation system & water harvesting
- Revitalisation of cooperative societies and/or institutional mechanisms for organised credit, marketing and other services
- Scope for better coordination and enhanced investment in agricultural research and development
- Proximity to the national capital region as well as other cities to enter in domestic and international markets
- Good network for transportation of agricultural produce
- Opportunity for investment in agriculture infrastructure such as silos, cold chains, processing industry and minor irrigation through public private partnerships
- Use of information technology for knowledge dissemination

Specific

- International demand for specialty products such as *basmati* rice, baby corn, sweet corn, *guar*, etc.
- Custom hiring for farm mechanisation
- Scope for increasing varietal & seed replacement rates and promotion of hybrid varieties
- Scope for farm residues / waste utilisation and promotion of bio-fertilizers and bio-pesticides
- Capacity building of farmers especially youth and farm women, extension and technical workers

Threats

General

- Diversion of good agricultural land to non-agricultural sector
- Lack of attraction of rural youth towards farming
- Damage to crops by blue bulls, monkeys, wild boars *etc.*
- Increasing competition of agriculture with industry

Specific

- Increasing cost of cultivation rendering farming unprofitable
- Inadequate quality control of inputs
- Incidence of pests, diseases and weeds and development of resistance to herbicides / pesticides
- Paucity of climate resilient varieties/hybrids and technologies
- Lack of required coordination amongst different agencies for agriculture development including exigencies / contingencies

5.2 Zone-wise SWOT Analysis

The State has been divided into three agro-climatic zones. The climatic conditions of zone – I and zone – II are very favorable for intensive farming with application of conservation agriculture. Zone – III represents arid conditions and soil and water management are more crucial. SWOT analysis of different districts presented in comprehensive district agriculture plans was examined and salient elements are consolidated below.

Zone – I (Panchkula, Ambala, Kurukshetra, Yamunanagar, Karnal, Kaithal, Panipat and Sonepat)

Strength

- Rice shellers and sugar mills are in crop production zone
- Vegetable crops like onion and garlic are grown largely due to good planting material/repurchase by NHRDF, Salaru (Kamal).
- Centre of Agricultural institutions such as I.A.R.I regional research centre, C.S.S.R.I., N.D.R.I, N.B.A.G.R, S.B.I., D.W.R, CCS HAU Regional Research Station, etc.

- Good network of canal and tube wells for irrigation
- Farmers are increasingly adopting maize and other income generating crops as diversification
- Soils are fit for intensive cultivation

Weakness

- Non-adoption of IPM, INM, over dependence on pesticides
- Lack of infrastructure facilities to avoid post harvest losses in fruits, vegetables and flowers
- Monoculture of rice –wheat cropping system and its adverse effect on natural assets
- Lack of pulses in crop rotation leading to poor soil health
- Poor management of organic waste
- Low adoption level of FYM, green manuring and vermi-composting and crop/farm residue management

Opportunities

- Promotion of organic manure & compost
- Scope for recycling of organic waste and improvement in soil health
- Scope for diversification in favour of dairy based farming systems, peri-urban and speciality agriculture
- Setting up of turmeric processing plant by Hafed will give thrust to turmeric under popular plantation
- Improving the linkages and synergies with private sector, NGOs and other public sector organizations
- Immense scope for mixed/multiple cropping for higher income and employment generation.

Threats

- Less area under horticulture, agro forestry , pulses and oilseed crops
- Continuous and exhaustive rice-wheat cropping system led to loss of soil fertility
- Poor post harvest technology and poor marketing facilities for vegetables/fruits/flowers
- High residues of pesticides due to indiscriminate use
- Problem of salinity and sodicity

Zone –II (Sirsa, Fatehabad, Hisar, Jind, Rohtak, Faridabad and Palwal)

Strength

- Cotton mills, Sugar mills & rice shellers are available
- *Guar* gum industries in Adampur, Siwani and Moriwala
- Soils are fit for most of the crops
- Well developed grain and vegetable markets

Weakness

- Increasing incidence of new pests and diseases in cotton
- Gaps in adoption of technologies such as seed treatment, imbalanced use of fertilizers and low adoption of IPM
- Declining water table, more than 1-2 feet per year
- Lack of pulses & oilseeds in present crop rotations
- Less adoption of inter cropping of onion, potato and raya in sugarcane

Opportunities

- Unexplored bio-diversity with respect to vegetables and fruit crops
- Established and upcoming marketing, agro-processing and ware housing/ godown facilities in and around the district
- Scope for mushroom, honey and horticultural products
- Agriculture wastes available in abundance which can be recycled to improve soil health and mushroom cultivation

Threats

- Declining total factor productivity and rising cost of cultivation especially in predominant cotton-wheat and paddy-wheat cropping systems
- Use of brackish ground water deteriorating soil health
- Very less area under pulses and oilseed crops
- Presence of affluents and toxic contents of heavy metals in Gurgaon and Agra canals
- Circulation of spurious inputs viz. seeds, weedicides and insecticides in the markets

Zone –III (Bhiwani, Mahendergarh, Rewari, Jhajjar, Gurgaon and Mewat)

Strength

In this zone, ther is a good scope for farmer-industry linkage as :

- Eight gum industries at Bhiwani, Siwani & Tosham
- Twenty five oil expeller at Bhiwani, Charkhi Dadri & Tosham
- Six cotton ginning industries at Bhiwani, Ch. Dadri, Siwani & Tosham
- One HAFED oil mill at Narnaul
- The proximity to the huge market of National Capital of Delhi with road and rail connectivity
- Malt industry at Rewari and Gurgaon

Weakness

- Lesser availability of quality seeds (especially hybrid seeds) of various crops

- Lack of proper knowledge of farmers of modern production, post harvest handling and marketing practices

Opportunities

- Good scope of drip irrigation in cotton, castor, horticultural crops
- Agri-processing units, oil mills and gum factories can be established for employment
- Access to the national and inter-national markets
- Mustard by-product available in abundance which may be recycled as compost/ vermicompost for improving soil health

Threats

- Infestation of *Orobanche* weed in mustard & tomato
- Excessive use of pesticides in vegetables is a concern to food quality

Source: Comprehensive Districts Agriculture Plans (C-DAP)

6. Attainable Potential and Strategies to Enhance Productivity of Crops

The productivity trends of important crops of the State were analysed to find the yield gaps. The major constraints in crop productivity improvement include late sowing, delay in availability of quality inputs, labour shortage, non-availability/high cost of machines and slow pace of mechanisation, imbalanced use of nutrients, poor adoption of IPM, post-harvest losses, depletion in quality & quantity of ground water, increasing soil salinity/alkalinity, erratic/inadequate rainfall, erratic canal water and power supply, increasing incidence of pests, diseases and weeds; non availability of varieties suitable for water stress, heat stress, efficient for nutrient use and conservation agriculture. The key strategies like natural resource management, hybrids development, increase in water and nutrient use efficiency, application of IPM, post harvest management etc. have been emphasized. The crop specific constraints and strategies are discussed below :

6.1 Rice

In Haryana, rice is one of the most important *Kharif* crops having witnessed tremendous increase in area, production and productivity during the last 45 years (Fig. 6.1 and 6.2). The area under cultivation of rice has increased from 1.92 lakh hectares in 1966-67 to 12.15 lakh hectares in 2012-13. The production has gone up from 2.23 lakh tons to 37.59 lakh tons (17times). Productivity has jumped from 11.61 q/ha to 30.44 q/ha (2.4 times). The State is known for the production of good quality scented rice (Fig. 6.3) and super fine quality non-scented rice (Fig. 6.4) and ranks fourth in productivity after Punjab, Tamil Nadu and Andhra Pradesh. During 2010-11, about 65% area of rice was under the cultivation of scented rice and 35% under non-scented rice varieties & hybrids. State contributes substantial quantity of rice (1.84 million tons annually) to the central pool, thus playing an important role in ensuring food security of the nation. Haryana contributes about 60% of the total export of *basmati* rice from the country.

The rice crop is raised by transplanting manually, mostly by hired labour. Most of the area of the crop is under tube-well and canal based irrigation. The nutritional requirement of the crop is met through inorganic fertilizers. Green manuring with *dhaincha* or moong bean and application of farm yard manure is also practised in limited areas to supplement inorganic fertilizers. Use of combine harvester is popular for non-scented dwarf varieties, whereas the scented varieties are manually harvested. In rice growing areas, the major cropping system is rice-wheat. In some areas, rotations like rice-potato and rice-winter vegetables are also followed. The main weeds affecting the crop include *sawank, mesta* and *motha*. The important insect pests and diseases are root weevil, leaf folder, plant hoppers, stem borer, blast, bacterial leaf blight, false smut and stem rot.

Fig. 6.1 - Area (000 hectares) of rice in Haryana

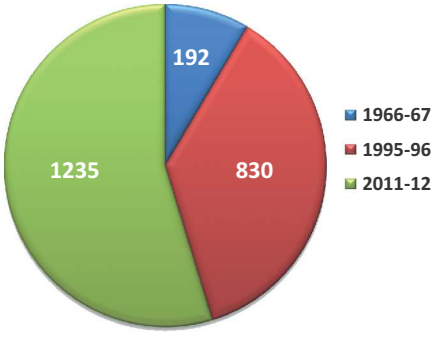
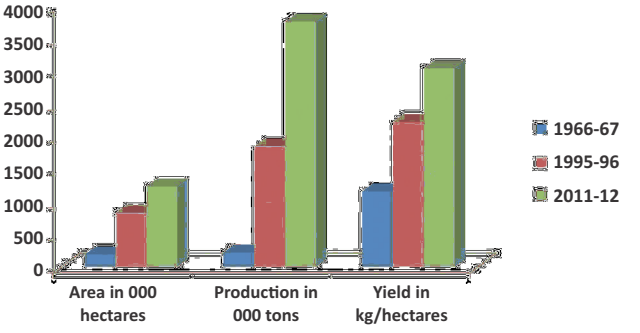
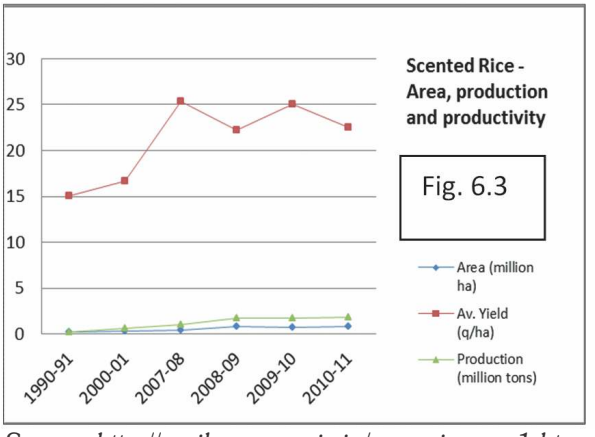
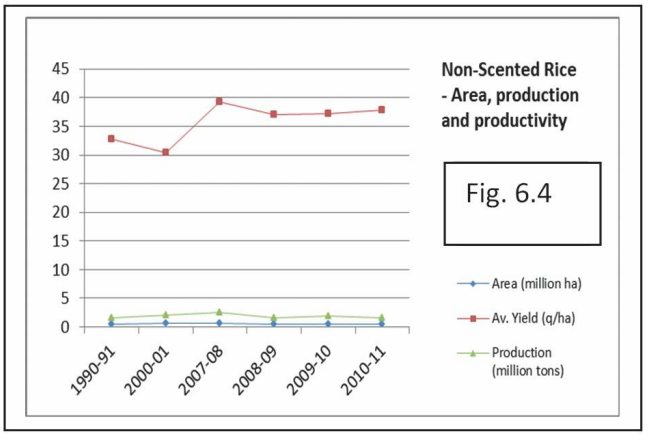


Fig. 6.2 - Area, production and productivity of rice in Haryana







Source: http://agriharyana.nic.in/cropwisearea1.htm

Attainable Potential: The State has been experiencing high fluctuation in rice productivity. For example, in the year 2001, the productivity was 2557 kg/ha. It reached 3361 kg/ha in 2007-08 and declined to 2788 kg/ha in 2010-11. Again, it went up in 201-12 (3044 kg/ha). Zonal level/ district level analysis (Table 6.1, 6.2 & 6.3) reveals that there are significant yield gaps among the districts of a zone. Data available at http://agriharyana.nic.in/cropwisearea1.htm indicates that there are wide gaps in crop yields among the blocks within the district. If the productivity of a district having yield below the State average (3.04 t/ha) is brought at par with the State average and the productivity of districts which are above the State average is brought at the level of district having maximum productivity, the additional 4.71 lakh tons of rice production can be achieved (Table 6.4). It is satisfying that a number of rice varieties in both scented and non-scented classes are available for the farmers. There is a need for their adoption and popularization.

Zone-I

Table 6.1: Estimated production of rice by achieving the targeted productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 3.04 t/ha				**Target to achieve 3.04 t/ha**
Panchkula	2.82	0.22	9	1.98
Kaithal	2.9	0.14	159	22.26
Panipat	2.64	0.4	76	30.4
Sonipat	2.41	0.63	95	59.85
Sub Total				**114.49**
District above State level productivity 3.04 t/ha				**Target to achieve 3.88 t/ha**
Ambala	**3.88**	0	83	0
Kurukshetra	3.79	0.09	121	10.89
Yamunanagar	3.67	0.21	73	15.33
Karnal	3.04	0.84	165	138.6
Sub Total				**164.82**
Overall Increase				**279.31**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-II

Table 6.2: Estimated production of rice by achieving the targeted productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 3.04 t/ha				**Target to achieve 3.04 t/ha**
Hisar	2.57	0.47	43	20.21
Jind	2.58	0.46	115	52.9
Rohtak	2.16	0.88	39	34.32
Faridabad	2.51	0.53	12	6.36
Palwal	2.75	0.29	32	9.28
Sub Total				**123.07**
District above State level productivity 3.04 t/ha				**Target to achieve 3.74 t/ha**
Sirsa	3.22	0.52	63	32.76
Fatehabad	**3.74**	0	87	0
Sub Total				**32.76**
Overall Increase				**155.83**

Data Source:http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.3: Estimated production of rice by achieving the targeted productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 3.04 t/ha				**Target to achieve 3.04 t/ha**
Bhiwani	2.56	0.48	18	8.64
Jhajjar	2.15	0.89	31	27.59
M.Garh	0	3.04	0	0
Sub Total				**36.23**
District above State level productivity 3.04 t/ha		**Target to achieve**		**3.04 t/ha**
Gurgaon	3.04	0	5	0
Mewat	3.04	0	6	0
Rewari	3.04	0	3	0
Sub Total				**0**
Overall Increase				**36.23**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.4: Additional production of rice by bridging the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	114.49 (4)	164.80 (4)	279.31
2.	II	123.07 (5)	32.76 (2)	155.83
3.	III	36.23 (3)	-	36.23
Total estimated additional production of rice				471.37

Note: Values in the parenthesis are the number of districts

Constraints

Non- availability/adoption of potential hybrids

Delayed and prolonged transplanting of rice

Sub-optimal plant population

Low seed replacement rate

Depletion in quality and quantity of ground water and increasing soil salinity / alkalinity

Increasing incidence of pests, diseases and weeds

Labour shortage, slow pace of mechanization, non-availability and high cost of machineries

Action plan

1. Popularization of green manuring through *dhaincha* and balanced use of ferilizers
2. Introduction of short duration varieties of *moong bean* and cowpea for improving soil health in rice-wheat system
3. Increasing area under *basmati* and replacement of rice with maize and soybean as sole crop or intercrop with *arhar* (pigeon-pea) in areas of depleting water table and soils with poor water holding capacity
4. Promotion of abiotic and biotic stress tolerant hybrids and varieties of rice. At least 10-15% areas to be brought under hybrid rice cultivation
5. Training to the farmers for preparation of nursery as per need of rice trans-planter
6. Nursery raising and transplanting dates for paddy not to be before 15th May and 15th June, respectively. The seed replacement rate should be more than 35%
7. The planning and recommendations to be based on resources of the districts/blocks
8. The nitrogen use efficiency to be enhanced by using granulated urea
9. Farmers to be made aware about timely sowing, seed replacement, use of quality inputs, adoption of IPM & integrated weed management practices, improved tillage practices like laser land levelling, zero tillage etc.
10. Promotion of rice trans-planter and other implements to reduce the labour cost. Laser land leveler, zero till multi-crop planter for direct seeding, turbo/happy seeder for residue management to be promoted
11. Focus on residue management and discouraging burning of paddy straw
12. Strengthening public-private partnership for production of quality seed

Researchable Issues

- Need to develop lo water requiring rice varieties/hybrids
- Development of high yielding *basmati* varieties and early maturing hybrids of coarse rice
- Evolve suitable varieties for DSR
- Development and dissemination of efficient techniques for enhancing water and fertilizer use efficiency
- Designing and promotion of cost effective machines and tools, refinement of mechanical trans-planter and nursery raising techniques
- Development of technology for residue management in rice

6.2 Wheat

Wheat is the staple food and main source of energy and nutrition in the Indian diet. Since the creation of Haryana State, remarkable advances have been made in enhancing productivity and production of

wheat. It is contributing substantially to food security in the country. With the adoption of improved technologies, productivity has increased by 3.70 times and production by 12 times during the year 2011-12 as compared to 1966-67 (Fig. 6.5 & 6.6). The record production of 130 lakh tons of wheat from 25.05 lakh hectares during 2011-12 (Fig. 6.6) is a land mark and for the first time, Haryana has attained the first position for two years continuously for the highest wheat productivity in the country. This agricultural transformation and rapid growth in productivity is attributed to the release of several high yielding varieties along with, technological package, enhanced availability of improved seed, fertilizers, better irrigation facilities and overall supportive infrastructure and policy environment.

Fig. 6.5 - Area (000 hectares) of wheat in Haryana

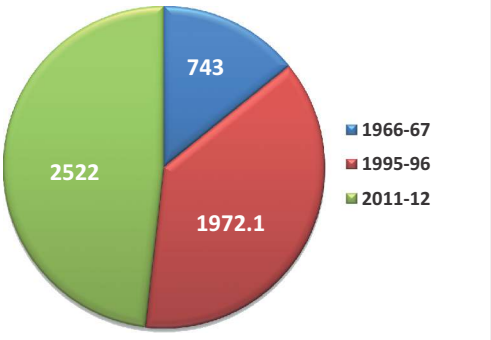
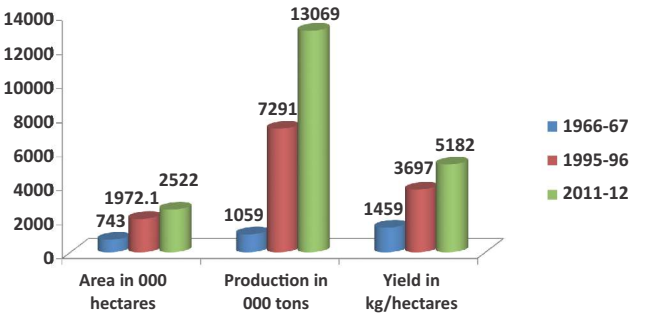


Fig. 6.6 - Area, production and productivity of wheat in Haryana



Source: http://agriharyana.nic.in/cropwisearea1.htm

CCS HAU continues to be one of the leading centres of wheat improvement in the country. The multi-disciplinary and multi-location approach has been successful in providing rich dividends through development of high yielding disease resistant varieties and matching production technologies. It has completely revolutionized wheat production in the State. The university is one of the partners in various ICAR network projects including those related to crop improvement for heat, drought, water-logging and salinity–alkalinity tolerance. The State has promoted varieties of wheat developed by ICAR and other institutions.

The major weeds affecting wheat crop are *Phalaris minor*, wild oats, *Chenopodium* and *Cicer arvensis*. The major insects and diseases include termites, aphids & jassids, surface hopper, rusts, smuts, black point, Karnal bunt and powdery mildew. The yellow rust problem has been noticed in recent years.

Attainable Potential: the focus need to be on enhancing the productivity in the districts performing below the State average. Within a district the block, performing lower than State average, need special attention. By enhancing productivity of lower performing districts the additional production of 1.76 lakh tons from zone– I, 1.44 lakh tons from zone – II and 2.62 lakh tons from zone- III (Table 6.5, 6.6& 6.7) may be achieved. This will add 5.83 lakh tons to the total wheat production of the State (Table 6.8).

Zone-I

Table 6.5: Estimated production of wheat by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 5.18 t/ha				**Target to achieve 5.18 t/ha**
Panchkula	3.59	1.59	16	25.44
Ambala	4.86	0.32	87	27.84
Sub Total				**53.28**
District above State level productivity 5.18 t/ha				**Target to achieve 5.67 t/ha**
Kurukshetra	5.44	0.23	112	25.76
Yamunanagar	5.36	0.31	85	26.35
Karnal	**5.67**	0	172	0
Kaithal	5.45	0.22	173	38.06
Sonipat	5.52	0.15	152	22.8
Panipat	5.55	0.12	87	10.44
Sub Total				**123.41**
Overall Increase				**176.69**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone - II

Table 6.6: Estimated production of wheat by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 5.18 t/ha				**Target to achieve 5.18 t/ha**
Hisar	5.09	0.09	237	21.33
Rohtak	5.02	0.16	103	16.48
Palwal	5.07	0.11	100	11
Faridabad	4.84	0.34	31	10.54
Sub Total				**59.35**
District above State level productivity 5.18 t/ha				**Target to achieve 5.47 t/ha**
Fatehabad	**5.47**	0	189	0
Sirsa	5.36	0.11	299	32.89
Jind	5.23	0.24	217	52.08
Sub Total				**84.97**
Overall Increase				**144.32**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.7: Estimated production of Wheat by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 5.18 t/ha				**Target to achieve 5.18 t/ha**
Bhiwani	4.31	0.87	151	131.37
Jhajjar	4.86	0.32	99	31.68
Gurgaon	4.96	0.22	52	11.44
Mewat	4.39	0.79	71	56.09
M.Garh	4.61	0.57	41	23.37
Rewari	5.02	0.16	48	7.68
Sub Total				**261.63**
District above State level productivity 5.18 t/ha				**Target to achieve 5.18 t/ha**
Overall Increase				**261.63**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.8: Additional production of wheat by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	53.28 (2)	123.41 (6)	176.69
2.	II	59.35 (4)	84.97 (3)	144.32
3.	III	261.63 (6)	-	261.63
Total estimated additional production of wheat				**582.64**

Note: Values in the parenthesis are the number of districts

Constraints

Delayed sowing

Adverse effect of terminal heat on grain filling

Development of herbicide tolerance in weeds

Increasing incidence of yellow rust and nematodes. (Ambala, kurukshetra, Karnal, Kaithal, Panchkula are most vulnerable districts)

Non availability of varieties suitable for conservation agriculture and efficient for water & nutrient use

Some times water for irrigation is not timely available

Action Plan

- Emphasis on timely sowing, compulsory seed treatment and adoption of suitable varieties of

recommended for different agro-climatic conditions, avoid delayed sowing

- Ensuring timely availability of quality inputs and irrigation water
- Adoption of resource conservation technologies (RCT) like use of laser land leveling, surface seeding, zero-till-sowing, furrow irrigated raised bed-planting system (FIRBS), residue management in zero till systems using new planters like turbo seeder, use of slow release fertilizer etc., which have given significant yield increase and reduction in cost of cultivation
- Seed Replacement Rate (SRR) over 50% to be maintained and balanced use of fertilizers need to be emphasized
- Utilization of off-season nursery facility for rapid generation advancement, seed multiplication and screening for diseases
- Trans-boundary disease and pests surveillance network need to be developed to address possible out-breaks of new races of diseases especially stripe rust, leaf rust, stem rust, foliar blight etc.

Researchable Issues

Development of varieties tolerant to terminal heat and salinity, resistant to diseases including yellow rusts, nematodes and resistant to lodging

Evolve varieties for short duration, zero tillage and suited for low input conditions

Emphasis on hybrids development

Development of package of practices to enhance the water and fertilizer use efficiency

Effective and low cost storage technology

6.3 Barley

Barley is mainly used as industrial raw material for malting and brewing, and also as cattle feed. Barley may also be utilized as green fodder under water scarcity conditions. In modern times, it is preferred as health food in urinary as well as diabetic problems. The average yield has increased from 13.13 q/ha in 1966-67 to 36.33 q/ha in 2011-12 (Fig. 6.7 & 6.8). The increase in productivity is due to adoption of lodging resistant high yielding varieties. Overall area under barley has declined, which may be attributed to expansion of

Fig. 6.7 - Area (000 hectares) of barley in Haryana

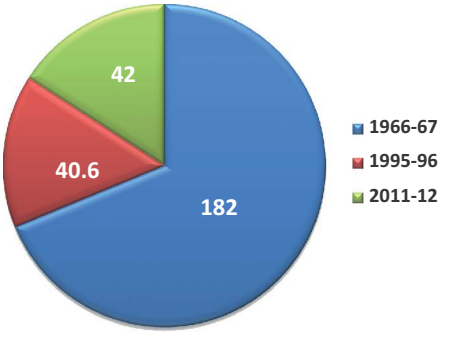
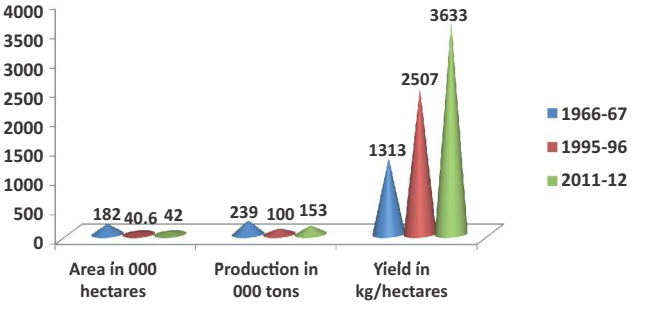


Fig. 6.8 - Area, production and productivity of barley in Haryana



Data Source: *http://agriharyana.nic.in/cropwisearea1.htm*

irrigation facilities and large scale adoption of high yielding varieties of wheat by the farmers. However, it has maintained its place in cropping patterns of western zone of the State where adequate irrigation facilities are not available and in eastern zone where soils are affected by salts. The area under barley may increase because of its industrial use and increasing demand in health food products. Major pests and diseases affecting barley include termite, *aphids*, smuts and rusts.

Attainable Potential: By enhancing productivity of lower performing districts, the additional production 2.91 and 13.07 thousand tons from zone – II and zone – III (Table 6.9 & 6.10) may be achieved adding to a total of 15.98 thousand tons (Table 6.11) to the total production of the State. Zone – I has negligible area under barley cultivation and hence, strategy for enhancing production in zone II and III are summarized in tables 6.9 and 6.10.

Table 6.9: Estimated production of barley by achieving the target productivity in Zone-II (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 3.63 t/ha				**Target to achieve 3.63 t/ha**
Rohtak	3.14	0.49	2	0.98
Faridabad	0	3.63	0	0
Sub Total				**0.98**
District above State level productivity 3.63 t/ha				**Target to achieve 3.95 t/ha**
Hisar	3.75	0.2	4	0.8
Fatehabad	3.85	0.1	3	0.3
Sirsa	3.87	0.08	7	0.56
Palwal	**3.95**	0	1	0
Jind	3.68	0.27	1	0.27
Sub Total				**1.93**
Overall Increase				**2.91**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Constraints

Inadequate availability of quality seeds

Less profitability compared to wheat

Lack of farmer friendly contract farming system

Action Plan

Compulsory Seed treatment

Promotion of suitable crop production, protection and management practices to reduce the yield gap

Production of quality seed and its timely availability to farmers

Farmer-industry connect for production, value addition and marketing

Zone-III

Table 6.10: Estimated production of barley by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 3.63 t/ha				**Target to achieve 3.63 t/ha**
Bhiwani	3.29	0.34	13	4.42
M.Garh	2.34	1.29	1	1.29
Sub Total				**5.71**
District above State level productivity 3.63 t/ha				**Target to achieve 4.71 t/ha**
Jhajjar	3.7	1.01	5	5.05
Gurgaon	**4.71**	0	2	0
Mewat	3.94	0.77	1	0.77
Rewari	3.94	0.77	2	1.54
Sub Total				**7.36**
Overall Increase				**13.07**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.11: Additional production of barley by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	0	0	0
2.	II	0.98 (2)	1.93 (5)	2.91
3.	III	5.71 (2)	7.36 (4)	13.07
Total estimated additional production of barley				**15.98**

Note: Values in the parenthesis are the number of districts

Researchable Issues

- Development of high yielding, lodging resistant, disease resistant two rowed barley varieties for malt industry with suitable package of practices
- Development of barley varieties suitable for fodder/ dual purpose
- Refinement of crop production, protection and management practices so as to reduce the yield gap
- Processing enabled barley varieties for food industry
- Development of high yielding barley hybrids resistant to pests and diseases

6.4 Maize

Maize is the third important cereal crop in India after rice and wheat. This crop is considered as one of the potential crops to break R-W rotation in Haryana. It can be cultivated throughout the year during *kharif, rabi* and spring seasons. The demand for maize is increasing every year due to the expansion of maize based industries and change in food habits. In Haryana, maize occupied an area of 9,000 ha in 2011-12 (Fig. 6.9) with the productivity of 26.66 q/ha (Fig. 6.10). Area under cultivation is increasing during spring season after harvesting of potato and sugarcane *ratoon* crop.

Fig. 6.9 - Area (000 hectares) of maize in Haryana

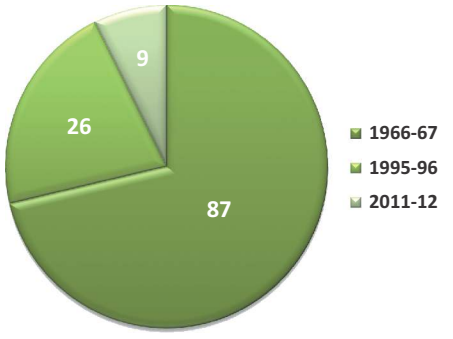
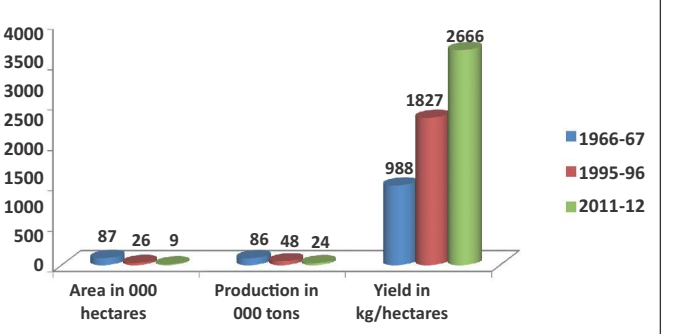


Fig. 6.10 - Area, production and productivity of maize in Haryana



Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Maize research is being carried out at CCS HAU, Regional Research Station, Karnal under the aegis of AICRP on maize. This station has played a leading role in the development of single cross hybrids and productive inbred lines with resistance to major biotic and abiotic stresses. The superiority of single cross maize hybrids is due to their high productivity, uniformity, high yield potential, faster germination, less seed requirement/ha, better tolerance / resistance to biotic and abiotic stresses, easy seed production and high acceptability among farmers. The single cross hybrid technology developed at Karnal station catalysed its adoption by other maize research centres of the country. The germplasm from exotic and indigenous sources have been utilised in the development of new inbred lines. Over 450 inbred lines have been developed by this centre having different desirable traits.

Production and protection technologies and seed production for single cross hybrids, maize inter-cropping and product recipes of baby corn have also been developed. It has also registered 50 inbred lines with National Bureau of Plant Genetic Resources, New Delhi and shared these inbred lines with other research centres of the country. The progressive farmers are being trained in maize and baby corn production technologies which is expected to help in increasing farmers' income.

Attainable Potential : There is no cultivation of maize in zone – II and zone – III. However, maize cultivation can be promoted in each zone except some districts of zone – III. Additional production of maize (1.81 thousand tons) can be achieved by enhancing the productivity of lower performing districts in zone – I. (Table 6.12 & 6.13).

Zone-I

Table 6.12: Estimated production of maize by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 2.67 t/ha				**Target to achieve 2.67 t/ha**
Panchkula	2.47	0.2	6	1.2
Kurukshetra	0	2.67	0	0
Karnal	0	2.67	0	0
Kaithal	0	2.67	0	0
Panipat	0	2.67	0	0
Sub Total				**1.2**
District above State level productivity 2.67 t/ha				**Target to achieve 2.98 t/ha**
Ambala	**2.98**	0	1	0
Yamunanagar	2.68	0.3	1	0.3
Sonipat	2.67	0.31	1	0.31
Sub Total				**0.61**
Overall Increase				**1.81**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.13: Additional production of maize by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	1.2 (5)	0.61 (3)	1.81
2.	II	0	0	0
3.	III	0	0	0
Total estimated additional production of maize				**1.81**

Note: Values in the parenthesis are the number of districts

Constraints

Lack of value addition, processing, post harvest technology and marketing support for speciality corn

Blue bull and wild boar menace

Lack / slow pace of development of machines and tools for maize cultivation

Action Plan

Public-Private Partnerships to be encouraged for the development of single cross hybrids and also for the development of processing and dissemination of technologies. (Since maize has

multiple uses like poultry feed, processed food and nutritional animal feed, use for starch etc, collaboration with industries should be promoted)

Increasing area under specialty corn like QPM, baby corn and sweet corn through contract farming

Timely availability of quality hybrid seed and other inputs

Mechanization for timely operations *viz.,* sowing, inter-culture, earthing up, harvesting, shelling and residue recycling

Special thrust to increase the area under winter maize

Zero-tillage during winter under rice-maize systems for timeliness in planting and reduced cost of production

Researchable Issues

Development of single cross hybrids of different maturity groups of normal and specialty corns *viz.,* QPM, baby corn, sweet corn, popcorn, high oil corn etc

Cold/frost tolerant winter maize

Development of productive inbred lines having resistance to biotic and abiotic stresses for economic seed production

Development of agro-techniques for single cross hybrid seed production and commercial cultivation for *kharif, rabi*, spring and intercropping

Development of efficient machinery for mechanization

Development of value addition, processing and post harvest technologies

6.5 *Bajra*

Bajra or pearlmillet *(Pennisetum glaucum)*, is the staple food and fodder crop grown in marginal environments in arid and drier semi-arid regions of the country. This is a C4 crop having high carbon fixing properties. It is a rich source of fibres and mineralsespecially iron, calcium and Zn. The major *bajra* growing States are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana contributing 6.71% of the *bajra* area of the country. It is a widely cultivated crop in Haryana after rice and wheat. In Haryana, it occupies 0.57 million hectares area (Fig. 6.11) with the average yield of 20.40 q/ha in 2011-12 (Fig. 6.12). It is mainly grown in the districts of Hisar, Fatehabad, Sirsa, Bhiwani, Jind, Jhajjar, Rohtak, Gurgaon, Rewari, Mahendergarh, Mewat and Faridabad. Insects and diseases affecting the crop include white grubs, hairy caterpillar, grey weevil, downy mildew, ergot, smut etc. The Policy Paper No 2 of NRAA on pearl millet indicates that there is increasing trend of alternate use of pearl millet e.g. brewing, alcohol production, poultry & animal feed, fodder, roof material, baked products, flakes and pops, weaning & health foods and drinks. Due to its nutritional properties, its demand in global market is also increasing. The per cent market surplus ratio of *bajra* in Haryana is continuously increasing. It was over 82% in 2008-09 indicating more availability of grains in the market. Through the organized marketing and collaboration with industry, the farmers can take advantage of new emerging trends.

Fig. 6.11 - Area (000 hectares) of *bajra* in Haryana

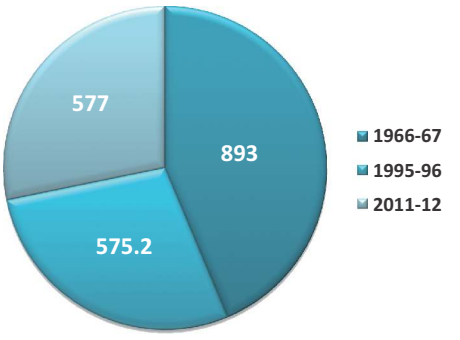
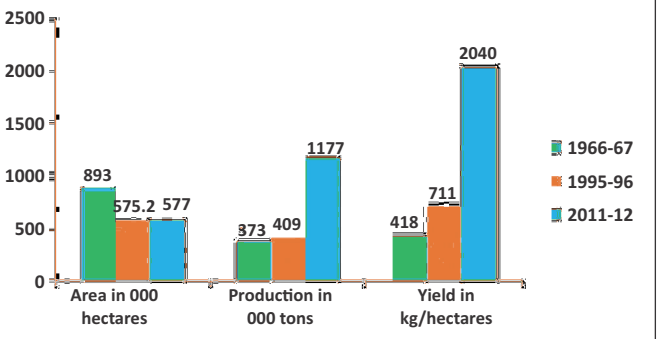


Fig. 6.12 - Area, production and productivity of *bajra* in Haryana



Data Source: *http://agriharyana.nic.in/cropwisearea1.htm*

Attainable Potential : The districts/ blocks which are performing below the State average should be targeted to enhance the productivity and within the district, the block performing lower than State average, be embattled. With enhancing productivity of lower performing districts the additional production 3.48, 10.96 and 73.19 thousand tons can be achieved from zone – I, zone – II and zone- III, respectively (Table 6.14, 6.15& 6.16) adding to a total of 87.63 thousand tons (Table 6.17) to the total production of the State.

Zone-I

Table 6.14: Estimated production of *bajra* by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 2.04 t/ha				**Target to achieve 2.04 t/ha**
Kurukshetra	0	2.04	0	0
Panipat	0	2.04	0	0
Sub Total				**0**
District above State level productivity 2.04 t/ha				**Target to achieve 2.47 t/ha**
Panchkula	2.04	0.43	1	0.43
Ambala	2.04	0.43	1	0.43
Yamunanagar	2.04	0.43	1	0.43
Karnal	2.04	0.43	1	0.43
Kaithal	**2.47**	0	6	0
Sonipat	2.31	0.16	11	1.76
Sub Total				**3.48**
Overall Increase				**3.48**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-II

Table 6.15: Estimated production of *bajra* by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 2.04 t/ha				**Target to achieve 2.04 t/ha**
Rohtak	1.96	0.08	20	1.6
Faridabad	1.52	0.52	4	2.08
Palwal	1.93	0.11	8	0.88
Sub Total				**4.56**
District above State level productivity 2.04 t/ha				**Target to achieve 2.23 t/ha**
Hisar	2.19	0.04	45	1.8
Fatehabad	**2.23**	0	5	0
Sirsa	2.13	0.1	4	0.4
Jind	2.08	0.15	28	4.2
Sub Total				**6.4**
Overall Increase				**10.96**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.16: Estimated production of *bajra* by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 2.04 t/ha				**Target to achieve 2.04 t/ha**
Bhiwani	1.74	0.3	171	51.3
Jhajjar	1.91	0.13	38	4.94
Mewat	1.89	0.15	25	3.75
Sub Total				59.99
District above State level productivity 2.04 t/ha				**Target to achieve 2.34 t/ha**
Gurgaon	2.21	0.13	32	4.16
M.Garh	2.26	0.08	113	9.04
Rewari	**2.34**	0	63	0
Sub Total				**13.2**
Overall Increase				**73.19**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.17: Additional production of *bajra* by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	0 (2)	3.48 (6)	3.48
2.	II	4.56 (3)	6.4 (4)	10.96
3.	III	59.99 (3)	13.2 (3)	73.19
Total estimated additional production of bajra				**87.63**

Note: Values in the parenthesis are the number of districts

Constraints

Low adoption of production technology

Poor plant stand and quality of seed

Predominantly rainfed crop

Unorganized market for *bajra*

Action Plan

- Large scale promotion of high yielding early maturing hybrids tolerant to drought
- Development of hybrids utilising diversified sources of CMS lines and superior restorers
- Application of appropriate agronomic practices such as optimum seed rate, timely sowing, optimum plant population, IPM, EMM, IWM, etc.
- Strategy to have 100% seed replacement and balanced use of fertilizers
- Strengthening of public-private partnerships for hybrid research and seed production.
- Ensure one supplemental/life/crop saving irrigation

Researchable Issues

- Since the use of *bajra* in industry is increasing, the hybrids (suited to industry) having extended shelf-life and reduced anti-nutritional factors need to be developed
- Downy mildew resistant, drought/heat tolerant and short duration hybrids need to be developed
- Hybrids having minimum losses from birds are required
- Feasible technology for post harvest processing, value addition and development of quality products need to be developed

6.6 Oilseeds

Rapeseed-mustard crops in India comprise traditionally grown indigenous species, namely toria (*Brassica campestris* L. var. toria), brown sarson (*Brassica campestris* L. var. brown sarson), yellow sarson (*Brassica campestris* L. var. yellow sarson), Indian mustard (*Brassica juncea* (L.), black mustard (*Brassica nigra*) and taramira (*Eruca sativa/vesicaria Mill.*). Rapeseed-mustard occupied 0.53 million hectare area (Fig. 6.13) with 0.74 million tons production and 13.96 q/ha average yield in Haryana in the year 2011-12 (Fig. 6.14). Additionally, non-traditional species like gobhi sarson (*Brassica napus* L.)

and Ethiopian mustard or *Karan rai* (*Brassica carinata*) are also cultivated. Rapeseeds and mustard, occupying about 95% of the total area under oilseeds, is the major oilseed crops of the State. Sunflower, sesame, groundnut, soybean and castor also have good potential for growth in the State. Pests and diseases affecting oilseeds amongst others include red hairy caterpillar, *aphids / jassids,* mustard sawfly, *alternaria* blight, downy mildew, white grub and white rust.

Fig. 6.13 - Area (000 hectares) of *rabi* oilseeds in Haryana

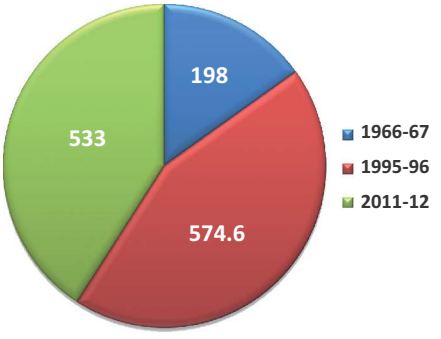
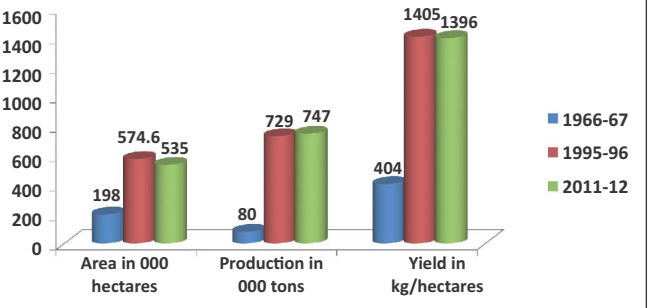


Fig. 6.14 - Area, production and productivity of *rabi* oilseeds in Haryana



Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Attainable Potential : The production and productivity of lower performing districts can be enhanced and additional production of 2.34 thousand tons from zone–I, 21.72 thousand tons from zone–II and 117.9 thousand tons from zone-III (Table 6.18, 6.19& 6.20) can be achieved adding to a total of 141.96 (Table 6.21) thousand tons to the total production of the State.

Zone-I

Table 6.18: Estimated production of *rabi* oilseeds by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 1.39 t/ha				**Target to achieve 1.39 t/ha**
District above State level productivity 1.39 t/ha				**Target to achieve 1.65 t/ha**
Panchkula	1.39	0.26	1	0.26
Ambala	1.39	0.26	1	0.26
Kurukshetra	1.39	0.26	2	0.52
Yamunanagar	1.39	0.26	2	0.52
Karnal	1.39	0.26	1	0.26
Kaithal	1.39	0.26	1	0.26
Sonipat	**1.65**	0	2	0
Panipat	1.39	0.26	1	0.26
Sub Total				**2.34**
Overall Increase				**2.34**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-II

Table 6.19 : Estimated production of *rabi* oilseeds by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 1.39 t/ha				**Target to achieve 1.39 t/ha**
District above State level productivity 1.39 t/ha				**Target to achieve 1.87 t/ha**
Hisar	1.71	0.16	60	9.6
Fatehabad	**1.87**	0	9	0
Sirsa	1.68	0.19	35	6.65
Rohtak	1.52	0.35	13	4.55
Palwal	**1.87**	0	3	0
Faridabad	1.67	0.2	1	0.2
Jind	1.69	0.18	4	0.72
Sub Total				**21.72**
Overall Increase				**21.72**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.20: Estimated production of *rabi* oilseeds by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 1.39 t/ha				**Target to achieve 1.39 t/ha**
Bhiwani	1.2	0.19	170	32.3
M.Garh	0.82	0.57	98	55.86
Sub Total				**88.16**
District above State level productivity 1.39 t/ha				**Target to achieve 2.02 t/ha**
Jhajjar	1.59	0.43	29	12.47
Gurgaon	**2.02**	0	13	0
Mewat	1.79	0.23	25	5.75
Rewari	1.84	0.18	64	11.52
Sub Total				**29.74**
Overall Increase				**117.9**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.21: Additional production of oilseeds by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	0	2.34 (8)	2.34
2.	II	0	21.72 (7)	21.72
3.	III	88.16 (2)	29.74 (4)	117.9
Total estimated additional production of oilseeds				**141.96**

Note: Values in the parenthesis are the number of districts

Constraints

- Oilseed crops are mainly grown under rainfed and marginal conditions
- Narrow genetic base for important traits
- Increased incidence of white rust, aphids, *orobanche* and weeds
- High temperature during crop establishment and frost damage during reproductive phase
- Poor mechanisation especially for harvesting and threshing
- Non availability of quality seeds especially in groundnut and crop damage due to white grub

Action Plan

- Promotion of only high yielding early varieties /hybrids
- Promotion of short duration paddy – toria – wheat or paddy – mustard crop rotation
- One supportive irrigation, preferably using sprinklers.
- Popularizing ridge seeder under rainfed areas and promotion of mechanisation
- Use of recommended dose of fertilizers specifically, sulphur and phosphorus.
- Promoting seed cluster / seed villages concept especially for groundnut seed production

Researchable issues

- Soybean, sunflower, groundnut and castor should also receive due attention of researchers as the State has potential to grow these crops
- Research on the development of varieties/hybrids on rapeseed-mustard need renewed emphasis as it is major oilseeds crop of the State. Develop high yielding, disease resistant and cold & frost tolerant hybrids/ varieties for different agro-climatic conditions
- Developing varieties with low *erucic* and *glucosinolate* content in oil in toria and rapeseed mustard
- Development and implementation of cost effective technologies e.g. sowing by ridger seeder
- Development of integrated management practices for weed, natural resources, nutrients and pests & diseases

6.7 Pulses

The country has witnessed record production of 18 million tons of pulse crops from 26.2 million hectare area during the year 2010-11. Haryana produces 1.8 lakh tons of pulses from 1.8 lakh hectare of land. *Arhar*, *moong* bean and *urd bean* are main *kharif* crops and chickpea (gram) is major pulse crop of *rabi* season.

Rabi is the main season for pulse crop production, the major share of which goes to chickpea. It is grown in about 73% of the total area under pulses and accounts for 75% of the total pulses production of the State. Other *rabi* pulses occupy about 4.0% of the total area and production (Fig. 6.15). The contribution of *kharif* pulses is 23% in area and 21% in production of the total pulses (Fig. 6.16).

Fig. 6.15 - Area, production and productivity of *rabi* pulses in Haryana

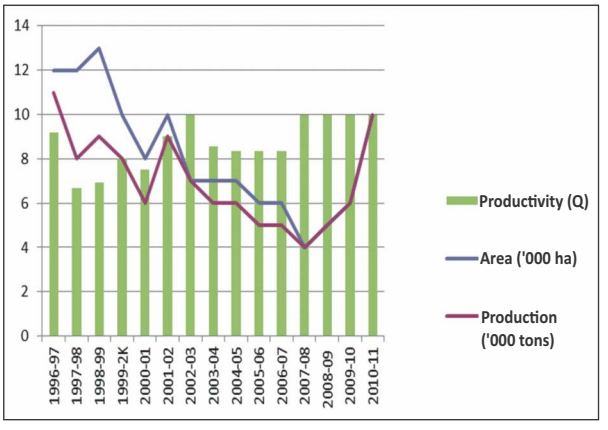
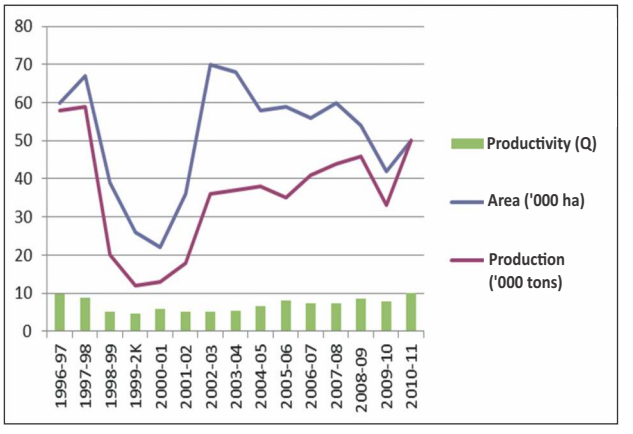


Fig. 6.16 - Area, production and productivity of *kharif* pulses in Haryana



There has been drastic reduction in area under gram (Fig. 6.17) and accordingly affected the production and productivity of gram (Fig. 6.18).

Fig. 6.17 - Area (000 hectares) of gram in Haryana

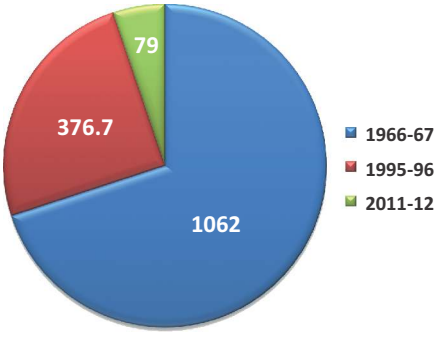
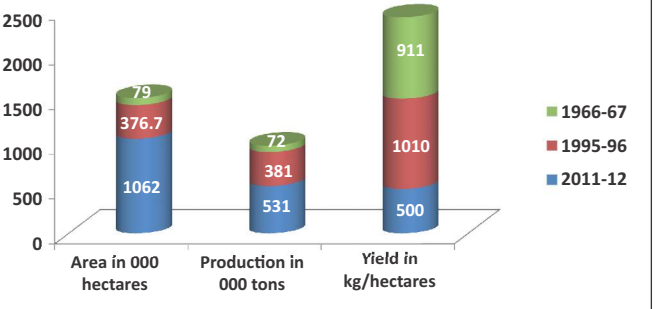


Fig. 6.18 - Area, production and productivity of gram in Haryana



Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Attainable Potential : Enhancing productivity of pulses is a national issue. The potential of varieties exists and that can be harnessed by technological interventions. In Haryana an additional production of 7.05 thousand tons (Table 6.24) in pulses can be achieved by enhancing productivity of lower performing districts in zone – II and zone- III (Table 6.22& 6.23). There is no cultivation of pulses in zone – I. There should be emphasis on inclusion of pulses in crop rotations either as sole crop or inter crop.

Zone-II

Table 6.22: Estimated production of gram by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity .9 t/ha				**Target to achieve .9 t/ha**
Hisar	0.83	0.07	14	0.98
Palwal	0	0.9	0	0
Faridabad	0	0.9	0	0
Jind	0	0.9	0	0
Sub Total				**0.98**
District above State level productivity .9 t/ha				**Target to achieve 1.32 t/ha**
Fatehabad	1.2	0.12	1	0.12
Sirsa	0.97	0.35	7	2.45
Rohtak	**1.32**	0	1	0
Sub Total				**2.57**
Overall Increase				**3.55**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.23: Estimated production of gram by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity .9 t/ha				**Target to achieve .9 t/ha**
Bhiwani	0.88	0.02	47	0.94
Jhajjar	0	0.9	0	0
Gurgaon	0	0.9	0	0
Rewari	0	0.9	0	0
Sub Total				**0.94**
District above State level productivity .9 t/ha				**Target to achieve 1.29 t/ha**
Mewat	**1.29**	0	1	0
M.Garh	0.97	0.32	8	2.56
Sub Total				**2.56**
Overall Increase				**3.5**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.24: Additional production of gram by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	0	0	0
2.	II	0.98 (4)	2.57 (3)	3.55
3.	III	0.94 (4)	2.56 (2)	3.5
Total estimated additional production of gram				**7.05**

Note: Values in the parenthesis are the number of districts

Constraints

- Narrow genetic base
- Highly sensitive to biotic and abiotic stresses and vulnerable to heavy losses
- Low seed and varietal replacement
- Post harvest losses and inadequate storage facilities
- Fluctuating prices
- Poor seed setting

Action Plan

- There should be emphasis on inclusion of pulses in crop rotations as intercropping/intra-cropping
- Promotion of hybrids of pigeon pea
- Promotion of cultivation of improved varieties of *Kabuli* gram
- Promotion and adoption of improved package of practices to improve seed setting and yield
- Popularization of improved short duration, disease resistant varieties of various pulses through large scale field demonstrations to overcome existing yield gaps (25-30%)
- At least 50% area of rice-wheat system to be covered with new short duration disease resistant varieties of *moong* bean in between (catch crop) the two crops
- Use of *rhizobium* culture and bio-fertilizers to be promoted
- Use of sulphur and other micronutrients in deficient regions to be popularized. (The striking 20-30% increase in pulse yield has been obtained with the application of Sulphur and Zinc)
- Promotion of IPM technology
- One life saving irrigation or supplemental irrigation so as to enhance production substantially

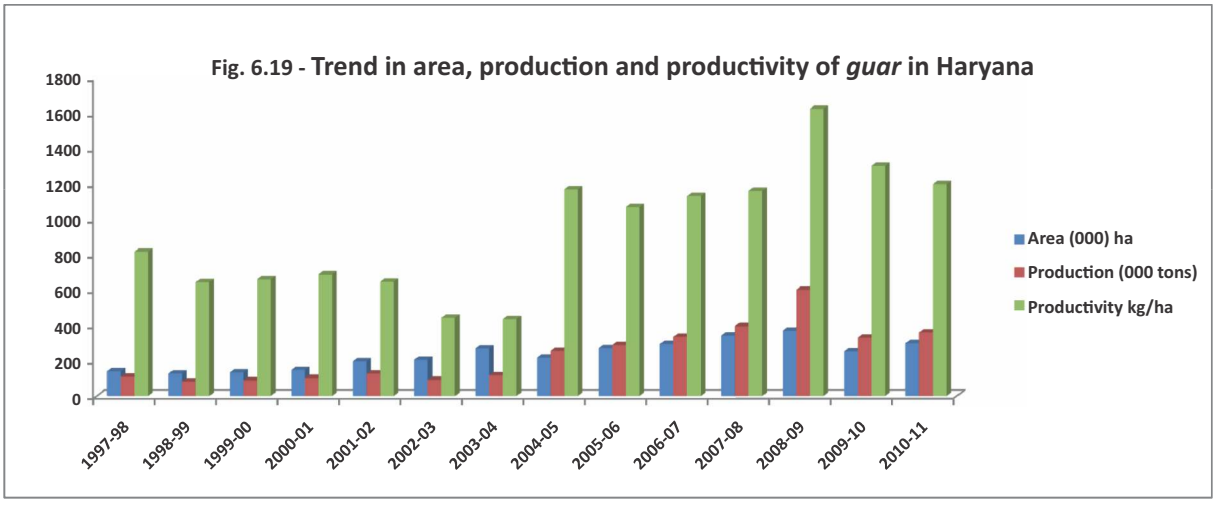
Researchable Issues

- More emphasis to be given on the development of high yielding varieties in *Kabuli* gram, lentil, *arhar, moong* bean etc.
- Development of varieties with resistance to disease, insect pests, drought & salinity and suited to sole and intercropping

- Germplasm collection and utilization in breeding programme
- Assessment of nutritional and anti-nutritional components, bio-fortification and improving bio-availability of iron and zinc in pulses
- Development of drought and disease resistant varieties (Yellow Vein Mosaic and Pod Borer).
- Development of IPM technology for different crops and regions

6.8 *Guar*

Guar / Cluster bean (*Cyamopsis tetragonoloba* L Taub) is native to the Indian subcontinent. It is a rain fed crop and is sensitive to salinity and water logging but responds to irrigation under low moisture conditions. India accounts for 80% of the total *guar* production in the world and is the largest exporter to over 65 countries. The foreign exchange of Rs. 5.0 crores earned in 1971-72 has exponentially increased to Rs. 2805 crores in 2010-11. *Guar* is grown in Rajasthan, Gujarat, Haryana and Punjab. In Haryana, it is cultivated in south west districts *viz*., Bhiwani, Gurgaon, Mewat, Mahendergarh, Rewari, Hisar, Fatehabad and Sirsa. Though Rajasthan ranks first in respect of both area and production, Haryana contributes to nearly 30 per cent of the country's *guar* production from an area of merely 9% (3 lakh hectare) with production of 3.6 lakh tons and productivity of 1300 kg per hectare (2010-11) (Fig. 6.19).



This increased productivity is due to development and release of high yielding short duration *guar* varieties *viz*., HG 365, HG 563, HG2 20, HG 884, HG 870, RGC 936. Most of the varieties developed by CCS HAU are high yielding with export quality gum content.

Guar Products and By-products

The most important industrial use of *guar* is in the form of *guar* gum. Approximately 90% of total *guar* produce is used for production of *guar* gum and rest is used for culinary purposes and cattle feed etc. A by-product of *guar* processing is *guar* meal (mixture of husks and germ) which is a potential source of protein. It is used for cattle as well as poultry feeding. *Guar* gum is derived from *guar* seed. The *guar* seed is typically made up of 40 to 46% germ, 38 to 45 % endosperm and 14-16 % husk. The gum is obtained from grounded seed which has a vast range of industrial applications. Fifty to fifty five percent *guar* gum

is used in oil drilling, textile, paper, explosives, mining, water treatment and fire fighting while 35-40 % is used in frozen foods, bakery, dairy products, canned foods, dressing, instant mixer, beverage and pet foods. The pharmaceutical use of *guar* gum is around 5% mainly for laxative, slimming aids, diabetic patients, tablet preparations, ointments etc. and the rest 5% is used for cosmetics and miscellaneous items (like mosquito coils). *Guar* beans have a large endosperm that contains galactomannan gum, a substance which forms a gel in water, and being natural gelling agent have several utilities for industrial purposes like thickening agent, emulsifying additive, stabilizer, bonding agent, hydrocolloid, flocculant, fracturing agent and natural fibre. The consumption pattern of *guar* seed is largely influenced by demand from the petroleum sector/ industry of USA and the oil fields in the Middle East. *Guar*, as a crop, has the potential to give higher returns with bare minimum inputs and to earn foreign exchange from its by-products which find diversified uses and applications.

Constraints

- Cultivation on marginal soils with low input and suboptimal plant population and sensitivity to water logging and salinity
- Susceptibility to diseases & pests and weed problems
- Very low seed replacement rate (0.1%), poor viability of seeds, and use of non-descriptor seed due to non-availability of quality seeds of recommended varieties
- Poor value addition
- Uncertainty in price as there is no MSP and inadequate market intelligence

Action Plan

- Promotion of high yielding and short duration genotypes with high and good quality gum possessing resistance to biotic and abiotic stresses
- Promoting suitable technologies and package of practices for different seasons and intercropping and integrated diseases, pests and weed management
- Popularisation of improved varieties and enhancement of seed replacement rate
- Training and capacity building of farmers for adoption of improved package of practices
- Awareness programmes for value addition and diversified use of *guar* including concentrated feeds like de-oiled cakes, *guar* meal etc.
- Regular interaction of farmers, policy makers, scientists and industries for re-orientation of research and extension. (It will also help in promotion, export and marketing of gum and other value added products)
- Rationalisation of pricing, MSP and effective market intelligence

Researchable Issue

- Development of varieties having resistance to disease, insect pests with quality required by industry
- Promotion of technology for the production of good quality *guar* seeds
- Development of package of practices for various agro-climatic conditions

6.9 Cotton

Globally, cotton is planted in diverse farming system on an area of 33-35 million hectares, representing less than 2.5% of the world's arable land. It is a fibre, fuel, feed and oil crop.

India occupies maximum area under cotton (12.2 million hectare) and accounts for 28% of the world acreage. It is second to China in cotton production (35.5 million bales) and contributes to 21% of the world harvest. India is the only country in the world where all four species of cotton *viz.*,*Gossypium hirsutum, G. arboreum, G. herbaceum* and *G. barbadense* are cultivated commercially. The area, production and productivity have undergone a sea change after the launch of Cotton Technology Mission and introduction of GM cotton hybrids.

It is a major cash crop of Haryana State in *kharif* season. It occupies 6.03 lakh hectare area, constituting 4.95% of total cotton area of the country. However, some progressive farmers are producing even more than 35 to 40 q/ha of cotton. There is immense scope to increase the productivity of cotton in the State by adopting improved technology with timely operation similar to States like Punjab and Gujarat. The area, production and productivity are shown in Fig. 6.20 & 6.21.

Fig. 6.20 - Area (000 hectares) of cotton in Haryana

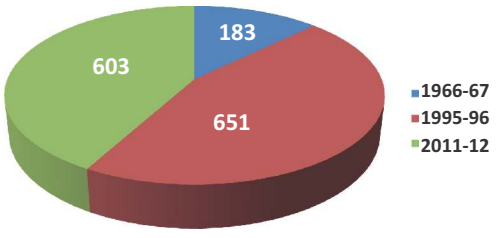
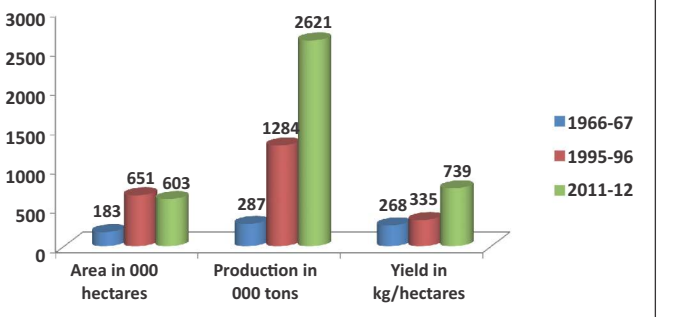


Fig. 6.21 - Area, production and productivity of cotton in Haryana



Data Source: http://agriharyana.nic.in/cropwisearea1.htm

The potential cotton growing districts with 78% area and production are Fatehabad, Hisar and Sirsa.

Attainable Potential : As stated earlier, in Haryana cotton is one of the major *kharif* crops. Either due to non adoption of technologies or climatic reasons, there are gaps in productivity at districts/ blocks levels. By bridging these gaps yield can be enhanced in the districts performing lower than State average. By enhancing productivity of lower performing districts the additional production of 0.04 thousand tons from zone–I, 16.44 thousand tons from zone–II and 8.97 thousand tons from zone- III can be achieved adding to a total of 25.45 thousand tons to the total production of the State (Table 6.25 to 6.28).

Zone-I

Table 6.25: Estimated production of cotton by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity .74 t/ha				**Target to achieve .74 t/ha**
Panchkula	0	0.74	0	0
Ambala	0	0.74	0	0
Kurukshetra	0	0.74	0	0
Yamunanagar	0	0.74	0	0
Karnal	0	0.74	0	0
Sonipat	0.7	0.04	1	0.04
Panipat	0	0.74	0	0
Sub Total				**0.04**
District above State level productivity .74 t/ha				**Target to achieve .79 t/ha**
kaithal	**0.79**	0	9	0
Sub Total				**0**
Overall Increase				**0.04**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-II

Table 6.26: Estimated production of cotton by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity .74 t/ha				**Target to achieve .74 t/ha**
Hisar	0.73	0.01	154	1.54
Rohtak	0.62	0.12	10	1.2
Palwal	0	0.74	0	0
Faridabad	0	0.74	0	0
Jind	0.69	0.05	63	3.15
Sub Total				**5.89**
District above State level productivity .74 t/ha				**Target to achieve .82 t/ha**
Fatehabad	**0.82**	0	91	0
Sirsa	0.77	0.05	211	10.55
Sub Total				**10.55**
Overall Increase				**16.44**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.27: Estimated production of cotton by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity .74 t/ha				**Target to achieve .74 t/ha**
Bhiwani	0.61	0.13	60	7.8
Jhajjar	0.48	0.26	1	0.26
Gurgaon	0	0.74	0	0
Mewat	0	0.74	0	0
M.Garh	0.46	0.28	2	0.56
Rewari	0.39	0.35	1	0.35
Sub Total				**8.97**
District above State level productivity .74 t/ha				**Target to achieve .74 t/ha**
Overall Increase				**8.97**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.28: Additional production of cotton by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	0.04 (7)	0.04 (1)	0.04
2.	II	5.89 (5)	10.55 (2)	16.44
3.	III	8.97 (6)	0	8.97
Total estimated additional production of cotton				**25.45**

Note: Values in the parenthesis are the number of districts

Bt cotton occupies 95% of the cotton area in the country. In Haryana, more than 90% is covered under Bt hybrids of *hirsutum* cotton. Varietal diversification is needed to reduce vulnerability of monoculture crop to epidemics of new pests and diseases. Pests and diseases affecting the crop include thrip & leaf hopper, bollworms, hairy caterpillar, semi-loopers, other leaf eating insects, leaf spot, anthracnose, root rot, leaf curl virus etc.

Constraints

Costly seed of Bt cotton hybrids and poor plant population due to use of low seed rate by the farmers

Delayed sowing due to lack of availability of canal irrigation

Lack of management practices for Bt hybrids

Leaf curl virus (CLCuV), *helicoverpa* and mealybug problems

Physiological shedding of fruiting bodies and sudden wilting and reddening of plants at the time when the plant has maximum number of bolls

Burning of seedling due to high temperature in late sown crop

Labour constraint for picking of cotton

Action Plan

Promotion of high density plantation

Emphasis on timely sowing, increase in availability of quality seeds and balanced use of fertilizers

Evolving early maturing *desi* cotton with suitable quality for textiles and domestic purposes

Development, validation and promotion of IPM/IRM strategies for Bt cotton

Testing of new molecules for control of fungal foliar diseases

Evolving sustainable farming systems through integrated approaches (INM, IWM, IPM), decision support systems, mechanization and climate resilient technologies

Application of management practices for insect pest particularly mealybug and *helicoverpa*.

Priority setting and market intelligence to prioritize demand driven research, forecasting and appropriate technology adoption

Promotion of integrated management of major insect pests and diseases (IPM)

Researchable Issues

Development of high yielding varieties / hybrids resistant to biotic and abiotic stresses, and genotypes suitable for high density cultivation with package of practices for different agro-climatic conditions.

High ginning out turn *desi* cotton hybrids based on genetic male sterility system

Development of improved package and practices for both Bt and non-Bt crop

Development of crop varieties suitable for intercropping in cotton

Development of IPM modules for hybrids/verities

Technologies for quality seed production to be developed

6.10 Sugarcane

Sugarcane is the second most important industrial crop in India after cotton and is grown on 50.9 lakh hectares area. It is a multi-product crop contributing to the production of sugar, ethanol, electricity, paper and other allied products. About 6 million farmers and a large number of agricultural labourers are involved in cane cultivation. Besides, more than half a million skilled and semi skilled workers, mostly from rural areas are engaged in the sugar industry, the largest agro processing industry of India. There is little scope for increase in area under the crop and hence increased demand for sugarcane has to be met through productivity enhancement. The crop is also associated with inherent inconsistencies in area and production due to various factors like climate, cane and sugar pricing, high input and labour costs

etc. The sugar sector demands not only increase in sugarcane production but also stability for its sustained growth. The country has witnessed remarkable growth in sugar production during the past few decades mainly due to adoption of improved varieties and technologies.

The area under sugarcane in Haryana was 1.5 lakh hectares in 1966-67 which thereafter started declining, (Fig. 6.22). The productivity has increased from 34.00 (1966-67) to 732 q/ha (2011-12) (Fig. 6.23). However, there still exists a gap in yield and sugar recovery which needs to be narrowed down by sustained and concerted R&D efforts. Pests and diseases affecting the crop include termite, stem borer and root borer, black bug, redmite, tarai borer, shoot borer, pyrilla, gurdaspur borer, white fly, redrot, wilt, grassy shoot ratoon stunting and smut. This crop is mainly grown in Yamunanagar, Ambala, Kurukeshetra, Kaithal, Jind, Sonepat, Rohtak, Hisar, Karnal, Panipat, Palwal, Sirsa and Fatehabad districts of the State. Haryana and Punjab have very low temperature in December-January which often causes frost. During May and June, the temperatures are extremely high. Due to extremes of weather, the active sugarcane growth is restricted to 4-5 months only.

Fig. 6.22 - Area (000 hectares) of sugarcane in Haryana

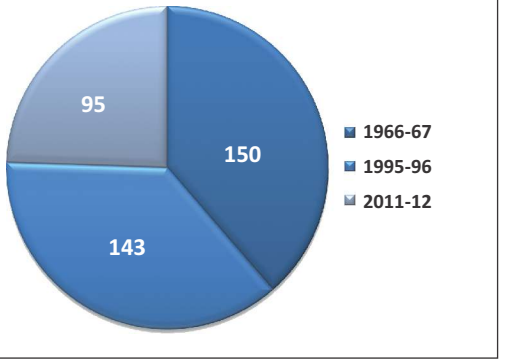
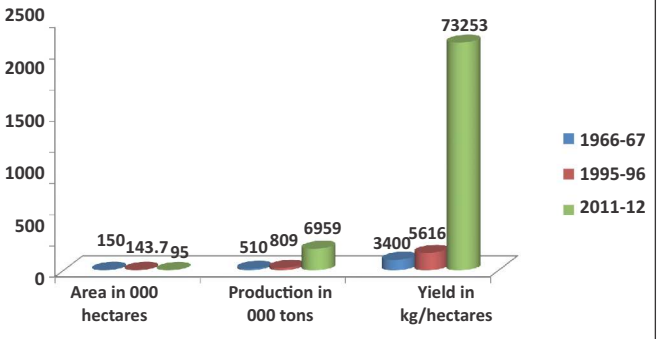


Fig. 6.23 - Area, production and productivity of sugarcane in Haryana



Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Sugar Recovery (percent cane) of Mills in Haryana

It is evident from the Fig.6.24, that recovery of sugar has shown a declining trend during the last five years. This is mainly due to non systematic and unbalanced varietal promotion and incidence of pests and diseases. During the period from 2009-10 to 2011-12, the average recovery of private sugar mills was about 9.86%, whereas the average recovery of mills under the cooperative sector is about 8.64%. This indicates that the mills in cooperative sector have great scope for improvement through better management.

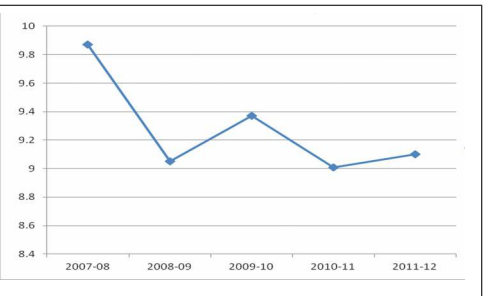


Fig. 6.24 Recovery of sugar in Haryana

Attainable Potential : The data on productivity of sugarcane indicates that there are yield differences among the districts. Some of the districts are performing below the State average, These districts should be targeted to enhance the productivity by technological interventions. By enhancing productivity of lower performing districts/blocks, the additional production 347.2 thousand tons from zone – I, 76.9 thousand tons from zone – II and 8.4 thousand tons from zone- III (Table 6.29, 6.30 & 6.31) can be achieved adding to a total of 423.64 thousand tons (Table 6.32) to the total production of the State.

Zone-I

Table 6.29: Estimated production of Sugarcane by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 73.25 t/ha				**Target to achieve 73.25 t/ha**
Panchkula	72.77	0.48	1	0.48
Ambala	71.58	1.67	9	15.03
Yamunanagar	66.02	7.23	26	187.98
Sub Total				**203.49**
District above State level productivity 73.25 t/ha				**Target to achieve 83.72 t/ha**
Kurukshetra	77.09	6.63	10	66.3
Karnal	79.77	3.95	11	43.45
Kaithal	82.51	1.21	2	2.42
Panipat	**83.72**	0	7	0
Sonipat	79.77	3.95	8	31.6
Sub Total				**143.77**
Overall Increase				**347.26**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-II

Table 6.30: Estimated production of Sugarcane by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 73.25 t/ha				**Target to achieve 73.25 t/ha**
Hisar	73.2	0.05	1	0.05
Sirsa	0	73.25	0	0
Rohtak	70.37	2.88	8	23.04
Palwal	54.25	19	2	38
Jind	73.08	0.17	3	0.51
Sub Total				**61.6**
District above State level productivity 73.25 t/ha				**Target to achieve 84 t/ha**
Fatehabad	**84**	0		0
Faridabad	77.65	6.35	1	6.35
Sub Total				**6.35**
Overall Increase				**67.95**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Zone-III

Table 6.31: Estimated production of Sugarcane by achieving the target productivity (Year 2011-12)

District	Yield (t/ha)	Targeted yield difference (t/ha)	Area covered (000 ha)	Estimated additional production (000 tons)
District below State level productivity 73.25 t/ha				**Target to achieve 73.25 t/ha**
Jhajjar	70.44	2.81	3	8.43
Gurgaon	0	73.25	0	0
Mewat	0	73.25	0	0
M.Garh	0	73.25	0	0
Rewari	0	73.25	0	0
Sub Total				**8.43**
District above State level productivity 73.25 t/ha				**Target to achieve 78.76 t/ha**
Bhiwani	**78.76**	0	3	0
Sub Total				**0**
Overall Increase				**8.43**

Data Source: http://agriharyana.nic.in/cropwisearea1.htm

Table 6.32: Additional production of sugarcane by filling the productivity gaps among districts

Sr. No.	Zone	Additional production (000 t)		Total production (000 t)
		From districts below State average (000 t)	From districts above State average (000 t)	
1.	I	203.49 (3)	143.77 (5)	347.26
2.	II	61.6 (5)	6.35 (2)	67.95
3.	III	8.43 (5)	0 (1)	8.43
Total estimated additional production of sugarcane				**423.64**

Note: Values in the parenthesis are the number of districts

Constraints

Poor germination

Inadequate availability of quality seed of potential varieties

Late planting after wheat harvesting

Occurrence of drought during grand growth phase

The cane yields are lower due to short growing season, pests and diseases - particularly red rot, top borer and *Pyrilla*, floods and water logging

Poor sugar recovery

Poor ratoon management

Fluctuation in area and high cost of production

Lack of mechanization

Non-availability of canal water at sowing and critical stages

Imbalanced(excess of urea and less use of super phosphate) nutrient application

Burning of trash

Partial adoption of package of practices viz. earthing up & propping up

Action Plan

Encourage autumn & winter planting with intercropping of onion, garlic, mustard and pulses etc.

Promote balanced use of fertilizers

Strengthening of tissue culture labs for mass multiplication of quality seed material.

Promote practices for enhancing ratoon crop productivity

Promote integrated weed and nutrient management for plant, ratoon and intercropping systems

Production of quality seed by application of moist hot air treatment

Advancing maturity and minimising post-harvest sucrose losses

Regular farmers, scientist and industry interaction

Raising of primary and secondary seed nursery at CCS HAU, government farms, sugar mills and progressive farmers' fields

Promotion of ring pit techniques and wide row spacing

Researchable Issues

Develop varieties with high yield, high sugar content, with better ratooning ability, resistant to biotic & abiotic (drought, salinity, water logging / flooding, low / high temperature) stresses, suitable for inter-cropping

Suitable machine and tools for autumn and winter planting and also for other operations

Development of IPM and bio-control technology for pest control

Development of specific agronomical practices for varieties suitable for different agro-climatic zones for plant, ratoon and intercropping conditions

To explore the possibility of sugar-beet cultivation for increasing the crushing duration and capacity utilisation

6.11 Additional production

By bridging the gaps through technological interventions and timely delivery of inputs, additional production of atleast 11.6 lakh tons of food grains, 1.4 lakh tons oil seeds, 4.2 lakh tons sugarcane, 7.1 thousand tons of gram and 25.4 thousand tons of cotton (Table 6.33) can be achieved.

Table 6.33: Estimated additional production of major crops by enhancing productivity of lower performing districts/blocks

Major crops	Estimated additional production (000' t) per annum
Rice	471.37
Wheat	582.64
Barley	15.98
Maize	1.81
Bajra	87.63
Oilseeds	141.96
Gram	7.05
Cotton	25.45
Sugarcane	423.64

6.12 Drivers of achieving attainable and potential yield

A review of data on productivity indicates that gaps in productivity exist among the districts/blocks in all crops. The key Input for getting attainable yield would be promotion of precision farming that includes:

- Development of input efficient varieties/hybrids
- Micro-management of resources particularly irrigation water and soil health
- Timely sowing, seed treatment and balanced use of fertilizers
- Use of quality seeds of recommended varieties/hybrids suitable for the region/blocks
- Timely availability of inputs
- Irrigation as per recommended schedule
- Maintain optimum plant population
- Timely management pests and diseases
- Post harvest management
- Linking farmers with market

7. Seed Production Plan

In order to achieve the targets of food grains production, the Government of India, State Governments and SAUs/ICAR institutes have put major efforts to develop improved varieties/hybrids of crops along with the package of practices. Concerted efforts are also being made to enhance the seed replacement rates of various crops grown under diverse agro-climatic conditions and intensive cropping systems. The Seed Policy, 2002 is in place which envisages the creation of a facilitative climate for growth of a competitive and localized seed industry, encouragement of import of useful germplasm, and boosting of exports as core elements of the agricultural strategy of the new millennium (http://agricoop.nic.in/seedpolicy.htm#introduction).

The quality seed acts as the key factor for agricultural growth and becomes instrumental in efficient utilisation of other inputs particularly water and fertilizers. Survey reveals that crop yields using certified seeds were 15-20% higher than the farmers' self-saved seed. Thus achieving higher productivity, the availability of good quality seed is utmost important. Due to concerted efforts made by the government, the seed replacement rate has gone considerably high in Haryana for most of the crops (Table 7.1 and 7.2). However, there is scope to enhance the seed replacement rate in wheat, paddy and gram. The availability of quality seed of wheat and rice will have to be enhanced and made available at proper place and time. The government has taken steps to prepare the rolling seed plan by involving public institutions, private sectors, NGOs and farmers. In order to get maximum advantage of this initiative, it is suggested that the latest varieties and hybrids should be included in the seed multiplication plan.

Table 7.1 Seed replacement rate (%) of major *kharif* crops of Haryana (2003-2010)

Crop	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Paddy	14.49	14.15	17.00	16.49	17.00	20.08	25.00
Bajra	59.26	51.00	52.65	60.20	63.00	65.28	80.00
Cotton	46.20	49.00	43.00	52.36	65.00	80.00	95.00
Kharif pulses	60.57	28.00	62.00	59.34	65.00	77.10	80.00

Source: Agricoop.nic.in/Rabi2012/State/Haryana.ppt

Table 7.2 Seed replacement rate (%) of major *rabi* crops of Haryana (2007-2013)

Crop	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Wheat	24.00	25.90	34.00	37.00	50.63	52.00
Gram	11.00	10.51	13.39	15.00	24.47	25.00
Barley	54.00	62.00	90.00	90.00	85.5	85.00
Oilseeds	72.00	75.76	93.53	95.00	95.00	97.00

Source: rkvy.nic.in/download%5Cstrategy%5CHaryana.ppt

In Haryana, over 14 lakh quintals of *rabi* seeds mainly wheat is required at present rate of replacement (Table 7.3) and similarly, about 1.5 lakh quintals of *kharif* seeds (Table 7.4) are required.

Table 7.3: Seed rolling plan for *rabi* crops

Crop	Crop area in lakh ha.				Seed rate/ha. (qty. in qtls.)	SRR minimum/ already achieved whichever is higher	Qty. of seed required (in lakh qtls.)			
	2013-14	2014-15	2015-16	2016-17			2013-14	2014-15	2015-16	2016-17
Wheat	25.5	25.63	25.88	25.96	1	53	13.52	13.58	13.72	13.76
Gram	1.25	1.26	1.28	1.29	0.4	25	0.13	0.13	0.13	0.13
Mustard/ *Toria*	5.3	5.57	5.84	6.14	0.05	95	0.25	0.26	0.28	0.29
Lentil	0.08	0.08	0.09	0.09	0.5	35	0.01	0.01	0.02	0.02
Barley	0.50	0.54	0.58	0.62	0.75	82	0.31	0.33	0.36	0.38
Total	**32.63**	**33.08**	**33.67**	**34.10**			**14.21**	**14.32**	**14.49**	**14.58**

Source: seednet.gov.in/SeedPlan/seedplan.htm

As per Seeds Act, 1966, there are three categories of seeds of notified varieties *viz*., breeder, foundation and certified seed. The production of seed incurs additional cost on different operations such as field inspection, rouging, grading, seed treatment, packaging and storage in comparison to grain production. Advance planning is needed to produce the required quantity of quality seeds.

The seed production in India is undertaken both by public as well as private sectors. Indian Council for Agricultural Research (ICAR) and the State Agricultural Universities (SAUs) develop improved crop varieties and produce breeder seed. Multiplication of seed for commercial purposes is predominantly done by the public seed agencies like National Seed Corporation (NSC), State Farms Corporation of India and the State Seed Corporations (SSC).

Strengthening of seed sector

- *Human resource development for seed production*
- *New varieties should be brought in seed chain as early as possible*
- *Public - private partnership may be strengthened*

Haryana Seed Development Corporation and Haryana State Seed Certification Agency were established in 1974 for production, distribution, and processing, safe storage and to ensure timely supply of quality. The seed certification agency is responsible for certification of seeds of crops/varieties notified by the *Government of India as per prescribed* standards. The public sector is primarily engaged in production of seeds of high volume and low value crops with major share of wheat and rice crops.

In Indian seed industry, the private sector emerged in 1980s and it has now grown into quite a large industry. The private sector is mainly focussed on high value, low volume crops and hybrids in rice, maize, *bajra*, cotton, sorghum, sunflower and vegetables. In order to increase the seed replacement rate, both the sectors have tremendous scope for increasing their capacity and capability for timely availability of quality seeds and planting materials to the farmers.

Table 7.4: Seed rolling plan for *kharif* crops

Crop	Crop area in lakh ha.				Seed rate/ha. (qty. in qtls.)	SRR minimum/ already achieved whichever is higher	Qty. of seed required (in lakh qtls.)			
	2013-14	2014-15	2015-16	2016-17			2013-14	2014-15	2015-16	2016-17
Paddy Variety	10	10.01	10.11	10.21	0.25	25	0.625	0.651	0.657	0.664
Paddy Hybrid	1.5	1.58	1.65	1.74	0.1	100	0.150	0.158	0.165	0.174
Total	11.5	11.58	11.76	11.95			0.775	0.808	0.822	0.837
Maize Hyb.	0.09	0.13	0.19	0.24	0.1	100	0.009	0.013	0.019	0.024
Jowar Var.	0.65	0.68	0.73	0.80	0.25	50	0.081	0.085	0.091	0.100
Bajra Hyb.	5.50	5.56	5.61	5.67	0.05	100	0.275	0.278	0.281	0.283
Bajra Var.	0.25	0.26	0.28	0.31	0.05	75	0.009	0.010	0.011	0.012
Arhar Urad/	0.15	0.16	0.17	0.19	0.15	40	0.015	0.024	0.025	0.028
Moth	0.05	0.05	0.06	0.06	0.15	35	0.003	0.003	0.003	0.003
Moong bean	0.25	0.26	0.28	0.31	0.15	80	0.030	0.032	0.042	0.037
Guar	3.00	3.15	3.21	3.28	0.2	40	0.240	0.252	0.257	0.262
Sunflo-wer Hyb.	0.10	0.11	0.11	0.12	0.25	100	0.025	0.026	0.028	0.031
Cotton Hyb.	5.90	5.96	6.02	6.08	0.01	100	0.059	0.060	0.060	0.061
Cotton Var.	0.10	0.11	0.11	0.12	0.2	85	0.017	0.021	0.022	0.025
G.Total	**27.54**	**28.00**	**28.53**	**29.12**			**1.538**	**1.610**	**1.662**	**1.703**

Source : *seednet.gov.in*

Constraints

- o High cost of seed production
- o Obsolete processing and storage infrastructure and facilities
- o Weak seed production chain

Action Plan

Implementation of district wise regular and contingent seed production plan.

Inclusion of latest notified and/or protected varieties and hybrids in seed production plan.

Creation of "Hybrid Seed Production Cell" under Department of Agriculture for large scale production of hybrid seeds of different crops in collaboration with the University and private sector.

Setting up of "State Mission on Seed" and restructuring and streamlining of the public sector, NGOs, private sector seed production agencies.

Initiating seed production programme on high value crops like *guar* and also on the crops. recommended for diversification like soybean, sunflower, *arhar,* oats *and* castor.

Strengthening seed production

- *Launch "State Mission on Seed"*
- *Establish "Hybrid Seed Production Cell"*
- *Upgradation of seed testing laboratories*
- *Creation of awareness about different legislations viz., Seed Act, Biological Diversity Act, Protection of Plant Varieties & Farmers Rights Act, Geographical Indications Act*

State Seed Corporation to be rejuvenated to address the emerging seed scenario.

Strengthening of maintenance breeding, production of nucleus/breeder/foundation/ certified seed.

Developing technologies for processing, storage and marketing intelligence.

Up-gradation of seed testing laboratories of the department and ISTA accreditation for seed testing laboratory of CCS HAU.

Standardization of pre-sowing treatments for enhancing germination and field emergence of marginal seed lots of various crops.

Management of seed-borne diseases and insect-pests in seed production programme through treatment with recommended chemicals.

Strengthening seed storage facility and develop seed bank for meeting the exigencies.

Creation of awareness about different legislations *viz.,* Seed Act, Biological Diversity Act, Protection of Plant Varieties &Farmers Rights Act, Geographical Indications Act among the seed producing agencies and farmers.

Training and capacity building of staff of certification and seed production agencies for effective monitoring and production of quality seed

Training of scientists in the latest developments in seed technology to make the seed sector globally competitive

Course curricula on seed aspects to be revisited incorporating the latest knowledge on seed technologies

8. Farm Mechanization

Increasing agricultural production and value addition to the farm produce are two important factors for enhancing the rural prosperity. Farm mechanization can be decisive to realize this goal. The average farm power availability in the State need to be properly utilized, which is around 2.25 KW/ha and is more than recommended availability (http://farmech.gov.in/Farmer Guide/HR/index1.html). The increase in power utilization is mainly due to increase in tractors, largely used for transportation, and tube wells. This uneven growth of machinery has not benefited farmers as per their expectations in enhancing the productivity. To make State agriculture globally competitive, profitable, eco-friendly and sustainable, the efficiency of inputs (seed, chemical, fertilizer, irrigation water etc.) has to be enhanced by efficient management of pre-harvest and post harvest operations. One of the major constraints in this direction is the inadequacy of farm power and machinery with the farmers.

Several studies conducted in different parts of India have shown that mechanization has helped in reduction of cost of cultivation, increasing production & productivity and generation of income & employment. A paradigm shift in agricultural mechanization is required to realize this goal. Cost-effective equipments for tillage operations, paddy transplanting, sugarcane planting & harvesting, cotton picking and potato planter & digger need to be introduced in the State. Introduction of suitable equipments for maize, sunflower, *guar*, castor, forage and fodder crops sowing, harvesting, threshing and processing would help in crop diversification.

Key steps for farm mechanization

- *Development of cost effective machines and tools relevant for women, marginal and small farmers need special attention*
- *Scaling-up of indigenously developed machines and tools*
- *Skill development programmes for local manufacturers*
- *Organization of demonstrations of machine and tools which help in labour & time saving, water management and processing*
- *Training for rural youth for setting-up agri-clinics*

Efficient and low cost machines/equipments for crop residue management of field crops, water harvesting, resource conservation (Laser guided land leveller, ridge and bed planter, rotavator, tractor operated pond excavation machinery, drip and sprinkler irrigation systems, happy seeder etc) also need to be appropriately promoted to make agriculture profitable. The area/location specific low cost and efficient small machines and tools have to be developed/refined and promoted. In this endeavour, the skill development programme for local manufactures will be of immense use.

Due to reduction in the size of the holdings, it is difficult for the farmers to hold the machinery on their own unless it is cheap and affordable. The machines for farm operations and primary processing are very capital intensive and majority of our farmers do not get the desired advantages in view of the shortage of capital with them to acquire these assets. The farmers in Haryana are reluctant to adopt paddy transplanter due to the high cost of machine, cumbersome process of nursery raising and lack of training and demonstration. Therefore, an arrangement has to be made to develop human resource

and provide custom hiring service facility to the farmers. The unemployed agricultural graduates should be engaged and helped in this venture. Hence, it is expected that an agri-clinic set up by an agricultural graduate with facilities to provide service to the farmers in their production, post harvest primary processing operations and attending to repair and maintenance works of their machinery and equipment will form the back bone of the farming community for employment and commercialization of agriculture.

Constraints

Non-availability of low cost and efficient farm implements for various crops including sugarcane planting and harvesting, efficient rice transplanter, cotton picker etc.

Lack of machinery suitable for small holdings

High cost of farm equipments and implements

Lack of service and maintenance support for machinery

Action Plan

Manufacturing of cost effective farm implements for adoption by small farmers and women.

Support and encouragement to unemployed youth/agriculture graduates/farmers to form cooperatives / self-help groups as providers of custom hiring services

Skilled manpower development for agricultural engineering research, services and techno-entrepreneurship

Popularisation of cost effective farmer friendly machine and tools such as rice transplanter, sugarcane trash harvester and chopper, cotton picker, bed planter, potato planter and digger, straw reaper, reaper binder, self-propelled sprayer, ridger seeder, power tiller etc.

Researchable Issues

Development of machine and tools for maize, *guar*, soybean, castor, groundnut and sunflower cultivation as well as post harvest management

Refinement and promotion of locally developed machine and tools

Out scaling of innovations, based on their techno – economic feasibility, relevance and utility would be the key for inclusive growth of small holder farmers. Hence, identification of such innovations like happy seeder, laser leveler, zero till drill, paddy transplanter, multipurpose machines and tools and their faster adoption/use will benefit considerably the small holding farmers. Therefore, efficiency of such machines need to be enhanced

Long term studies on impact of farm machineries on soil structure

9. Conservation Agriculture

The impact of over exploitation of natural resources, basically land and water, and effects of climate change are alarming and affecting sustainability of agriculture. There is hardly any option to increase the land use under cultivation in Haryana. The research and development policies will have to focus more closely on better resource management and vertical growth in agriculture.

Conservation Agriculture (CA) aims at achieving the goal of sustainable and profitable agriculture leading to improved livelihoods of farmers and production of quality products at competitive and cheaper rates. CA holds tremendous potential for all sizes of farms and agro-ecological systems, but its adoption is perhaps most urgently required by small holder farmers, especially those facing acute labour shortages. Haryana Kisan Ayog has brought out a comprehensive report on "Conservation Agriculture for Sustainable Crop Production in Haryana". This report of the Working Group dwells on the low-cost conceptual model "more crop per drop" based on the use of conservation agriculture practices. The key conservation agriculture technologies identified for large scale adoption by the farmers of Haryana include laser land leveling, double till/no-till in rice-wheat system (direct seeded rice, zero till seeding with full residues), intensification of sugarcane production system, summer *moong* bean/cowpea/early maize in rice-wheat system, diversification, crop residue management, adoption of micro-irrigation technology in irrigated areas, and watershed management in arid areas.

Zero till technology is being promoted amongst the farmers for timely sowing of crops, saving of energy as well as reduction of cost of cultivation. CA has been proven to work in a variety of agro-ecological zones and farming systems. Hence, out-scaling of CA for large scale benefits and impact on soil health is crucial in the present context.

There is need for much better understanding to resolve many conflicting practices like the frequent use of rotavator. Therefore, the CA practices should be implemented based on local conditions and farmers' understanding as suggested by the "Working Group on Natural Resource Management in Haryana". Direct seeded rice and alternate crops/intercrops (hybrid maize, soyabean, maize+soybean/soybean+pigeonpea/vegetables) have also been suggested for the adoption under CA.

CA technologies

- *Laser land levelling*
- *Double till, no-till in rice-wheat system*
  - *direct seeded rice*
  - *zero till seeding with full residues*
- *Intensification of sugarcane production system*
- *Summer moong / cowpea / early maize in rice-wheat system*
- *Diversification and adoption of micro-irrigation technology in irrigated areas*
- *Watershed management in arid areas*
- *Crop residue management*

However, concerted policy initiatives and reorientation of research and development agenda will be required for large scale adoption and popularization of conservation technologies for sustainable agriculture. Capacity building for resource conservation and management in agriculture will help in sustaining and securing food supplies in the future. This will need investment in technology development, dissemination and strengthening of farm infrastructure to make the best possible use of our arable resources to meet the challenges of food and fibre production.

"Conserve Water to Secure Agriculture and Our Life in future." *– National Water Mission*

10. Diversification in State Agriculture

There are three major cropping systems in Haryana *viz.* rice-wheat, cotton-wheat and pearl millet-wheat. The sugarcane-wheat system is also popular in eastern parts. Among these, rice-wheat occupies more than 58% area. (Economic Survey of Haryana, 2012-13). The study of four years from 2002-03 to 2005-06 conducted at 12 locations in eastern Haryana (Karnal and Ambala districts) on nutrient management depicts that rice-wheat is the most exhaustive cropping system as it needs 728.1 kg NPK/ha. The same study on nutrient management conducted in districts of western Haryana (Rewari, Bhiwani, Hisar and Fatehabad) in cotton-wheat and pearl millet-wheat systems at 12 locations each reflects that cotton-wheat-and pearl millet-wheat are the next heavy takers of NPK with the total uptake of 626.2 and 562.2 kg/ha (*al*.http://www.hau.ernet.in/farmer/Diversificationthroughfarming%20.pdf). This has also created imbalance in cropping pattern and eliminated the pulses from the cropping system in irrigated agro-ecosystem. The dependence upon these systems is showing adverse effect on soil and water resources. It is widely believed that diversification in agriculture will help in achieving the growth objectives of State, saving and strengthening the natural resources and enhancement in the productivity, profitability and employment in agriculture.

Haryana agriculture will continue to support country to meet the requirements of food security, on the one hand, and, on the other, it has to rapidly diversify itself to function in a rural urban continuum in the State with rapid developments of agri-business, employment generation and economic growth. All this will happen if the State policy and institutional structure gives appropriate signals for diversification by providing cost-effective & efficient technology and organizational & financial support and required policies relating to market reform and infrastructure in the context of the rural urban continuum. It has been argued that agricultural diversification in India is basically driven by domestic demand (www.iari.res.in/files/18-lecture-Dr-YK-Alagh-21-6-2011.pdf), but the WTO regime has provided opportunity to take advantage of international demand as well. India is planning to enhance its global share to 4% in agriculture product trade. This will provide vast opportunity to Haryana farmers if they diversify their approach in agriculture.

Why diversification?

- *About 58% area is under highly exhaustive R-W cropping system*
- *For sustainable use of soil and water*
- *Agriculture has to function in a rural urban continuum in the State to harness global agri-business opportunities and enhancing income of the farmers*

The Government of India has recently taken several initiatives towards promoting crop diversification. These include Technology Mission on Horticulture, National Agriculture Insurance Scheme, National Rainfed Area Authority, Rashtriya Krishi Vikas Yojna, Technology Mission on Cotton, Pulses, Maize and Oilseeds, creation of watershed development fund, strengthening agricultural marketing, seed bank schemes, cooperative sector reforms etc. Haryana has taken lead in implementation of these schemes.

10.1 Crop Diversification Plan

The efforts need to be greatly enhanced involving diversification of some area of rice to hybrid maize, soybean, maize+soybean, soybean+pigeonpea, vegetables, agro-horticulture and agro-forestry as suggested by Working Group on "Natural Resource Management in Haryana". Besides, the group has suggested that the area from late sown wheat should be diverted to other crops. The farmers should be encouraged to grow pulses as sole/inter/relay crop. Promotion of low water requiring varieties of each crop will be desirable. Based on discussions and reports, the following cropping systems for different zones may be considered to promote diversification (Table 10.1).

Table 10.1: Potential cropping systems for various agro-climatic zones in Haryana

	Cropping systems
Zone – I	Soybean-wheat-*moong* bean/maize-wheat- moong bean
	Maize-lentil/field pea/gram
	Sugarcane-with intercrops like onion and garlic
	Paddy(early)-winter maize with inter crops of vegetables
	Paddy-wheat-green manuring/green fodder.
	Paddy-wheat-sorghum-wheat-moong bean
	Paddy--sunflower/wheat
	Paddy-*moong* bean (summer)
	Fodder-*toria*-wheat-*moong* bean
	Fodder-*toria*-sunflower, sorghum (fodder)-berseem
	Sugarcane-ratoon- sunflower
	Maize-potato-sunflower/vegetables
	Ginger+turmeric+colosia-maize/fodder crop
	Bhindi-potato-cucurbits, *kharif* vegetables-fieldpea
Zone – II	*Bajra*/sorghum-mustard, *bajra*/*guar*-wheat/mustard
	Bajra/*guar*-barley, cotton-wheat/relay wheat
	Fodder crop-sugarbeet
	Castor+ *guar, kharif*-pulses/*moong* bean-mustard
	Paddy(DSR)-winter maize with inter cropping of vegetables-green manure
	Paddy-wheat-green manuring/green fodder.
	Paddy/sorghum-wheat, paddy-wheat-*moong* bean
	Maize-potato-onion/vegetables
	Arhar-wheat-sorghum-berseem
	Til-barley, *guar*-berseem (for seed)/*oats*/fodder
Zone - III	Fallow-gram/mustard/barley.
	Castor/*guar*/*bajra*-gram.

	Bajra-mustard
	Bajra/*guar*-wheat/mustard
	Castor-fallow, *moong* bean-mustard, *guar*-barley
	Groundnut-wheat
	Sorghum-wheat-sugarcane-ratoon with inter crops
	Sorghum-mustard-cotton-wheat.
	Arhar-wheat-sorghum-berseem
	Urd bean/barley, maize-potato-onion/vegetable
	Potato-cucurbits-*bhindi*-potato
	Tomato-cururbits
	Kharif vegetables-fieldpea
	Tomato-fieldpea, potato-onion

Keeping in view the export potential of *guar,* use of barley in malt industry, globally increasing demand of oats for health food and farmers' inclination towards groundnut cultivation in some areas, there is need to strengthen research on these crops to meet the requirements of stakeholders.

10.2 Input Diversification

Keeping in view emerging demand for organic/safe food and decreasing health/availability of natural resources, the diversification in the use of inputs, and machines and tools has become necessary. Uses of bio-fertilizers, bio-agents, fertigation techniques, IPM, RCT, pressure irrigation, safe storage techniques, efficient machines etc are potential options. This type of diversification will help in quality production at lower cost.

10.3 Inter Cropping Approach

The inter cropping and relay cropping systems with suitable varieties of pulses/other crops will help in improving soil health and generating more income. The experiences show that pulse varieties like HC-5 of gram and SML-668 of moong bean can be adopted as relay/inter crops as they are giving good results in irrigated agro-ecosystem if sown with bed planting method. Likewise, the oilseed crops such as sunflower and variety RH-30 of mustard can find a place in R-W exhaustive cropping system. Autumn sugarcane-based cropping system is more remunerative if adopted with suitable intercrops like onion, garlic or wheat. Vegetable based *peri-urban* farming which includes potato, onion, tomato; pea, cucurbits, etc. are paying rich dividends to the farmers with higher benefit-cost ratio than rice-wheat sequence.

10.4 Horticulture, Fisheries and Animal Husbandry

These sectors may be the part of diversification. The separate reports have been prepared by Haryana Kisan Ayog as follows:

Development of Horticulture in Haryana

Development of Protected Cultivation in Haryana

Fisheries Development in Haryana

Development of Animal Husbandry in Haryana

Constraints

Reluctance of farmers having small and fragmented land holdings for diversification due to no assured market for diversified products

Inadequate technologies and infrastructure for post-harvest handling of perishable produce and insufficient agro-based industry

Lack of incentives and procurement policies for diversification

Action Plan

Provision for MSP for the crops to be promoted under diversification

Farmer-industry linkage and skill development of farmers would help in successful implementation of diversification

Crop diversification in rice-wheat system need to be promoted. Some area of rice need to be brought under maize and soybean

Intercropping of *guar*, *moong bean* and cowpea in cotton – wheat/vegetable rotation need to be promoted

Promotion of autumn planting of sugarcane and intercrop with *brassica*, onion, garlic, other vegetables and wheat may be beneficial

Promotion of agro-forestry by including onion, garlic, maize, wheat etc need to be done

Spring maize or sunflower after potato harvest may be promoted

Intercropping in *bajra* with *moong bean* and *guar* with cotton in dry regions needs to be adopted

Introduction of castor in Bhiwani and Mahendergarh areas is expected to bring good results

Strengthening of value addition programmes and development of diverse products need to be done

Assured market for crops adopted under diversification

Researchable Issues

Economically viable cropping systems should be identified for the adoption in R–W cropping system areas

Low water requiring varieties/hybrids of rice and wheat need to be developed and promoted. Similarly, varieties/hybrids suitable for inter-cropping/intra-cropping need to be developed

Availability of "easy to adopt value addition and post harvest technologies" would help in diversification

Efficient input use technologies would help in adoption of new crops

The crops like *guar,* oats, soybean, *arhar,* castor, groundnut, autom sugarcane etc., which have potential to break R-W cropping system, need special attention of researchers

11. Marketing

The Agricultural produce in Haryana is being regulated under the Punjab Agricultural Produce Markets Act, 1961. This Act was further amended in the year 2012. A strong and efficient marketing infrastructure has been created by setting up modern markets and evolving a feasible and efficient marketing system. Development of new *mandis* at various places has been taken up besides mega projects on up-gradation and modernization of grain and vegetable markets at Karnal and Rohtak. A modern air conditioned retail market, first of its own kind in the North India, is being set up at Panchkula and a modern terminal market is being developed in the NCR at Ganaur.

The Haryana State Agriculture Marketing Board (HSAMB) has been set up to provide modern integrated marketing infrastructure, improved accessibility to the markets, support agricultural development and provide farmers with opportunities to achieve better value for their produce. Agri-Business & Information Centres (ABIC) have been opened at Sirsa and Hisar. These centres provide information on market and agronomic practices. Seminars, workshops and buyer-seller meets etc. are organized to educate and train the farmers in improving the quality of agricultural produce.

The Haryana State Warehousing Corporation has 107 Warehouses across the State. The Corporation is operating an Inland Container Depot (ICD)-cum-Container Freight Station (CFS) at Rewari to provide cost effective services to the importers and exporters of Haryana and its adjoining area of the neighbouring States. Inland Container Depot, Rewari, has been connected online to the world through the Electronic Data Inter-Change (EDI) system. A committee of State Ministers has been constituted to promote market reforms and to recommend development of barriers free National market (WG on Agriculture Production, 2010)

Haryana Kisan Ayog has constituted a WG on "Linking Farmers to Market" to review the present status of marketing infrastructure facilities in the State. This group will identify the alternative forms of marketing such as direct marketing; markets run by farmers or their associations, contract farming, corporate entities, cooperatives etc. and suggest strategies/policies required to encourage their involvement. Besides the group will study market information services, including ICT its dissemination through media and suggest appropriate measures to make these more accessible, efficient and useful to the farmers and consumers alike.

Acton Plan

1. Certification and procurement facilities for organic farming should be established
2. Automation of operations in agriculture marketing such as primary processing and grading, storage etc should be done so that farmers get better return on investment
3. Participation of private sector in handling storage and supply chain in collaboration with farmers should be encouraged.
4. Linking farmers with industry/market.

12. Biodiversity Conservation

The concerted efforts are needed for the reversal in slowdown in genetic gains (breaking yield barriers) through effective use of germplasm. The rich indigenous plant genetic resources need to be conserved, catalogued and advantageously used. Farmer's varieties and Geographical Indications (GI) of plant resources of the State should be protected and used in research programmes.

Rural communities have been playing an important role in the conservation and enhancement of biodiversity since time immemorial. Their traditional knowledge, practices and innovations need to be preserved, documented and safeguarded. Due attention is needed to take advantage of the provisions of Protection of Plant Varieties & Farmers' Rights Act (2001), Biological Diversity Act (2002), Geographical Indications of Goods (Registration and Protection) Act (1999) etc. The recent initiatives of the Government regarding establishment of State Agriculture Innovation Fund (SAIF) and the State Biodiversity Board shall go a long way in conserving the biodiversity of the State.

Constraints

Lack of documentation of biodiversity, traditional knowledge and practices

Need for synergy between departments

Effect of climate change

Strategies

Pre-breeding through the use of trait specific germplasm need to be strengthened for the development of varieties suitable under emerging climatic conditions

Ensuring farmers' participation for bio-diversity protections as per International treaty on Farmers' Rights. (Paragraph 9.2 c)

Strengthening on farm *in-situ* conservation of farmers' varieties (especially in *guar*, pulses, oilseeds, forages) and registration of farmers' varieties

Promotion of agro-forestry through remunerative prices, incentives and strengthening of R&D in the universities

Strengthening of research on climate change and mainstreaming of carbon trading / credits in R&D planning

Training and awareness among the masses about biodiversity & intellectual property protection, agro-forestry, agro-tourism, climate change etc. and capacity building of different stakeholders and agencies for risk / disaster management

13. Education, Extension and Entrepreneurship Development

13.1 Agricultural Education

The main purpose of education is to build capacity of our human resource to make agriculture a technology centric occupation. The horizon of agriculture is expanding and therefore, the agricultural graduates are encountering more competition and challenges. More job opportunities are emerging with the change in market dynamics. Earlier seed, pesticide, fertilizer and farm machinery sectors were the only the potential sectors to employ the agricultural graduates/rural youth. Now opportunities are emerging in IT linked agri-extension, bio-technology, food processing, cold storage, packaging, supply chain management and farm credit. Private sector and NGOs are creating opportunities in R&D. The training and education course curricula is to be reoriented keeping these points in view as this focus will empower agri-graduates for taking up their own enterprises and generating income. The ICAR has already taken steps in this direction. However, the following suggestions need focus in our planning:

Besides improving the quality of courses, the instructional processes should be modernized. The education should be human skill development centred. Ultimately, the quality and skills being imparted must inculcate expectations of different stakeholders. It will be appropriate if specialized trainings in degree programmes are introduced

Entrepreneurship development and self-employment orientation in agricultural education should receive high priority. There is need to develop human resource in post harvest management, processing value addition, management of machine & tools, packaging, storage, IPM, INM, marketing etc. Vocational courses should be introduced at diploma/certificate level for rural youth including women

The students and faculty should be exposed to the domestic and international developments relating to agriculture such as WTO, Agreement on Agriculture, TRIPS, SPS issues and Geographical Indications (GI), CBD etc. as all these issues have direct impact on our agriculture. The national policies and legislations relating to agriculture and allied sectors, IPR etc should also be included in the course curriculum

Faculty up-gradation need to be a continuous process

13.2 Agricultural Extension

Due to globalization and trade pressures to compete, the focus of agriculture is slowly shifting as per demand of the market. There is need for linkages and partnerships to support agricultural innovations and development. The following embellishments in technology transfer programmes may make them more effective:

13.2.1 Stimulus to Extension System: The traditional way of technology transfer has contributed significantly to usher in agricultural revolution. However, presently the new needs have arisen and accordingly the functioning of this system has to be made effective and buoyant to address the new situation. The ICT should be made an effective tool of technology transfer and knowledge provider. The skill of all extension workers should be scaled-up for this purpose. The ICT should be extended and strengthened for documenting and dissemination of traditional and modern knowledge, practices and innovations and creation of need based databases and portals.

13.2.2 KVKs as Incubator Centres: For the capacity building of rural youth, the KVKs need to be knowledge, skill and technology incubators also. That will help youth in establishing their own enterprise and generate employment. Incubation on adoption of IPM, INM, PHT, Value addition, mass multiplication through tissue culture, hybrid seed production etc. can be taken initially.

Need for change

- *Agricultural graduates are to be empowered to harness emerging opportunities in agri-business*
- *KVKs need to work as incubators and knowledge sharing centres*
- *Entrepreneurship development programmes need to be strengthened*
- *Women empowerment through trainings and visits is required*

13.2.3 Knowledge Sharing: Mainstreaming and strengthening the extension/crop advisory services and putting input delivery mechanism, knowledge sharing with innovative farmers, and development of public-private-farmer partnerships are the keys to improve productivity at farm level. Continuous interface with industry and innovator farmers would be of much use. Development of awareness among the farmers about sanitary and phyto-sanitary (SPS) issues and residue management is important. Helping farmers in the establishment of producers associations/clubs/ societies is expected to pay rich dividends.

13.2.4 Building Cadre of Technology Agents: To make technology transfer efficient, building a cadre of Technology Agents and strengthening of Agri-Clinics will go a long way. For this, an aggressive vocational training programme has to be taken for rural youths and women.

13.2.5 Extension Kiosks: Creation of commodity specific extension kiosks on important crops, with focus on package and practices, value addition for PHT, IPM, input availability, prices, marketing information etc. will be helpful in faster transfer of technology and employment generation. These kiosks may be established at KVKs, KGKs, Universities, Research Institutions and line departments.

13.3 Entrepreneurship Development

The enhancement in crop productivity, quality of products and on-farm/off-farm employment generation in Haryana would need to adapt to changing market demands and application of advanced technologies. Opportunities are emerging for agri-business in domestic and global markets. Enormous opportunities are emerging for income generation in agriculture mechanization, machines & tools manufacturing, value addition, PHT, protected cultivation, mass multiplication of planting material, organic farming, seed production, IPM, marketing and trade etc. The Government of India vide notification no. 31(RE-2012) dated 04th February, 2013, has decided to allow the export of 14 commodities/product groups of processed/value added agricultural products. Therefore, farmers and students are to be trained in these emerging areas to capitalize the opportunities :

13.3.1 High Value Agriculture: As per the latest statistics released by the WTO for the global trend, India's share in global agricultural exports has gone up to more than 2% at present. Major performers are *Basmati* and non-*Basmati* rice, bovine meat, *guar* gum, peanuts, wheat and processed food exports. The global demand is rising fast for value added foods like organic produce, vitamin/mineral/fibre rich food-grains/products, chemical residue free products, processed/preserved food, insect-pests & disease free food products, hormone-free meat, and regionally-branded products. All these items increase consumer appeal and willingness to pay a premium on quality over similar products produced by traditional methods. Value-added agriculture is now considered the key for increase the farm income and is also a significant rural development strategy. In general terms it refers to the adoption of cultivation practices and processes that increase the value of primary agricultural commodities. Small-scale organic agriculture, food processing, protected/green house agriculture, modern nursery raising, agri-tourism, and bio-fuels development are examples of various value-added initiatives that have created new jobs.

The protected cultivation is one of the most promising areas of agriculture in the current context. The State Government is in process of promoting high value agriculture in view of availability of market and proximity of State to the International Airport. Two Centers of Excellence for Vegetables and Fruit Crop Nurseries established in Haryana are functioning at Karnal and Sirsa, respectively in collaboration with Israel.

13.3.2 Seed Business: Among many areas for entrepreneurship, seed sector offers huge opportunities. Global commercial seed market was valued at $37 Billion in 2010 with 5% market growth. Improved varieties, hybrids and GM seeds - resistant to diseases and climatic stresses - are in heavy demand in order to cope with the food requirement. Maize was the highest revenue generating segment. Soybean was second biggest segment with 14% share in global commercial seed market. Tomato seed was another top growing segment followed by cotton seed. Genetically modified seeds were estimated to be the fastest growing segment. Indian seed market, estimated at US$1.1 billion, was the 6th largest in the world. Over the years, the Indian seed market has been growing at the rate of 12% per annum ((http://www.marketsandmarkets.com/Market-Reports/seeds-market-376.html)).

13.3.3 Development of Farmer Relevant Machines and Tools: Farm mechanization has been considered vital for optimal utilization of the available sources and reducing the cost of cultivation. Hence, energy conservation techniques through the use of agricultural machinery have to be given emphasis. Agricultural implements/machinery market in India has huge untapped potential. This market in India was estimated at Rs. (₹) 299.1 billion in 2010. The demand of farm implements/ machinery in domestic market is increasing swiftly. The neighbouring and African countries are also opening markets for Indian farm implements. India is full of small manufactures of farm implements/ machinery, however they need up-skilling.

13.3.4 Food Processing: The Indian food processing industry is primarily export oriented. India's geographical situation gives it the unique advantage of connectivity to Europe, Middle East, Japan, Singapore, Thailand, Malaysia and Korea. One such example indicating India's location advantage is the value of trade in agriculture and processed food between India and Gulf region.

The top five destinations for India's export of processed agricultural products are USA, Indonesia, Vietnam, UAE and China (http://commerce.nic.in/pquestion/LS11032013.pdf). The quantity exported from India is shown in table 13.1.

Table 13.1: The details of processed products exported by India

Year	Quantity (MT)	Value (US$)
2009-10	20,00,690.69	2261.65
2010-11	30,71,987.00	3647.51
2011-12	45,64,664.62	7827.61
2012-13 (Apr. – Dec.)*	36,85,311.30	7872.71

Source: http://commerce.nic.in/pquestion/LS11032013.pdf

To ensure a consistent progress in these areas of agriculture, a stable policy for processed and /or value added agri-products is required for enabling Haryana to move up the value chain in export of agricultural commodities. This would also ensure better realization to farmers, minimizing post harvest losses, employment generation in food processing industries and more investments in creation of infrastructure facilities for agricultural produce. It is expected that the adoption of above policy would stimulate much required investments in the processing sector and cold chain infrastructure in the State which would ultimately result in reduction of wastage of perishable products.

Action Plan:

1. Skill development programme for rural youth and students in the aforesaid areas including the use of ICT are to be regularly conducted. Diploma courses may also be introduced for this purpose
2. Market connect of entrepreneurs should have legal protection
3. Infrastructural and technological back-up should be available to such entrepreneurs

"Uttam kheti, madhyam baan;
nishidh chakri, bhikh nidam".
– Ghagh

It means that agriculture is the best, followed by business, salaried jobs and beggary, in that order.

14. Research Gaps

Haryana has a lot of potential for enhancing production and productivity as indicated from the analysis of attainable potential of crops. Besides, the State can harness opportunities of global agri-business. Obviously, the research programmes will have to be made more dynamic to bridge the critical gaps between technology generation and emerging requirements. The National Food Security Act, 2013, passed by the Parliament and implemented by Government of Haryana, has also necessitated augmented production of food grains, oilseeds, pulses and other food items by making our agriculture more efficient and resilient. Some of the broader areas which need immediate attention are:

14.1 Technology for Small Farmers

More research focus is required to evolve technologies matching the need of small and marginal farm holders who are about 65% of total farmers in the State. These farmers need appropriate, cost-effective and technically viable technologies. Similarly, the farmers of rainfed areas also need specific technologies to enhance efficiency of agriculture. Improving the efficiency of water and fertilizers use is the most important need of these farmers. Block/district specific vulnerability and impact assessment studies are necessary for addressing the problems of the farmers.

The farm mechanization may not be adopted by small farmers without the availability of low cost and efficient machines and tools. Women friendly machine and tools are rarely available. The intensive research efforts will also have to be made in this direction and also to improve the efficiency of indigenous machine and tools in order to reduce drudgery in farm operations, especially of women.

14.2 Climate Resilient Varieties and Hybrids

Frequent fluctuations in climate have necessitated the strengthening of crop breeding programmes in order to develop hybrids/varieties which can successfully face the climatic hazards. There is a need to develop varieties/hybrids of different crops tolerant to heat stress, efficient in input use and resistant to new diseases and pests. CCSHAU has achieved appreciable success in developing input efficient varieties of various crops in the past including varieties of wheat & barley and hybrids of maize and *bajra*. The application of bio-technology in crop improvement programmes is to be promoted properly. More intensive efforts will be needed in this direction to face the climate change. The crops which have export or industrial value like *basmati* rice, *guar*, *oats,* barley, soybean, sunflower, groundnut etc should also receive more attention of researchers. The private sector has now come-up in a big way to develop hybrids in cotton and rice. This is a big challenge before scientists and a strategic research programme is needed to compete with private sector.

14.3 Natural Resources and CA

Scaling-up the research to develop the efficient technologies for soil and water management and enhancing fertilizer use efficiency is an urgent need. Feasible, efficient and cost-effective technologies for micro-management of natural resources and INM in agriculture at block level are to be made available. Water scarcity has to be addressed through improved efficiency of irrigation systems and promotion of low water requiring varieties in different cropping systems.

Benefits of conservation agriculture have been acknowledged world over for resource conservation and enhancing agricultural production as well as quality of produce. However, more research efforts are required to develop these technologies for various agro-climatic conditions of Haryana. Development of technology for crop residue management also needs immediate attention. The use of plastic for soil solarisation and mulch has also helped in increased production and efficient water use. Development of suitable technologies to cut the cost of plastic would help in its faster adoption. The efforts to develop and use of bio-degradable plastics should be encouraged. CCSHAU has developed low cost technology for the production of bio-degradable plastic. It may be refined and promoted for wider use.

Filling the gaps

- *Bridging the gaps among area specific availability of resources, technology generation and technology transfer is required*
- *Integration of bio-technology with conventional breeding approach be promoted*
- *Stakeholders participation in research planning would yield dividend*
- *Out-scaling the farm led innovations required*

14.4 Scaling-up of IPM

Keeping in view the health hazards, cost of production and environmental pollution issues, IPM is being recommended. It is estimated that insect-pests and diseases cause about 15-20% losses in production of field and horticultural crops. The frequent use of pesticides to control pests and diseases escalate the cost of production. Cotton, rice, vegetable and fruit crop growers face recurring problem of huge losses due to high cost of pest control. Besides, high use of pesticides increases the pesticide residue in products and thereby such products are not accepted in global agri-trade. Therefore, intensive efforts will have to be done to develop suitable low cost IPM technology. The IPM is knowledge intensive technology and therefore, matching human resource needs to be developed.

14.5 Post Harvest/Value Addition Technologies, Packaging and Branding

Post harvest management and branding of products are crucial for profitability. Besides capacity building of farmers through education and training, technological back-up should be provided to the farmers. In Indian food industry, the primary processing accounts for almost 80% of the value addition. To enter the global market, the State food industry will have to move to secondary and tertiary processing. Obviously, processing industry and entrepreneurs would need technological support. Changing market trends are influencing branding and packaging with eco-friendly, recyclable and bio-degradable material and there is a growing sophistication in it. The research institutions also need to come out with technologies for value addition/processing along with packaging in harmony with international standards for promoting export.

14.6 Diversification in Agriculture

Diversification has become the general recommendation to solve many problems in agriculture. Intensive studies are needed on diversification to replace or intensify cropping systems. It is understood that reforms are under consideration of the Government for fixation of Minimum Support Price (MSP) and procurement policy for pulses and oilseeds and vegetables, especially potato, onion and garlic

which will promote diversification in agriculture. The groundnut, soybean, sorghum, sunflower, *guar,* castor and pigeonpea are the potential crops which can be promoted under diversification. However, there is need to generate suitable varieties/hybrids along with production and protection technologies with sufficient data on cost benefit ratio and market needs.

14.7 Technology for Organic/Speciality and *Peri*-urban Farming

Haryana has enormous scope for organic/speciality and *peri*-urban farming. The research on these areas needs to be suitably strengthened to support farmers for better return on investment.

14.8 Out-scaling Farm-led Innovations

The farmers have been silently contributing to the agricultural development and evolved innovative methods of farming and also the crop varieties and adopted them to get better production. It is always argued that farmers' innovations are inexpensive, easily accessible, and locally appropriate and tested in real farm situation. The technologies developed by them have rarely been verified, refined, demonstrated and documented. There is urgent need to assess farm innovations decisively and make them available for larger benefits of agriculture. The recommendations of "National Workshop on Farmer-Led Innovations organized by Haryana Kisan Ayog in collaboration with ICAR, CCSHAU, TAAS, PPV&FRA and NIF in 2011 need serious consideration. Inclusion of innovative farmers in decision making, research planning and extension will have greater impact on agricultural sustainability.

14.9 Strengthening Decision Support System

The research on the development of viable decision support system (DSS) is critical in revamping agriculture production and productivity in Haryana. The data bank will help in risk management by accurate forecasting and early warning. A forecasting system for new diseases and pests, market fluctuations and demands should also be strengthened. This will need a strong survey and surveillance system in place. Tamil Nadu has created infrastructure for collecting weather related data at block level. Karnataka is developing a more ambitious system of collecting seven weather parameters at sub-block level. Similar, pursuits are required in Haryana. Infact, a vigorous application of Information and Communication Technology (ICT) based on research data is required.

"The ultimate goal of farming is not the growing of crops, but the cultivation and perfection of human beings." *- Masanobu Fukuoka*

15. Recommendations

The remarkable progress in enhancing agricultural production and productivity in Haryana has been achieved mainly due to research and development, infrastructure development and policy interventions. Now agriculture is facing new challenges which are generally termed as second generation problems. Therefore, it is mandatory to shift focus of research, extension and human resource development to address the emerging problems. The National Commission on Farmers (2007) and "Working Group on Agriculture Production" (2010) have made comprehensive and detailed recommendations for further enhancing agricultural production and productivity in India. Considering these and other related documents and above all discussions/consultations (Annexure – I) with scientists and other stakeholders the "Working Group on Productivity Enhancement of Crops in Haryana", constituted by Haryana Kisan Ayog has come out with this report. The cropwise action plan/researchable issues and critical research gaps have been identified and are given in detail in chapter 6 and 14, respectively. The salient recommendations are as under:

Research

- Haryana has 50% of total area under *basmati* rice in India. The country exports about 5.5 lakh tons of basmati rice every year. Out of which, 60% is contributed by Haryana. Obviously, a strong research programme needs to be developed to meet the requirements of the export market and also to enhance the market share in future
- There is an increasing trend of percent market surplus ratio of *bajra* in Haryana indicating more availability of grains in the market. This market surplus can be put to the alternate uses by industry including developing value added products, health foods, poultry feed, alcohol, roof material, drinks etc. Hence, there is a need to develop specific hybrids which meet the needs of various stakeholders
- The *guar* (cluster bean) is emerging as export and industrial crop and the State is the major stakeholder. Therefore, focused research to meet the demand of industry and export should be undertaken. Keeping in view use of barley in malt industry, globally increasing demand of oats for health food and farmers' inclination towards cultivation of groundnut in some areas, there is need to strengthen research on these crops to meet the requirements of stakeholders and enhance the farm income
- Maize, soybean, castor, sunflower, groundnut, gram, autumn sugarcane and *arhar* have the potential to break the water-intensive rice-wheat cropping system in Haryana. The development of climate resilient hybrids/varieties of these crops may be taken on priority. Appropriate technologies for faster artificial screening of germplasm against diseases, drought, temperature and salinity need to be developed for breeding climate resilient varieties of crops
- Water use efficient rice varieties suitable for DSR and wheat varieties for zero tillage need to be developed and promoted
- The private sector has now come up in a big way to develop varieties/hybrids in cotton and rice. CCSHAU may take appropriate measures to complement efforts to develop hybrids in the interest of farmers

- There is urgent need to provide technological support to small and marginal farmers which account for 65% of the total farming families. These farmers need remunerative farming and cropping systems for which they require low cost machines, tools and feasible technologies. Hence, a State Mission on "Mechanization of Small Farms" may be launched. Research programmes should receive due focus on micro-management of resources including crop residue management and refinement of technologies to meet requirements of such farmers
- Soil and water management problems have emerged as core issues in State agriculture. Increasing organic carbon in soils and enhancing nutrients and water use efficiency are major challenges before the scientists and planners. Therefore, focused research is needed for the development of technologies which provide solution to these problems. The balanced use of fertilizers, promotion of bio-fertilizers, INM and intercropping/relay cropping with pulse crops are to be taken-up. The CA technologies need to be refined and strategically promoted
- The short and long term programmes for the management of weeds, insect-pests, nematodes and diseases should be undertaken. The focus should also be on the control of newly emerging diseases, pests and obnoxious weeds. The yellow rust of wheat and leaf curl virus (CLCuv) in cotton have appeared in certain regions of Haryana. Hence, development of its resistant varieties and management practices should receive priority. The IPM approach may be refined in order to make it easily adoptable and farmer friendly. Strengthening of survey, surveillance, monitoring, and forecasting of emerging pests would help in mitigating crop losses
- The knowledge and technology sharing are important instruments to solve the problems associated with productivity enhancement. The research programmes need to be formulated by sharing knowledge and experiences of farmers, grass-root innovators, agri- entrepreneurs and agro-industries. Possibilities of participation of private sector, where necessary, should be explored and mainstreamed
- The research on the development of viable decision support system (DSS) is critical in revamping agriculture production in Haryana. The data bank will help in risk management by accurate planning, forecasting and early warning. The

Recommendations

- *Establishment of "Gene Bank" at CCSHAU, Hisar for conservation of plant genetic resources*
- *Up-gradation of seed testing laboratories of the department and ISTA accreditation for seed testing laboratory of CCS HAU*
- *Launching of State Missions on "Quality Seed Production" and "Mechanization of Small Farms"*
- *Establishment of "Hybrid Seed Production Cell"*
- *Promote "Innovations" and "Branding" in agriculture*
- *Emphasis on the development of climate resilient varieties/hybrids and soil & water management technologies*
- *Need to develop technologies for micro-management of resources*
- *Technology transfer system needs to be modernized based on ICT*
- *Provision of incentives to farmers for crop diversification*
- *Set-up coordination committee of input agencies for timely availability of inputs*
- *Possibilities of public-private partnership need to be explored to solve the core problems*

information generation system for natural resources, new diseases and pests, market fluctuations and demands need to be strengthened at block level for micro-planning.

Branding of Agri-products

Haryana can regain its agricultural growth trajectory by promoting innovations and inventiveness in this sector. The competition for the development of class products can be created by assuring intellectual property rights and incentives to inventors. CCSHAU and other research institutions should have a mission to create unique products including value added and processed products which meet international standards. Branding of such products (with registered trademark and logo) including organic products, bio-tech products, rice, baby corn, mushrooms, bio-fertilizers, honey, vegetables, fruits etc would attract stakeholders from inside and outside the country. HSDC has popularized crop seeds under brand name "HARYANA BEEJ". Such efforts will help farmers, agro-industry and entrepreneurs in competing in market and enhancing their income. This will have far reaching impact on production and productivity of agriculture in general and crops in particular in the State.

Seed Production

Launching of "State Seed Mission" for effective implementation of seed production programmes of different crops in different regions with the following activities:

- Systematic advanced planning and effective implementation of seed production programmes
- Enhancement in seed/varietal replacement rate and preparation of district wise contingent plan
- State Seed Corporation to be reformed/re-organised to address the emerging seed scenario relating to availability of quality seeds
- Up-gradation of seed testing laboratories of the department and ISTA accreditation for seed testing laboratory of CCS HAU; regular capacity building of staff of certification and seed production agencies
- Creation of "Hybrid Seed Production Cell" under Department of Agriculture in collaboration with the CCSHAU and private sector. Production of hybrid seeds in maize, *bajra*, rice, cotton, sunflower, pigeon-pea, mustard, castor etc to be aggressively taken-up to increase the area under hybrid cultivation. Systematic strengthening of *guar* seed production programme is also urgently needed
- Mass awareness and training programmes for improving the quality of farm saved seed may be taken up
- The seed treatment to be made compulsory
- Inclusion of notified and/or protected varieties and hybrids in package of practices developed by different institutions /sectors need to be done in shortest possible time

Extension and Capacity Building

Women in Haryana are major work force in agriculture as they are involved in each and every activity of farming. They have little or no exposure to new ideas and technologies. Their skill improvement would have direct impact on technology adoption and enhancing agricultural production and productivity

Use of bio-fertilizers and locally available farm yard manure, vermi-compost and green manure need to be promoted. At least 25% area may be targeted under bio-fertilizer and green manuring application every year. Mass campaigns may be organized to make farmers aware about the benefits of these inputs and harms of burning of dung, rice/wheat straw and sugarcane trash etc.

Promotion of water saving technologies, use of micro-nutrients and popularisation of cost effective farm machinery like rice transplanter, sugarcane trash harvester/chopper, etc. need high attention to reduce the cost of cultivation. The farmers will have to be trained for effective adoption of these technologies

Precision farming that includes seed treatment, use of quality seed, timely sowing, maintenance of optimum plant population, irrigation at critical stages of crop growth, INM, application of appropriate pest management practices etc. need to be vigorously promoted for enhancing productivity

The hands-on training to farmers, farm labourers and field functionaries on PHM, operation of biogas plant, vermi-compost units, integrated nutrient management, IPM, use of industrial wastes, pressmud, repair and maintenance of implements/farm machines, etc. will have direct impact on enhancement of farm income

All KVKs need to develop "Extension Kiosks" and "Incubation Centres" that will have long term impact on revolutionizing State agriculture. Farmers and farm labourers may be trained on high-value agriculture technologies to compete in domestic and global markets

Important features and provisions of different legislations *viz.,* Seed Act 1966, Biological Diversity Act 2002, Protection of Plant Varieties & Farmers Rights Act 2001 and Geographical Indications of Goods Act 1999 may be included in the package of practices of the State to make farmers and field functionaries aware

Technology transfer system needs to be modernized based on ICT. Provision of incentives and awards to farmers and extension workers for the faster adoption/transfer of the technology should be there. Extension and training programmes for input suppliers for updating their knowledge need to be introduced

Infrastructure Development

Establishment of "Gene Bank" at CCSHAU for conservation of plant genetic resources is required. In addition, the seed and fodder Banks may be created by the State departments concerned under the technical guidance of the Universities for sustainability of farming systems and meeting the exigencies

Creation/strengthening of certification facilities for testing of organic products, soil & water

quality, seed health and pesticide residues need to be undertaken. In addition, creation of storage facilities agricultural inputs and produce require attention for reducing post harvest losses

Development of incubation centres for benefit of entrepreneurs and stakeholders for promoting commercial agriculture

Development of facilities for weather data collection and base line survey of all natural resources at block level for micro-level planning and effective management of resources need to be undertaken

Policy Framework

Providing incentives to farmers for crop diversification and creating enabling environment for promoting industries and market support for the promotion of crops like maize, *guar*, soybean, sunflower, castor, groundnut, autumn sugarcane and *arhar*.

Establishment of effective and speedy delivery systems for new technologies and crop advisories. Soil Health Card (SHC) services may be linked to Unique Farmer Identity (UFI) and information network.

Strengthening of input delivery mechanism for ensuring quality inputs in adequate quantity, at affordable prices and right time/place. (A policy to make agricultural graduates dealers of agricultural input needs to be brought in place. This will improve efficiency and effectiveness of technology transfer).

Water and power pricing need to be rationalised for their economic and efficient use.

There is need to introduce a simplified process of credit facilities to the farmers/ entrepreneurs with a conducive taxation policy for encouraging agro-based industries. These measures will create employment opportunities.

MGNREGS may be linked to farming to ensure the availability of farm labour.

A coordination committee need to be constituted including the members of various departments viz; agriculture, irrigation, electricity, rural development, along with government input agencies to facilitate timely availability of inputs.

Contract farming and custom hiring services need to be incentivised and promoted.

Public-private partnerships need to be promoted to accelerate programmes like development of hybrids, water harvesting, processing and packaging, supply chain establishment, storage, marketing, energy management etc.

Promotion of solar, bio-mass and wind power in agriculture needs special attention.

The farmers need assured access to basic resources, which include land, water, bio-resources, credit and insurance, technology and knowledge management and market.

- National Commission on Farmers

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LIST OF TABLES

Table No.	Title of the Table	Page No.
1.1	Agricultural Zones of the State	2
2.1	Productivity status of major crops	9
2.2	Percent growth in Haryana agriculture (at 2004-05 prices)	11
4.1	Erratic rainfall in Haryana impacting agriculture	17
4.2	Soils showing macro and micro-nutrients deficiency	18
4.3	Average size of holdings (ha) 2011-12 in different zones of Haryana	19
4.4	Number of districts in different zones performing below the State average in productivity based on data 2011-12	21
4.5	Productivity (kg/ha) gaps at block level in different districts (kg/ha)	22
4.6	Important insect pests and diseases of major crops in Haryana	23
4.7	Increase in cost of production of major crops (Rs Q/ha)	24
6.1	Estimated production of rice by achieving the targeted productivity (Year 2011-12)	34
6.2	Estimated production of rice by achieving the targeted productivity (Year 2011-12)	34
6.3	Estimated production of rice by achieving the targeted productivity (Year 2011-12)	35
6.4	Additional production of rice by bridging the productivity gaps among districts	35
6.5	Estimated production of wheat by achieving the target productivity (Year 2011-12)	38
6.6	Estimated production of wheat by achieving the target productivity (Year 2011-12)	38
6.7	Estimated production of Wheat by achieving the target productivity (Year 2011-12)	39
6.8	Additional production of wheat by filling the productivity gaps among districts	39
6.9	Estimated production of barley by achieving the target productivity in Zone-II (Year 2011-12)	41
6.10	Estimated production of barley by achieving the target productivity (Year 2011-12)	42
6.11	Additional production of barley by filling the productivity gaps among districts	42
6.12	Estimated production of maize by achieving the target productivity (Year 2011-12)	44
6.13	Additional production of maize by filling the productivity gaps among districts	44
6.14	Estimated production of *bajra* by achieving the target productivity (Year 2011-12)	46
6.15	Estimated production of *bajra* by achieving the target productivity (Year 2011-12)	47
6.16	Estimated production of *bajra* by achieving the target productivity (Year 2011-12)	47
6.17	Additional production of *bajra* by filling the productivity gaps among districts	48

6.18	Estimated production of *rabi* oilseeds by achieving the target productivity (Year 2011-12)	49
6.19	Estimated production of *rabi* oilseeds by achieving the target productivity (Year 2011-12)	50
6.20	Estimated production of *rabi* oilseeds by achieving the target productivity (Year 2011-12)	50
6.21	Additional production of oilseeds by filling the productivity gaps among districts	51
6.22	Estimated production of gram by achieving the target productivity (Year 2011-12)	53
6.23	Estimated production of gram by achieving the target productivity (Year 2011-12)	53
6.24	Additional production of gram by filling the productivity gaps among districts	54
6.25	Estimated production of cotton by achieving the target productivity (Year 2011-12)	58
6.26	Estimated production of cotton by achieving the target productivity (Year 2011-12)	58
6.27	Estimated production of cotton by achieving the target productivity (Year 2011-12)	59
6.28	Additional production of cotton by filling the productivity gaps among districts	59
6.29	Estimated production of Sugarcane by achieving the target productivity (Year 2011-12)	62
6.30	Estimated production of Sugarcane by achieving the target productivity (Year 2011-12)	62
6.31	Estimated production of Sugarcane by achieving the target productivity (Year 2011-12)	63
6.32	Additional production of sugarcane by filling the productivity gaps among districts	63
6.33	Estimated additional production of major crops by enhancing productivity of lower performing districts/blocks.	65
7.1	Seed replacement rate (%) of major *kharif* crops of Haryana (2003-2010)	66
7.2	Seed replacement rate (%) of major *rabi* crops of Haryana (2007-2013)	66
7.3	Seed rolling plan for *rabi* crops	67
7.4	Seed rolling plan for *kharif* crops	68
10.1	Potential cropping systems for various agro-climatic zones in Haryana	74
13.1	The details of processed products exported by India	82

LIST OF FIGURES

Figure No.	Title of the Figure	Page No.
1.1	Map Showing ecology and cropping pattern zones	2
2.1	Production of food grains in Haryana (000 tons)	9
2.2	Production of pulses, oilseeds and cotton in Haryana	9
2.3	Decadal growth (%) of productivity of major *kharif* crops in Haryana	10
2.4	Decadal growth (%) of productivity of major *rabi* crops in Haryana	10
2.5	Decadal growth (%) of productivity of major commercial crops in Haryana	11
3.1	Change in area (%) under major *kharif* crops in Haryana	14
3.2	Change in area (%) under major *rabi* crops in Haryana	15
4.1	Increasing use of fertilizers and pesticides	20
4.2	Increasing use of tractors, tubewells & Electricity	20
6.1	Area (000 hectares) of rice in Haryana	33
6.2	Area, production and productivity of rice in Haryana	33
6.3	Area, production and productivity of scented rice	33
6.4	Area, production and productivity of non-scented rice	33
6.5	Area (000 hectares) of wheat in Haryana	37
6.6	Area, production and productivity of wheat in Haryana	37
6.7	Area (000 hectares) of barley in Haryana	40
6.8	Area, production and productivity of barley in Haryana	40
6.9	Area (000 hectares) of maize in Haryana	43
6.10	Area, production and productivity of maize in Haryana	43
6.11	Area (000 hectares) of *bajra* in Haryana	46
6.12	Area, production and productivity of *bajra* in Haryana	46
6.13	Area (000 hectares) of *rabi* oilseeds in Haryana	49
6.14	Area, production and productivity of *rabi* oilseeds in Haryana	49
6.15	Area, production and productivity of *rabi* pulses in Haryana	52
6.16	Area, production and productivity of *kharif* pulses in Haryana	52
6.17	Area (000 hectares) of gram in Haryana	52
6.18	Area, production and productivity of gram in Haryana	52
6.19	Trend in area, production and productivity of *guar* in Haryana	55
6.20	Area (000 hectares) of cotton in Haryana	57
6.21	Area, production and productivity of cotton in Haryana	57
6.22	Area (000 hectares) of sugarcane in Haryana	61
6.23	Area, production and productivity of sugarcane in Haryana	61
6.24	Recovery of sugar in Haryana	61

Annexure-I

Consultations Meetings of the working group held with various stakeholders including farmers, scientists, policy makers, State development departments and input agencies.

Date	Event	Venue
January 28, 2012	Meeting of the working group	TAAS, New Delhi
February 23-24, 2012	Consultation meeting with scientists	CCS HAU, Hisar
February 25, 2012	Consultation with farmers	CCS HAU, Hisar
March 16, 2012	Consultation meeting with policy makers and State development departments	New Haryana Civil Secretariat, Chandigarh
March 17, 2012	Consultation meeting with input and supply agencies (public, private)	NDRI, Karnal
April 17, 2012	Meeting of the working group for synthesis of outcome of the consultation meetings	PPV&FR Authority, New Delhi
May 4-5, 2012	Discussion on basic structure of the report Preparation of information on rice, wheat, barley	TAAS and PPV&FR Authority, New Delhi
May 24-25, 2012	Preparation of information on maize, bajra, pulses and oilseeds Preparation of information on sugarcane, guar and cotton	TAAS and PPV&FR Authority, New Delhi
June 20-24, 2012	Cross cutting issues on crop management, NRM Documentation of information on seed Preparation of the zero draft	PPV & FR Authority, New Delhi
September 17-18, 2012	Preparation of the first draft report	PPV & FR Authority, New Delhi
January 1-2, 2013	Review and editing of the first draft report	TAAS, New Delhi
June 22-23, 2013	Discussion on draft	NDRI, Karnal
July 04, 2013	Discussion on draft	NASC Complex, New Delhi
July 16-18, 2013	Discussion on draft	Hamirpur, HP
August 17, 2013	Final discussion on draft	TAAS, New Delhi

ACRONYMS

ABIC	:	Agri-Business & Information Centres
AD	:	Anno Domini
AICRP	:	All India Coordinated Research Project
APEDA	:	Agricultural and Processed Food Products Export Development Authority
BC	:	Before Christ
CA	:	Conservation Agriculture
CAGR	:	Compound Annual Growth Rate
CBD	:	Convention of Biodiversity
CCSHAU	:	Chaudhary Charan Singh Agricultural University
C-DAP	:	Comprehensive, District Agriculture Plan
CFS	:	Container Freight Station
CMS	:	Cytoplasmic Male Sterility
CRIDA	:	Central Research Institute for Dryland Agriculture
CSSRI	:	Central Soil Salinity Research Institute
DSR	:	Direct Seeded Rice
DSS	:	Decision Support System
DWR	:	Directorate of Wheat Research
EDI	:	Electronic Data Inter-Change
EMM	:	Environmental Mosquito Management
FCI	:	Food Corporation of India
FIRBS	:	Furrow Irrigated Raised Bed Planting System
FYM	:	Farmyard Manure
GAP	:	Good Agricultural Practices
GDP	:	Gross domestic product
GHG	:	Greenhouse Gases
GI	:	Geographical Indications
GIS	:	Geographic Information System
GM	:	Genetically Modified
GOI	:	Government of India
HAFED	:	Haryana State Co-operative Supply and Marketing Federation Limited
HKA	:	Haryana Kisan Ayog
HLRDC	:	Haryana Land Reclamation and Development Corporation
HSAMB	:	Haryana State Agriculture Marketing Board

HSDC	:	Haryana Seed Development Corporations
HSMF	:	Haryana State Federation of Cooperative Sugar Mills
HSSCA	:	Haryana State Seed Certification Agency
IARI	:	Indian Agricultural Research Institute
ICAR	:	Indian council of agricultural research
ICD	:	Inland Container Depot
ICT	:	Information and Communications Technology
INM	:	Integrated Nutrient Management
INRS	:	Indian Rupees
IPM	:	Integrated Pest Management
IPM	:	Integrated Pest Management
IRM	:	insect resistance management
ISOPOM	:	Integrated Scheme of Oilseeds, pulses, oil palm and maize
ISTA	:	International Seed Testing Association
IT	:	Information Technologies
IWM	:	Integrated Water Management
KCC	:	Kisan Credit Cards
KGK	:	Krishi Gyan Kendra
KVK	:	Krishi Vigyan Kendra
KWH	:	kilowatt-hour
MGNREGS	:	Mahatma Gandhi National Rural Employment Guarantee Scheme
mha	:	Million Hectare
MNC	:	Multinational Corporation
MPEDA	:	Marine Products Export Development Authority
MSP	:	Minimum Support Price
MT	:	Million Tones
NBAGR	:	National Bureau of Animal Genetic Resources
NCF	:	National Commission on Farmers
NCR	:	National Capital Region
NCT	:	National Capital Territory
NDRI	:	National Dairy Research Institute
NGO	:	Non-governmental organizations
NHRDF	:	National Horticultural Research and Development Foundation
NIF	:	National Innovation Foundation
NPK	:	Nitrogen Phosphorus Potassium
NRAA	:	National Rainfed Area Authority

NRM	:	Natural Resource Management
NSC	:	National Seed Corporation
NSFM	:	National Food Security Mission
OCM	:	Organic Carbon Matter
PHM	:	Post Harvest Management
PHT	:	Post Harvest Technology
PPV&FRA	:	Protection of Plant Varieties & Farmers' Rights Authority
QPM	:	Quality Protein Maize
RCT	:	Resource Conserving Technologies
RKVY	:	Rashtriya Krishi Vikas Yojana
SAU	:	State Agricultural Universities
SBB	:	State Biodiversity Board
SBI	:	Sugarcane Breeding Institute
SHC	:	Soil Health Card
SLM	:	Suitable Land Management
SOM	:	Soil Organic Matter
SPS	:	Sanitary and Phyto-sanitary
SRR	:	Seed Replacement Rate
SSC	:	Seed State corporation
SWOT	:	Strength, Weakness, Opportunity and Threats Analysis
TAAS	:	Trust for Advancement of Agricultural Sciences
TEEB	:	The Economics of Ecosystems and Biodiversity
TFP	:	Total Factor Productivity
TRIPS	:	Trade Related Intellectual Property Right
UAE	:	United Arab Emirates
UFI	:	Unique Farmer Identity
USA	:	United States of America
USAR	:	*Usar* land (Scheme for Reclamation of Alkali Soils)
WBCIS	:	Weather Based Crop Insurance Scheme
WG	:	Working Group
WGAP	:	Working Group on Agriculture Production
WTO	:	World Trade Organization

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