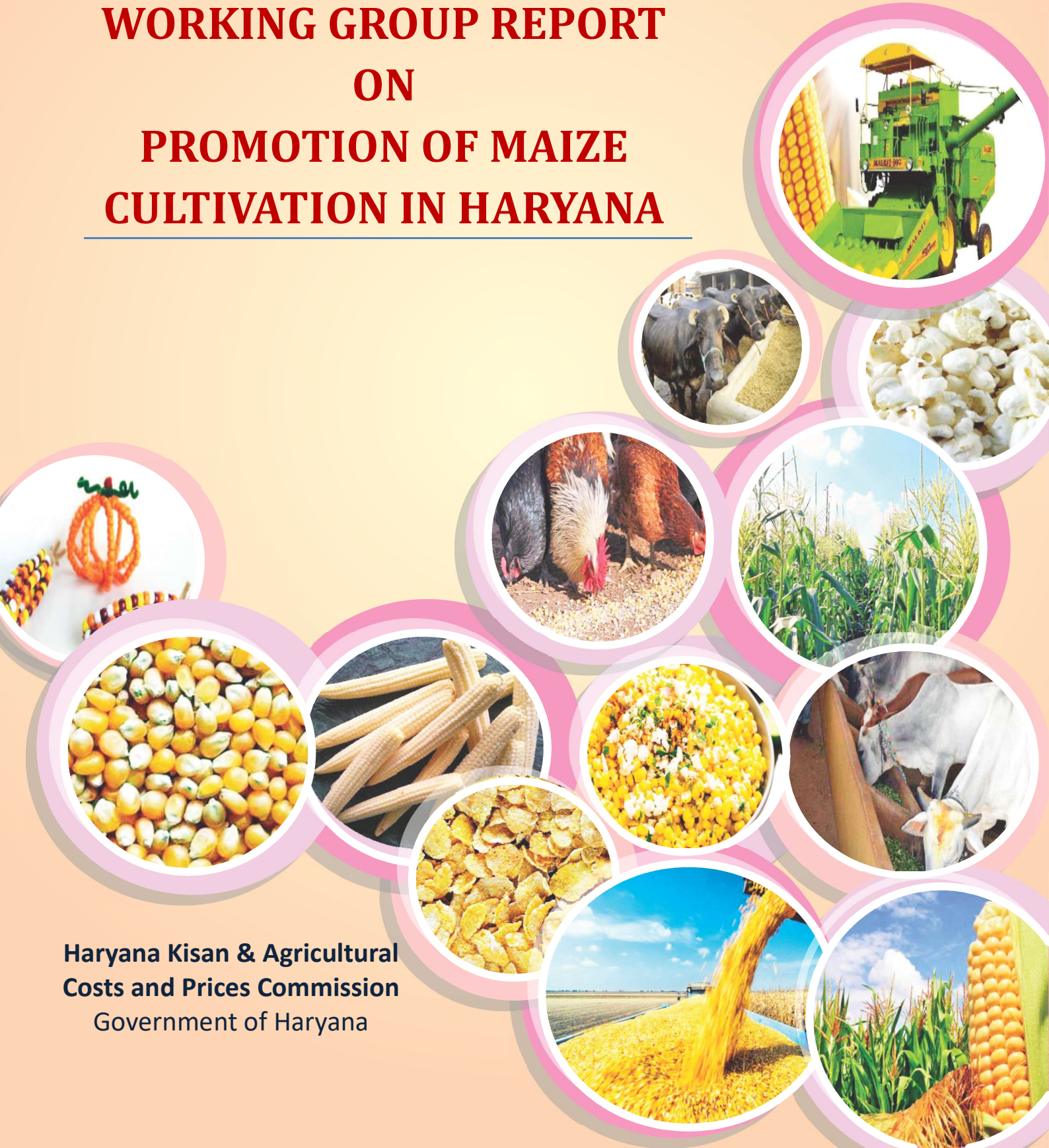
WORKING GROUP REPORT ON PROMOTION OF MAIZE CULTIVATION IN HARYANA



Haryana Kisan & Agricultural Costs and Prices Commission
Government of Haryana

Report of Working Group

on

'Promotion of Maize Cultivation in Haryana'

Dr. Sain Dass, Dr. Shankar Lal Jat, Dr. R.K. Yadav,
Dr. Anjani Kumar and Dr. Jawala Jindal

2020

Submitted to

Haryana Kisan & Agricultural Costs and Prices Commission
(Government of Haryana)
Anaj Mandi, Sector-20, Panchkula-134116

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Working Group report on
"Promotion of Maize Cultivation in Haryana"

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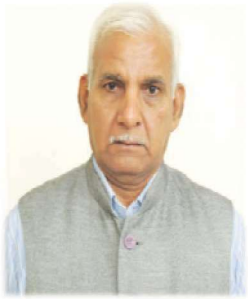


Foreword

Haryana played a key role in Green Revolution making our country self-reliant in food production. The hard working, dynamic and resilient farmers of the state have played important role in transforming the nation from a 'food deficit' to the 'food surplus' country. However, extensive cultivation of the wheat and rice has caused over-exploitation of the precious natural resources particularly water and soil. Burning of rice straw is another major issue Haryana in particular and the nation as a whole due to the very short time window available between harvesting of rice and sowing of wheat. These issues can be addressed by farmers shifting from rice to maize cultivation.

Maize crop also known as queen of the cereals is mainly used as food, poultry feed, fodder and industrial raw material. Being a less water demanding crop, shifting from rice to maize could immediately address the issue of declining water table. Maize cultivation will enable to reduced cost of electricity for pumping water, lessen the risk of terminal heat stress in wheat due to early sowing and reduce the use of pesticides as compared to rice.

Appropriate policy and programme interventions from the government are needed to make an impact in favour of crop diversification through maize. Development of proper infrastructure can promote maize diversification particularly for specialty corn like sweet corn, baby corn and popcorn as the demand for these is increasing day by day in the country. The silage prepared from maize is of best quality and is highly preferred over silage of other fodder crops. Establishment of linkages between the specialty corn (baby corn and sweet corn), fodder and silage cultivation farms and dairy farms could further boost livestock industry and will also ensure better remuneration to maize growers.

Promotion of mechanized maize cultivation through arrangement of machines like maize planters, combine harvesters, dryers etc. to the farmers on custom hire basis will help to achieve the goal. Establishment of end-user industries like maize based food, poultry feed and starch industries and storage facilities would promote entrepreneurship and attract investment in agriculture creating competition in the market. It will also help in achieving the target of raising income of farmers' and reducing the stress on natural resources much faster.

Haryana Kisan & Agricultural Costs and Prices Commission constituted a working group under chairmanship of Dr. Sain Dass and Dr. Shankar Lal, Dr. Anjani Kumar, Dr. R K Yadav and Dr. Jawala Jindal as members from various related subjects to suggest measures for large scale adoption of maize cultivation for crop diversification in Haryana. After several deliberations and discussions with different stakeholders, the working group has done a commendable job in presenting the current scenario, interventions needed & showing the future road map for diversification through maize crop.

I am sure that recommendations of this group will help in formulating strategies by the State government and other stakeholders for the promotion of maize cultivation.

(Ramesh Kumar Yadava)

Dr. Sain Dass
Chairman
Working Group
Former Director, Maize (ICAR) and
Maize Expert, New Delhi.

Preface

Rice became a major food crop in Haryana after the introduction of high yielding varieties along with expansion of irrigation facilities and strong policy support as assured procurements at the minimum support price. This promoted a monotonous rice-wheat cropping system which created problem of fast depletion of ground water, degrading soil physical health, declining factor productivity and environmental pollution. To check further deterioration of the agriculture scenarios in the state, the government of Haryana took initiative for diversification of this cropping system.

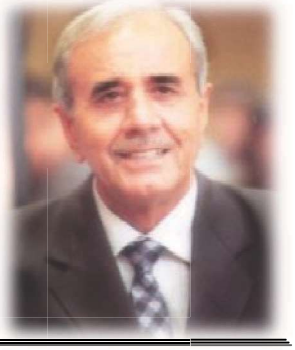
The government started *Jal hi Jeevan Yojana* to promote primarily maize and other crops in place of rice for arresting the further decline of the natural resources and saving them for our future generation.To make the diversification sustainable and effective a working group was constituted by Haryana Kisan and Agricultural Costs and Prices Commission on "Promotion of the maize cultivation in Haryana". The group had comprehensive meetings, extensive field visits and consultation workshops with stakeholders in maize value chain involving farmers, traders, industries (seed, feed, poultry, starch, machinery etc), state department officials, scientists of universities and KVKs.

These interactions and visits helped the members WG to understand the emerging demand for maize in the state and the willingness of different stakeholders to promote maize cultivation. This report is an outcome of the extensive interaction and analysis to promote long-term strategy for maize development in Haryana that may go a long way in ensuring agricultural sustainability and improving livelihood of the farmers. We feel that if the suggested measures are implemented, Haryana will witness a maize revolution in the near future and will be role model for other ecologies facing the similar problem of natural resource degradation.

The completion of report would not have been possible without support of many institutions and individuals. We place our appreciation and gratitude to the Aayog for reposing faith in us for this important task. We are also thankful to all stakeholder including farmers, industry representatives, scientists and government officials for their input during the interactions to make this report more vibrant. Their help and cooperation during the preparation of report are gratefully acknowledged.

(Sain Dass)

Dr. R. S. Balyan
Member Secretary
Haryana Kisan & Agricultural
Costs and Prices Commission , Panchkula
(Government of Haryana).



Acknowledgments

Northern- Western Indian States – Haryana, Punjab and Western Uttar Pradesh are well known heartland of Green Revolution and provide bulk of wheat and rice in the national food basket. Paddy, grown initially in about 2-3 lakh hectare mostly in the eastern districts of Haryana, has now occupied about 13 to 14 lakh hectare area spread all over the state. This increase in area has lead to more paddy production and graeter contribution to central pool but simultaneously it has resulted in many problems of which, beside environmental pollution, the depleting ground water table is of greater concern.

The Haryana Kisan & Agricultural Costs and Prices Commission as well as Government have thought of diversifying the paddy cropped area with number different crops in respective seasons. Best suitable alternative of paddy in kharif season is the maize crop that helps to combat and reversing these effects in the State. Therefore, HKACPC constituted a working Group on 'Promotion of Maize Cultivation in Haryana' with Dr. Sain Dass as Chairman, Dr. Shankar Lal, Dr. Anjani Kumar, Dr. Ramesh Kumar Yadav and Dr. Jawala Joindal as the Members to deliberate on this state of affairs and put forward suggestive guidelines in this regard. The expert group deserves all the appreciation for their sincere efforts in finalization of this report.

I am confident that this report will turn a new leaf and enlighten a 'Way Forward' for promotion of maize farming in Haryana as the beneficial option. I also believe that this important publication will be of immense use to the planners, administrators, researchers, farmers and other stakeholders. I do hope that the implementation of various recommendations by the government will promote maize farming in Haryana in a big way.

My sincere thank are to Dr. Ramesh Kumar Yadava, Chairman Haryana Kisan & Agricultural Costs and Prices Commission and Dr. Shyam Bhaskar, Member for their guidance and support during the functioning of the working group. I am also thankful to Dr. Partap Singh, Consultant, Dr. Sanjay Yadav and Mrs Vandana, Research Fellows and other staff members of HKACPC for their valuable assistance rendered in the preparation of this document.

Finally, I am thankful to the all stakeholders and farmers of the Haryana state who put forward their valuable suggestions in preparation of this report.

(Rajender Singh Balyan)

HARYANA KISAN & AGRICULTURAL COSTS AND PRICES COMMISSION

(Government of Haryana)

Anaj Mandi, Sector – 20, Panchkula-134116

NOTIFICATION

No. HKACPC/2019/341-54 **Dated: 14th June,2019**

The Chairman, Haryana Kisan & Agricultural Costs and Prices Commission is pleased to constitute the following working group on **"Promotion of Maize Cultivation in Haryana":**

1. Dr. Sain Dass, Former Director, Maize (ICAR) and Maize Expert, New Delhi. Chairman
2. Dr. Shankar Lal, Maize Agronomist, ICAR-IIMR, Ludhiana. Member
3. Dr. Anjani Kumar, Economist International Food Policy Research Institute (IFPRI), New Delhi Member
4. Dr. R K Yadav, Vegetable Specialist, ICAR,-IARI, New Delhi Member
5. Dr. Jawala Jindal, Assistant Entomologist (Maize) Dept. of Pl. Breed. & Genet., PAU, Ludhiana Member

Officials from Haryana Kisan & Agricultural Costs and Prices Commission:

1. Dr. R S Balyan, Member Secretary, HKACPC Administrative Support
2. Dr. Partap Singh Partap, Consultant, HKACPC Nodal Officer
3. Dr. Sanjay Yadav, Research Fellow, HKACPC Associate Nodal Officer

Terms of Reference:

1. To analyse the present status of maize cultivation in Haryana (India) and its scope *vis a vis* Pop corn, Baby corn, Sweet corn, QPM, fodder, silage etc.
2. To analyse strength and weakness of diversification with maize in R-W sequence in Haryana.
3. To suggest measures for capacity building and value chain strengthening to ensure effective diversification.
4. To suggest ways & means to make maize cultivation more profitable through practicing intercropping.
5. To recommend "Way Forward" and mechanism for knowledge & technology transfer/dissemination for popularisation of maize cultivation.
6. Strategies for improving natural resources with maize based diversification.

Other Terms and Conditions (Administrative):

1. On submission of report, the members will be entitled for a lump sum honorarium of Rs. 25000/- each, whereas the Chairman will be paid an honorarium of Rs.50000/-.
2. Members of working group will be paid only TA for attending meetings on actual basis and an honorarium of Rs. 2000/- for each meeting. Local hospitality will be arranged by the Commission.
3. The working group may invite one or more special invitees to seek their views in specific meetings. Such special invitees will also be paid honorarium and other expenses by the Commission, as per norms for other members, for their participation and contribution, only for that particular meeting.
4. The Commission will bear the cost on conducting the meetings and printing of the report.
5. The working group should submit its report preferably in three months from the date of this notification.

MEMBER SECRETARY
HARYANA KISAN & AGRICULTURAL
COSTS AND PRICES COMMISSION

Endst No. HKACPC//2019/341-354 **Dated: 14th June, 2019**

A copy is forwarded for information and necessary action to :

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7. The Additional Chief Secretary Govt of Haryana, Agriculture & Farmers' Welfare Department, Chandigarh.
8. Vice-Chancellor, CCSHAU, Hisar
9. Dr. R.S. Balyan, Member Secretary, HKACPC, PKL
10. Dr. Shyam Bhaskar, Member, HKACPC, PKL
11. The Director General, Departmrnt of Agriculture and Farmers Welfare Haryana.
12. Dr. Partap Singh Partap, Consultant, HKACPC, PKL
13. Dr. Sanjay Yadav, Research Fellow, HKACPC, PKL
14. Accounts Officer, HKACPC, PKL.

MEMBER SECRETARY
HARYANA KISAN & AGRICULTURAL
COSTS AND PRICES COMMISSION

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Executive Summary

Expansion of rice to the non-traditional belt of Haryana was the need of hour to ensure food security of the country that happened due to good cultivars and expansion of irrigation facility. However, it has created problem of falling water table and environmental pollution. The diversification with alternate crops like maize was thought to be the best bet for coping with problem of falling water table and environmental degradation. The Government of Haryana took a good initiative to diversify the 50000 ha rice with alternate crop primarily maize in kharif 2019 by incentivizing free seed along with contribution of farmer share of crop insurance and procurement at minimum support prices. The growing of maize can save 90% water and 70% of energy compared to rice.

It also has environmental benefits of reducing greenhouse gas emission, solving problem of residue burning, improving soil physical properties and biodiversity, lesser ground water pollution. The maize growing will also help in enhanced wheat production due to reduced terminal heat stress by timely planting and gives opportunity for mustard cultivation, summer mung bean and early vegetables. Moreover, presently maize cultivation is completely mechanized and this crop is more suits for conservation agriculture and thus offers additional benefits of no problem of residue burning. The silage and green fodder from maize along with specialty corn (baby corn and sweet corn) by-products promotes the growth of livestock in the state.

However, as maize became non-traditional crop in this ecology and the stakeholders need handholding and strategy for it promotion. The Haryana Kisan and Agricultural Costs and Prices Commission, Government of Haryana constituted working group on Promotion of Maize Cultivation in Haryana" in June 2019 to suggest plausible strategy for successful maize based diversification. The group had meetings and visited field with all stakeholders including farmers, industries including seed, farm implement, starch and feed, farmer organizations to analyze the environment for successful diversification.

At present domestic demand for maize is 15 to 18 lakh tonnes primarily for poultry (12-15 lakh tonnes) and starch (3 lakh tonnes). State also needs maize for livestock feed, green fodder, silage, food and value addition. In future the high growth rate of poultry industry (>10%/year) and demand for ethanol/brewery/alcohol and poly-acrylic acid (PLA) for bio-plastic will need more maize in the state. In this scenario, present production of nearly 2 lakh tonnes requires all measures for enhancing its production in the state to thrive these industries and enhancing employment generation with saving of natural resources.

In this direction the government policy and support for advance arrangement of inputs, machinery arrangement, assured procurement at MSP like rice and wheat, crop insurance and establishment of corn villages urgently needed. The suitable areas with non-saline soil and non-waterlogged conditions should be identified for maize and publicity and trainings/awareness programme of maize in print and electronic media should be started in the month of May. The efforts should also be made for development of linkages with stakeholders for contract farming and innovative mechanism for diversification benefit transfer. The recently recommended long-duration single cross hybrid with 8-10 t/ha yield

potential at research farm should only be grown for better production which can ensure at least 7 t/ha productivity at the farmers field.

The immediate measure including publicity, inclusion of machinery in maize cultivation under subsidy net and its arrangement, Maize Divas, trainings to stakeholders, arrangement and handover of diversification kit (seed, agrochemical and literature) to farmer, seed availability of early season vegetables in *peri*-urban interface in maize system, procurement of maize, felicitation of the farmer/village adopting or official efforts towards successful diversification, establishment of corn villages (input and marketing support), maize farmer producer organization/SHGs establishment and promotion of silage from maize for dairy and export should be done appropriately on time by various stakeholders as suggested in the report.

We also found that the government should also take some intermediate measure including promotion of contract farming by poultry, feed, seed, starch etc industries, CSR fund of industry towards protection of natural resources by maize cultivation, reduction of subsidy on water pumping, rebate on the taxes for maize purchasing by industry, cold chain for specialty corn and vegetables, export facilitation by establishment of maize export zone and tax rebate/subsidized electricity for establishment of maize based agro-industry for sustainable maize diversification model. In long-run, steps for phasing out subsidy on water pumping for sustainability and phasing out of the incentives towards promotion/purchase of the established crops in the Haryana could also be thought of for overall sustainability of agriculture in the Haryana.

We are grateful to the Kisan Aayog for shouldering this responsibility on us for devising strategy for the promotion of maize in Haryana. We are in the opinion that a holistic effort of stakeholders with grater government involvement will help in the making diversification of rice with maize successful in Haryana by adopting the strategy and road map suggested in our report.

(Sain Dass)	**(Shankar Lal Jat)**	**(Anjani Kumar)**	**(R.K. Yadav)**	**(Jawala Jindal)**
Chairman	Member	Member	Member	Member

1. Maize for Diversification in Haryana

Rice and wheat are the major food grain crops in Haryana. Area under rice increased from 1.92 to 14.22 lakh ha and its production increased from 2.23 to 45.23 lakh tonnes during 1966-67 to 2017-18. Since late sixties, the introduction of high yielding varieties of rice along with expansion of irrigation, electricity facilities and assured procurement as favourable government policies boosted rice cultivation. Also, earlier the cultivation of rice was the need of hour for ensuring food security and it helped to bring out food self-sufficiency and prosperity of farmers in our country. Thus, at present the agriculture in Haryana is predominated by rice based cropping system. The traditional maize cultivated area has also been occupied by rice cultivation. This shifting was accelerated due to non-availability of high yielding cultivars in maize at that time.

The rice cultivation is recommended in the areas receiving rainfall more than 1200 mm; however, its expansion in the areas having limited water availability and lesser rainfall has resulted in decline of underground water table to an alarming level. Apart from declining water table, now the rice cultivation has created some other serious problem and environment threats *viz.*, enhanced ground water pollution by leaching of nutrients and pesticides, altered soil physical properties and the soil biodiversity, enhanced greenhouse gasses emission and also burning of rice residue is causing environmental pollution etc.

Adverse effect of rice cultivation

- Groundwater level has depleted by 1 m/year since 2013.
- Underground water level has plunged by 20-60 metres in 19 of 22 districts of Haryana due to non-conventional rice (<1200 mm rainfall area).
- More 'Dark Zones' as ground water is drying up rapidly.
- Canal waters and groundwater salinity has led to water logging.
- Ground water is getting polluted by leaching of nitrate and agrochemical.
- There is depletion of soil physical health along with environmental pollution, underground water contamination and loss of biodiversity.
- Favoured incidence of pest (weed, disease etc) is on increase.
- Human and animal health is affected due to excessive use of agrochemicals.

Need of potential substitute crop

An urgent need is felt to reduce the area under rice and, diversification of it with remunerative, less risky and eco-friendly crops can help in addressing many of these problems. Maize has potential to emerge as the most appropriate substitute which can bring more prosperity to the farming community without adversely affecting natural resources. It has also added advantage to save the precious resources like water and electricity. Maize was a major crop in North Eastern Haryana until 1970s in *kharif* season having more than 1.7 lakh ha in Karnal, Ambala, Kurukshetra, Yamunanagar, Panipat etc. Due to raw material availability, first starch industry of the country was established at Yamunanagar in 1937. However, because of our emphasis on rice and wheat to ensure food security of the nation, promotion of maize in irrigated area of state did not get due attention.

At present due to increased adverse consequences of rice cultivation and promising innovations in the maize research and development and availability of technical know-how it is high time to promote maize cultivation in the state to prevent further deterioration in natural resources and to ensure long-term sustainability of agricultural development in the state. In view of this, Haryana Kisan & Agricultural Costs and Prices Commission, Government of Haryana constituted a working group on "Maize for crop diversification". The group has meetings with the all the stakeholders involved in maize value chain for preparing road map of maize based diversification in the state (Annexure III).

Maize is the only crop that has many types like dent corn, flint corn, sweet corn, QPM, baby corn, popcorn, fodder maize etc. The maize cultivation leads to improvement in soil health and biodiversity. Utilization of maize is primarily in poultry and livestock/feed, starch, value addition etc. It also addresses issues of *peri*-urban agriculture with cultivation of baby corn, sweet corn, vegetables intercropping system. The export-oriented agriculture hubs can be established for feed, baby corn, sweet corn etc for employment generation in specialty corn and value addition. Maize helps for livestock promotion by use of by-products of sweet corn, baby corn, fodder maize, feed blocks and silage making for livestock and export to neighbouring states.

Considering potential of maize in crop diversification Government of Haryana considered it as major crop in *Jal hi Jeevan Yajna* launched in *kharif* 2019. In the beginning, the scheme envisaged replacement of 50000 ha area of Non-Basmati rice primarily under Maize and other crops. This Pilot Scheme was initiated in 7 Blocks of different districts (Table 1) in the state.

Table 1: Blocks identified for implementation of Crop Diversification Scheme in Haryana during *kharif* 2019

Sr. No.	Name of District	Name of Block	Average Cultivated Area under Paddy	Target Area under cultivation of Non-Basmati Rice for the adoption of new scheme
1	Karnal	Asandh	44500	12000
2	Kaithal	Pundri	40000	11000
3	Jind	Narwana	34907	7000
4	Kurukshetra	Thanesar	18200	7000
5	Ambala	Ambala-I	25212	8000
6	Yamunanagar	Radour	14000	2500
7	Sonipat	Gannaur	18538	2500
Total			**195357***	**50000**

* Approximately 45% of this area is non-basmati.
Source: Haryana Government Website.

The government has also provided incentives and support to the farmer for maize cultivation as alternate crop of rice with:

- ✧ Assured procurement by state Government at MSP
- ✧ Incentives of Rs 2000/- per acre for the farmer adopting maize
- ✧ Free maize hybrid seed supply for rice replacement
- ✧ Farmer's premium share for maize crop insurance under PMFBY paid by state government

In view of the initiatives taken by the government for crop diversification and to widen the scope of replacing rice by maize for saving water and developing a long-term strategy Haryana Kisan & Agricultural Cost and Price Commission (HKACPC), constituted a working group (WG) on "Promotion of the Maize Cultivation in Haryana" in July 2019. The details of the working group and its terms of references (TORs) are given in Annexure V. The working group adopted participatory approach and consulted a wide spectrum of stake holders across the entire maize value chain for developing the strategy. The stakeholders include farmers, members of the HKACPC, state department officials, scientists, industrialist, traders, input dealers, seed, farm machinery industry, feed, starch, poultry etc. The WG had series of meetings, field visits and meeting with industry representatives. The details of meetings are attached as Annexure IV.

2. Maize Scenario in India and the World

Maize is the highest producing cereal in the world with production of 1135 million tonnes having highest productivity of 5.75 t/ha. Though it is cultivated over 170 countries the USA, China, Brazil, Argentina, India, Indonesia, Mexico, Ukraine are the major producer of the crop in the world. The continent –wise major producer are USA, Brazil, Argentina and Mexico in America; China, India and Indonesia in Asia; Ukraine and Romania in Europe and South Africa, Nigeria and United Republic of Tanzania in Africa. India ranks 5th in production and 4th in acreage of the maize in the world. Maize is predominantly used for industrial purposes in the world with more than 80 percent of its production is used in poultry feed, starch, food processing and bio fuel industries.

Historically maize happened to be a predominant crop of the Northern and central India and non-traditional crop of southern and eastern India. However, in the recent past due to increased industrial uses and availability of the hybrid technology it has become important crop of southern India. At present Karnataka, Maharashtra, Madhya Pradesh and Andhra Pradesh are major producer of the maize in India. Targeting suitable hybrids in irrigated ecologies helped in gaining the average productivity of 10 t/ha in some districts of the country like Guntur, East Godavari, West Godavari (Andhra Pradesh), Khagriya (Bihar) in winter season. At the same time, targeting single cross hybrids in the *kharif* season productivity of Chhindwara district (MP) achieved 5 t/ha from the in the undulated topography and rainfed ecology. The success stories of enhancing maize production is only a decade old in India due to technological advancement in maize happened in recent past.

Figure 1 depicts the trends in area, production and productivity of maize in India during 1961-62 to 2017-18. The production of maize has increased from 4.3 million tonnes in

1961-62 to 28.8million tonnes in 2017-18, growing at an annual rate of 3.1%. Growth in both cultivated-area (1.1% per annum) and yield (2.1% per annum) has contributed to the growth in production. Post 2000, a swift increase in area, production and yield of maize has occurred mainly due to wide adoption of double cross and single cross hybrids, the high yielding cultivars that have enhanced profitability in maize cultivation. The annual growth rate in India's maize-production has been 5.2% during 2001-02 to 2017-18, contributed by growth in both area (2.2% per annum) and yield (2.99% per annum).

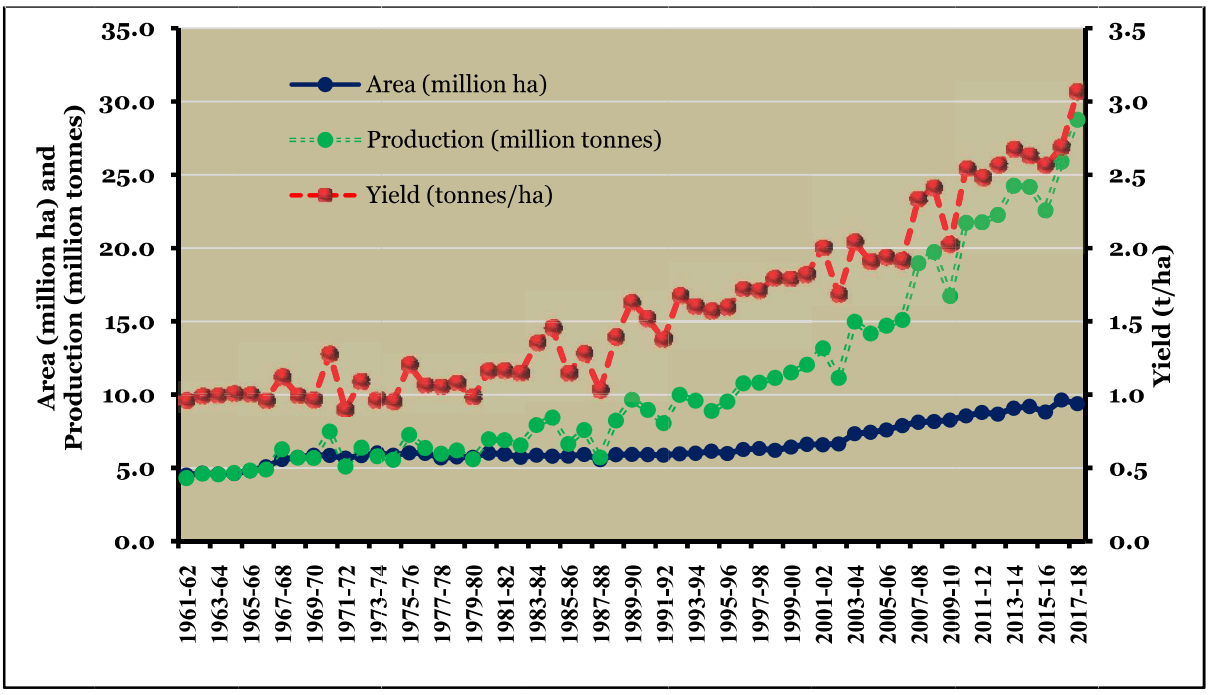

Fig. 1: Area, Production and Yield of Maize in India (1961-62 to 2017-18)

(Source: Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, 2019)

The data in Table 2 presents moving average triennium-ending (TE) figures for area, production and yield of maize in India during TE 1981-82 to TE 2017-18. The area under maize cultivation in India has grown from around 5.9 million ha in 1981-82 to 9.3 million ha in 2017-18 at an annual rate of around 1.6%. The production of maize has increased from around 6.5 million tonnes to 25.7 million tonnes at an annual rate of 4.1%, in the same period. The yield of maize – a key contributor in production-growth – has increased from 1.1 tonnes/ha to around 2.8 tonnes/ha during 1981-82 to 2017-18, with an annual growth rate of 2.5%. Table 2 indicates a sharp increase in area, production and yield of maize in India during 2001 to 2010-11. This period relates to introduction of high yielding single cross maize hybrid in various parts of India. The area, production and yield of maize increased at annual growth rates of 2.9%, 6.0% and 3.0%, respectively, during 2001-02 to 2010-11. Figure 2 shows trends in area, production and yield of maize in Haryana during 1961-62 to 2017-18. The figure depicts decline in both area and production of maize in Haryana. However, the yield of maize has increased from 0.9 tonnes/ha in 1961-62 to 3.2 tonnes/ha in 2017-18, growing at an annual rate of around 2.2%. Maize is cultivated during Kharif season in Haryana. Farmers in Haryana prefer to cultivate paddy than maize due to assured procurement of paddy by the government at minimum support price.

Table 2: Area, Production and Yield of Maize in India during trienniums 1981-82, 1991-92, 2001-02, 2011-12 and 2017-18

Triennium Year*	Area (million ha)	Production (million tonnes)	Yield (tonnes/ha)
1981-82	5.89	6.49	1.10
1991-92	5.89	8.89	1.51
2001-02	6.54	12.24	1.87
2011-12	8.53	20.07	2.35
2017-18	9.27	25.74	2.78
	CAGR (%)		
1961-62 to 1980-81	1.49	1.98	0.48
1981-82 to 1990-91	0.07	2.59	2.52
1991-92 to 2000-01	1.16	3.75	2.39
2001-02 to 2010-11	2.91	6.01	3.01
2011-12 to 2017-18	1.36	3.88	2.49
1981-82 to 2017-18	1.57	4.11	2.50

Note: * Three-year moving average triennium-ending year
Source: Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare, Govt. of India, 2019

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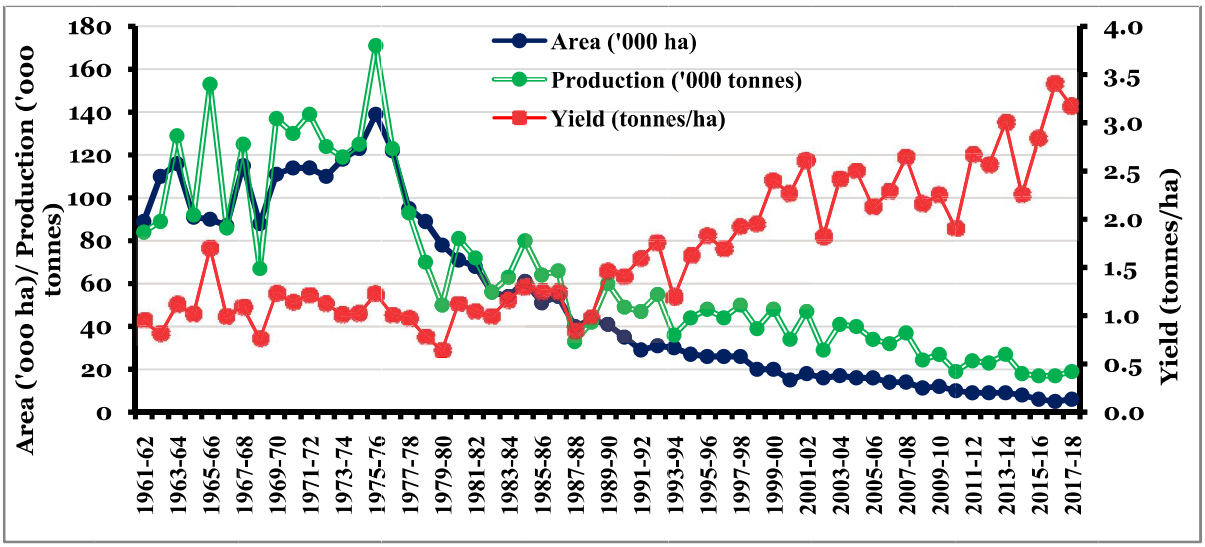

Figure 2: Area, Production and Yield of Maize in Haryana (1961-62 to 2017-18)
Source: India Stat database

Table 3 shows area, production and yield of maize during TE 1981-82 to TE 2017-18in Haryana. While there has been a continuous decline in area and production of maize in Haryana over the years, but the yield has increased. The area under maize in Haryana has decreased swiftly from 72.3 thousand ha in 1981-82 to 5.7 thousand ha in 2017-18. This has contributed in decline in production of maize from around 67.7 thousand tonnes to 17.7 thousand tonnes despite an increase in yield (0.9 tonnes/ha to 3.1 tonnes/ha, in the same period. A sharper decline in area (-9.5% per annum) and production (-6.8% per annum) of maize were seen during 2011-12 to 2017-18 and 2001-02 to 2010-11, respectively, in Haryana; but the yield has increased at an annual rate of 3.7% during 2011-12 to 2017-18.

Table 3: Area, Production and Yield of Maize in Haryana during TEs 1981-82, 1991-92, 2001-02, 2011-12 and 2017-18

Triennium Year	Area ('000 ha	Production ('000 tonnes)	Yield (tonnes/ha)
1981-82	72. 33	67.67	0.94
1991-92	35.00	52.00	1.49
2001-02	17.67	43.00	2.43
2011-12	10.33	23.33	2.26
2017-18	5.67	17.67	3.12
CAGR (%)			
1961-62 to 1980-81	-0.31	-0.98	-0.68
1981-82 to 1990-91	-6.17	-4.52	1.92
1991-92 to 2000-01	-6.53	-1.90	5.06
2001-02 to 2010-11	-5.81	-6.76	-1.00
2011-12 to 2017-18	-9.51	-6.12	3.74
1981-82 to 2017-18	-6.34	-3.47	3.06

Source: India Stat database

3. Maize as a solution for crop diversification

Presently, after accelerated hybrid maize development programme in the country and the state, a good number of hybrids with high yield potential are now available both at public and private sector organisations. These hybrids have performed well and competed with rice with lesser cost of cultivation as well as low water requirement. It has helped in reversing all the adverse effect of rice cultivation by reducing decline in ground water, enhancing input productivity and lesser environmental pollution. Being C_4 plant, maize has advantage over rice for energy saving and environmental benefit associated with maize can be used for future carbon trading.

These hybrids have immensely benefitted the farmers of India specially the Peninsular and Eastern India. The other less remunerative crops like upland rice, winter rice, cotton, sorghum, sugarcane of these ecologies were diversified with maize. After adoption of hybrid maize more than 30 lakh ha area has been shifted from these crops to maize in the different parts of the country (Maharashtra, Madhya Pradesh, West Bengal, Odisha and Tamil Nadu).

With the result, the rice-rice ecologies of peninsular and eastern India have taken an enormous lead in the maize cultivation. The maize being traditionally grown in northern and central India but now the major share comes from Peninsular and eastern India with productive maize hybrids. It helped in enhancing income of the farmers in these ecologies with water saving. The poultry and starch industry also flourished during past few decades which consume more than 85% of the maize produced in the country. India also turned from importer to the exporter of maize and its products.

Therefore, it is important to extend benefit of maize diversification to farmers of Haryana considering the progress made by the other states. A detailed comparison of rice and maize cultivation merits/demerits is appended in Annexure I. The salient advantages of diversification through maize cultivation are given below:

1. **Water saving**: The maize expansion will help in checking the ground water declining/saving of the water which can be used for enhancing cropping intensity and expanding irrigated areas in other crops. For production of 1 kg of rice 4000 litres of water required. Thus, the *saving of water to the tune of 90% by maize cultivation* instead of paddy (Maize Summit, 2018).

2. **Energy saving**: The rice cultivation requires at least 35-40 irrigation and maize requires only 4-5 irrigations and therefore the saving of the energy of at least 8 times in ground water pumping can be diverted for smooth running of the industry. The *maize cultivation saves 70% power* as compared to paddy (Maize Summit, 2018).

3. **Environmental benefit**: The maize cultivation also brings several environmental benefits like reducing greenhouse gas emission, solving problem of residue burning, improving soil physical properties and biodiversity, lesser ground water pollution etc. It will help in overall improvement in environmental quality leading to improved quality of life. The biomass of maize is easily degradable compared to rice due to less silicon content and therefore, improves organic matter content of the soil.

4. **Cropping system optimization:** The optimized duration of maize gives opportunity for subsequent crops and results in higher system productivity and profitability by following maize-wheat-mungbean (MWMb), maize-mustard-mungbean (MMMb), maize- autumn/winter/summer vegetable systems (Fig. 3 & 4).

    a. ***Enhanced wheat production*:** Wheat is the most important *rabi* crop in Haryana which occupies highest acreage (~2.5 million ha) in the state and its productivity is critical for the state agricultural economy. Maize takes less time than rice that advances the wheat planting and thereby increases its productivity and production by ensuring increased crop duration and avoiding the risk of terminal heat stress.

    b. ***Opportunity for mustard cultivation*:** Similarly, in mustard it gives option for timely planting and reduced risk of aphid infestation, which enhances its productivity.

    c. ***Summer mungbean*:** Further, the third *mungbean* crop can be taken with increased duration and yield for enhancing soil fertility.

    d. ***Early vegetables*:** The early vegetables for fetching higher prices in the market can be grown successfully after harvest of the maize. Some of the possible early vegetables cropping systems can be as per given in Figure 4.

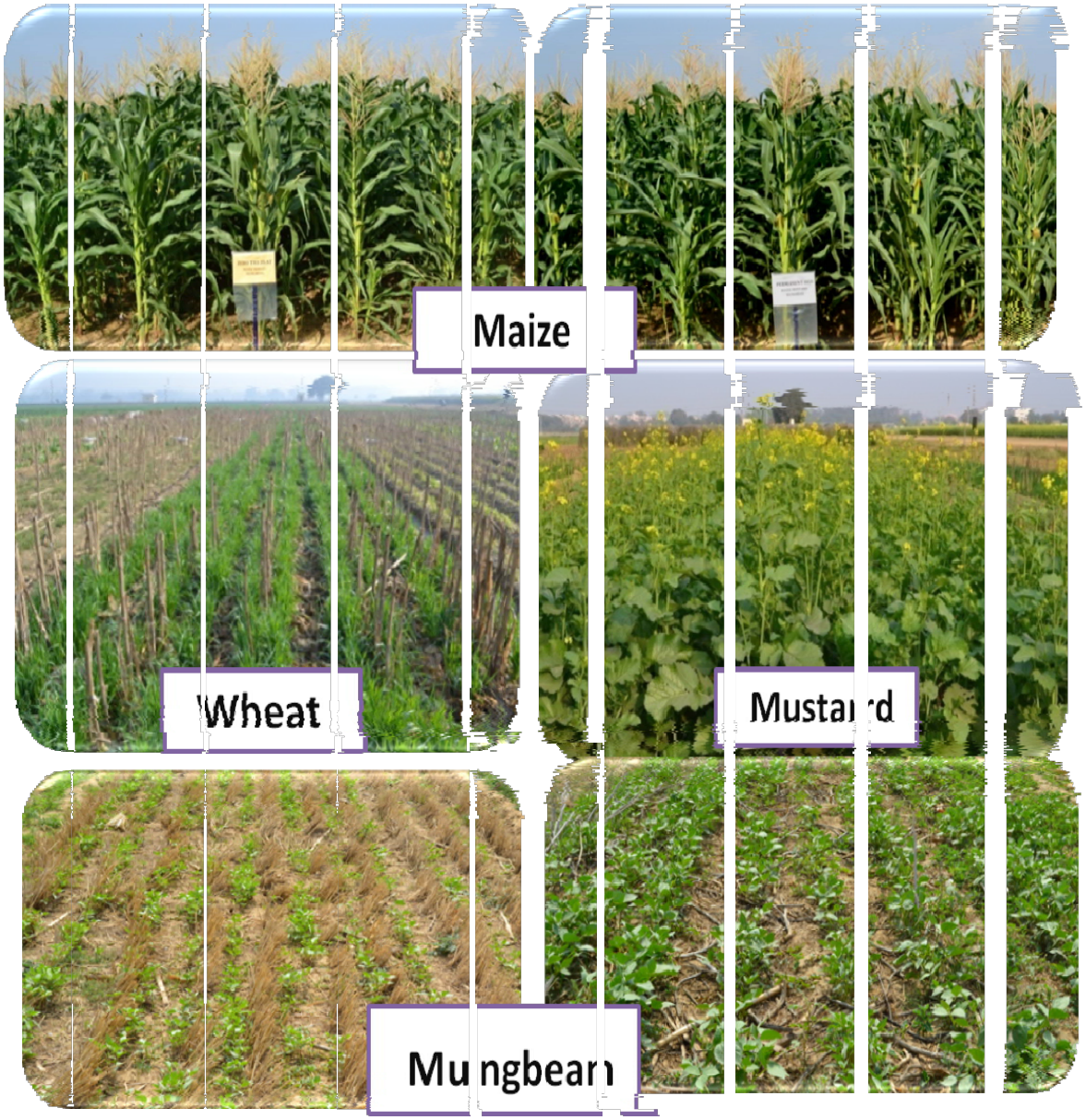

Fig. 3: Intensified conservation agriculture based maize system developed at ICAR-Indian Institute of Maize Research

5. **Reducing maize import:** Haryana has a substantial presence of maize based agro-industries (feed, starch, food processing etc) and they are largely dependent on maize from other states which enhances the cost of production of these enterprises and thus erode their competitiveness. The local production will improve their efficiency and competitiveness. The procurement of maize will also generate the revenue and employment for the state.

6. **Enhancing livestock productivity:** green fodder is in great demand in the state as well as in the nearby states. Maize is the best quality green fodder, and silage preparation from it can be used for enhancing livestock productivity in the state and can also be transported to neighbouring states. The stover of stay green maize hybrids can also be directly used for livestock feeding.

15 Jun-15 Oct	15 Oct- Dec	Jan-April	May-June
Maize			
	Sarson Sag (Pusa Sag No.1)	Onion (PusaRidhi)/ Hisar Onion-4	Palak (All Green), Coriander (Hisar Sugandh)
			
	Baby corn	Summer cauliflower	Radish: Pusa Chetki
15 June- 15 Oct	**15 Oct-15 Nov**	**15 Nov-15 Feb**	**15 Feb- 15 June**
Maize			
	Radish :Pusa Mridula	Potato: KufriBahar, KufriChipsona	Okra: Varsha Uphar, Pusa Bhindi-5
			
	Palak (All Green)	Pea: Pusa Pragati, Punjab Ageta , PB-87	Bottlegourd (Pusa Naveen) /melons (Pusa Madhuras)
15 June- 15 Oct	**15 Oct-15 Nov**	**15 Nov-15 Feb**	**15 Feb –May**
Maize			
	Methi : Pusa Early Bunching, Hisar Sonali, Lettuce: Great Lakes	Carrot (Pusa Rudhira), Hisar Garlic	Tomato: Pusa Rohini/ Hisar Arun

Fig. 4: Maize based early season and year-round vegetable cropping systems

7. ***Peri*-urban agriculture**: Haryana is surrounded by several high-end metropolitan cities that offers great opportunity for specialty corn (baby corn, sweet corn, popcorn), and high value early vegetables cultivated as sole or intercropped (Annexure II). A large part of Delhi being NCR region these products can be utilized as fresh locally or exported out of the country or can be processed if surplus. Processing industry can also be established for export being near to the airport and good transportation system in the state.

8. **Agro-industrial growth promotion**: The state being in the NCR region has a great advantage of the poultry, dairy and specialty corn production in which maize can play important role for flourishing these industries.

9. **Mechanization and conservation agriculture promotion**: Maize cultivation is completely mechanized from sowing to harvesting (Fig. 5) and thus it will reduce drudgery and saving of labour used in the case of rice transplanting. Maize is also a conservation agriculture friendly crop and thus will address issues of residue burning and degrading soil health.

Fig. 5: Maize cultivation machinery in the Indian market

10. **Nutrient use efficiency**: The leaching and denitrification losses in the rice are very high whereas these losses are very less in maize cultivation and thus maize cultivation will enhance the nutrient use efficiency.

11. **Employment generation and entrepreneurship**: The establishment of the corn based agro-industry *viz.* feed, poultry, specialty corn, silage making, starch etc will generate more employment and entrepreneurship opportunities in the state.

❖ Potential requirements of maize

Poultry Feed:

The poultry industries established in and most of the district *viz.* Jind, Karnal, Ambala, Panipat, National Capital Region, Gurugram, Narnaul, Yamunangar, Sonipat etc requires huge amount of feed made primarily using maize. The current total requirement of maize for poultry (broiler, layer, hatchery) is 12-15 lakh tonnes annually. As the poultry sector is growing at very fast rate (>10% annually), the demand for poultry feed is expected to continuously increase at similar pace.

Starch:

The starch industry established at Yamunanagar have requirement of more than 750 tonnes maize per day and hence total requirement of nearby 3 lakh tonnes of maize annually which likely to be increased further. With established of bigger starch industry at Pantnagar (Uttarakhand) and other at Phagwara (Punjab) and Una (Himachal Pradesh) will offers scope for export of the surplus production.

Livestock feed:

The state has an established livestock industry andmaize is also used for dairy industry as major ingredient. Thus, maize also will be needed for growth and sustainability of livestock sector.

Fodder and silage:

To enhance the productivity of livestock in the state and nearby dry state like Rajasthan, demand for green fodder and silage using maize is in great demand in the state of Haryana.

Value addition:

In view of dietary diversification and urbanization, the value-added maize products are in huge demand in the market. Corn flakes are very common used snakes and healthy biscuits. The chips made of maize became a new entry in the market in recent years.

Ethanol/Brewery/Alcohol: The maize can also be used for production for production of ethanol. The distilleries dry grains soluble (DDGS) as by-product of the ethanol industry can be used for feed industry that has 27% protein and 13% oil. The use of DDGS is very common in poultry and livestock sector of many countries are importing from USA. The current state requirement of at least15 to 18 lakh tonnes grain will require 2.5 to 3.0 lakh ha area under maize.

4. Strategy for maize promotion in Haryana

The efforts of the Haryana Government under ***Jal Hi JeeanYojna*** towards introduction of less water requiring crops replacing rice has been praised at various platforms. Hon'ble Prime Minister of India, Shri Narender Modi appreciated this initiative of Hon'ble Chief Minister of Haryana, Shri Manohar Lal Khattar repeatedly and urged other states to follow the same. These efforts will be helpful in ensuring of water for our future generation and to meet our national and regional need this mission to be further strengthened with a comprehensive strategy for making it a big success.

The following steps must be taken into consideration and implemented phase wise to achieve the above goal; and they can pave way to more sustainable agriculture.

A. Government policy and support:

For maize promotion, Government of Haryana needs to make policy and support for:

a) **Advance arrangement of inputs**: The government should make arrangements for a) latest high yielding single cross hybrid seeds, b) pesticides for plant protection latest by end of May.

b) **Machinery arrangement**: Maize at present is a fully mechanized crop and all kinds of machines are available from seed sowing to grain in bag. Hence, for promotion of maize cultivation subsidy to be extended for these equipments in Haryana. With suitable publicity, these equipment and machinery to be made available in the custom hiring centres compulsory integrated areas by end of May.

c) **Assured procurement at MSP:** The maize produced in the state should be procured by the state at minimum support price (MSP) alike rice and wheat. The marketing facility to be strengthened for maize procurement.

d) **Crop insurance:** The crop insurance policy to be revised for maize, on the basis of on the existing potential of the cultivars.

e) **Establishment of corn villages:** The success story of diversification shown at national level by establishment of villages like Atterna for baby corn and Manuali for sweet corn needs to be replicated across the state. Such villages for grain maize as well as quality protein maize (QPM) and pop corn can be established for easy access and quality production for stakeholders in maize value chain.

B. Identification of target areas:

The crop of maize can be cultivated in well-drained and non-saline soils. The highly depleted water table pockets should be given priority for the maize cultivation. The potential districts include Sonipat, Panipat, Karnal, Kurukshetra, Jind, Ambala, Yamunanagar, Punchkula etc can be targeted first. Possible areas/sub-districts and villages needs to be identified initially. Sub-soiler/Chisler to be first used to break the plough layer before going maize cultivation.

C. Publicity of maize:

During the month of May-June publicity for maize cultivation/promotion through television (TV), radio, newspaper, pamphlet, slogan etc in targeted areas is to be done. The publicity material should contain the potential benefits of maize cultivation, availability of technologies (seed, herbicide, and machinery), training schedule and government policy support. "**Maize Divas**" to be held at block levels during second fortnight of May to first week of June should be organized for enhanced adoption and advanced planning. In Maize Divas, the farmers should be provided literature (Annexure III) and input kit (seed, pesticide, and herbicide) as a token of encouragement.

D. Trainings/awareness programme on maize:

Maize has become almost a non-conventional crop in the Haryana. Therefore, intensive trainings required for better realization of the benefits of the latest technologies in its cultivation towards making maize as a remunerative option for the farmers.

(a) First, training to master trainers including KVK scientists and state department officials to be conducted by end of May at the district level in the targeted areas.

(b) These trainers will train the state department field extension workers, farmer etc.

(c) Training to farmers to be completed by first week of June.

E. Development of linkages with stakeholders:

All stakeholders of the maize value chain like farmers, industries (seed, feed, poultry, starch etc), SAUs, KVKs, NGOs, Bhartiya Kissan Sangh, etc needs to be involved and engaged in maize promotion.

F. Contract farming:

Vertical integration is essentially critical for accelerated development of maize value chain and contract farming could be one of the best options to promote farmers linkages with market and industry. The feed and starch industry to be facilitated for contract farming by taking seed industry in the loop. The industries can be given incentives for adoption of villages for maize cultivation.

G. Mechanism for diversification benefit transfer:

To ensure better implementation of the diversification, the latest (in last 5 year) recommended high yielding single cross hybrid of long duration should be deployed at farmer fields. The seed of such hybrids is to be made available in the market and farmers are to be allowed direct purchasing from the seed organization/agency. The reimbursement for the cost of seed is to be made available to the farmers directly in the saving account of beneficiaries.

5. Roadmap for maize promotion

Immediate mission mode project for 5 years should include following:

Activity	By	Time line
Publicity	State government, KVKs	First fortnight of May
Inclusion of maize cultivation machinery under subsidy net	State government	First fortnight of May
Maize Divas	State government with participation of SAU, ICAR, Farmer, Seed and input companies/dealers/traders, maize using industries (feed, poultry, starch)	By 15th May
Training to master trainers of state department	State government, SAU, ICAR	By 15th May
Arrangement of hybrid seed	State government/ or as per directives of the government to farmers for direct purchase from market	By 25th May
Handover of diversification kit (seed, agrochemical and literature) to farmer	State department	By 30th May
Arrangement of machinery for sowing	State government	By 30th May
Training to block level officials	State government	By 30th May
Training to farmers with lecture, literature and input	State department	By 05th June

Activity	By	Time line
Reimbursement of seed and agrochemical for maize production through DBT	Dedicated online portal of state government	10 days after sowing of maize crop
Incentives for maize cultivation through DBT	Dedicated online portal of state government	By 30th July
Maize harvesting equipment	State department	By 15 August
Seed availability of early season vegetables in peri-urban interface in maize system	State government	By 15th September
Procurement of maize from farmers	State Government or tax rebate to industry	After harvesting
Felicitation of the farmer/village adopting or official efforts towards successful diversification	State government in District/State level function	Continuous
Establishment of corn villages (input and marketing support)	CSR funds of the industries working in Haryana duly facilitated and documented by State Government	Continuous
Maize farmer producer organization/SHGs establishment	State government	Continuous
Quality protein maize villages for nutritious food, feed and silage	Processing industries with incentives by state government	Continuous
Baby corn, sweet corn and pop corn villages establishment	Processor, exporter and FPO with incentives by state government	Continuous
Promotion of silage from maize for dairy and export	State government through subsidy/incentive on machinery	On demand of farmer/FPO/SHG

Intermediate measures:

Beside these immediate measures for sustainability of maize diversifications following intermediate measures should also be adopted.

1. Promotion of contract farming by poultry, feed, seed, starch etc industries
2. CSR fund of industry towards protection of natural resources by maize cultivation
3. Reduction of subsidy on water pumping
4. Rebate on the taxes for maize purchasing by industry
5. Cold chain for specialty corn and vegetables
6. Export facilitation by establishment of maize export zone
7. Tax rebate/subsidized electricity for establishment of maize based agro-industry

Long-term measure

1. Steps for phasing out subsidy on water pumping for sustainability
2. Phasing out of the incentives towards promotion/purchase of the established crops in the Haryana

Annexure I. Detailed advantage of maize cultivation *v/s* rice

Parameters	Rice	Maize
Water requirement	Very high	Low (8-times lesser than rice)
Water productivity	Low	High
Residue burning	Residue burning results in environmental pollution and degrade biodiversity.	No such problem.
Ground water pollution	Nitrate and pesticide leaching.	No such problem
Duration	Long	Short, at least 20 days lesser than rice.
Planting/crop establishment	Cumbersome and labour consuming, nursery and transplanting	Easier, only direct seeding
Per day productivity	Less	Higher
Mechanization	Partially mechanized	Fully mechanized
Soil physical health	Degrading crop	Restoring/improving crop
Use of agrochemicals	More leaching	Less leaching
Cropping system optimization	Subsequent crops affected and results in low system productivity and profitability.	Subsequent crops benefitted and results in higher system productivity and profitability.
Climate resilience	A photosynthetically less efficient C_3 plant due to high photorespiration under increased temperature and its cultivation results in higher GHGs (methane, nitrous oxide) emission as well.	A photosynthetically efficient C_4 plant as there is no photorespiration under increased temperature and its cultivation results in lesser GHGs emission as well.
Policy intervention	Assured procurement at MSP.	Presently no such policy.
State requirement/demand	Surplus	Highly deficit
Use of biomass/ residue	High silicon deters for use in livestock, problem of collection, burning due to less turnover time for wheat seeding.	Green fodder used for animal fodder, easy dry fodder collection, easily decomposable, can be kept on the soil surface with zero-till planting or can be used for mushroom production.

Livestock promotion	Not much scope as mostly used for food and straw unsuitable for livestock.	Wider scope for livestock promotion as green fodder, silage and grain for feed. The fodder can be used for grazing/feeding to livestock at any stage of crop growth. It has no risk of any anti-nutritional compound.
Poultry industry growth	Less suitable.	Most suitable as major feed ingredient.
Value addition	Lesser opportunity due to more direct food consumption	More opportunity as 1000s of the products can be made from different types of maize.
Export opportunity	Only basmati has competitive market.	Grain, feed, starch and baby corn has great potential for the export in neighbouring countries as well as high value developed economy due to low cost of internal production and high external demand.
Conservation agriculture	Very less scope	Highly suitable for conservation agriculture.
Electricity and power/energy	Very high requirement	Very less requirement
Transportation cost of commodity	Non-basmati rice used in PDS incurs huge transportation cost.	Extra cost of transportation is incurred in import of maize from other state that increases the cost of raw material for industry.
Handling and post-harvest losses	High, extra infrastructure for storage of surplus rice is required.	Low, no carry stock due to shortage in the state and multiple industrial uses.
Silage	Not suitable	Best material for making silage which can be used in livestock and exported after meeting internal requirement.
Intercropping scope	Not suitable	Most suitable crop for growing pulses, vegetables and flowers due to wide spaced rows of the crop.
Dietary diversification and nutritional security	Lesser opportunity	Quality protein maize can be integrated in diets of all group persons for nutritional security.
Overall cropping system profitability	Less	More

Annexure II: Suitable intercropping systems with maize for Haryana

A. Intercropping with maize from mid-June to mid-October

- Maize + cowpea (fodder)
- Maize + moongbean
- Maize + Radish (Pusa Chetki)
- Maize + Coriander/Palak

Maize + cowpea (fodder) **Maize+ cucurbits**

Maize +moong bean

Maize +cluster bean (Pusa Navbahar)

B. Vegetable crops with maize based cropping system during different period

Mid June-mid Oct	Mid Oct-December	Jan-April	May-June
Maize	Sarson sag,	Onion	Palak
	Radish	Summer squash	Radish (Pusa Chetki)
	Palak	Summer cauliflower (Happy noble seeds)	Coriander
	Methi	Tomato	Palak
	Spinach	Summer cauliflower	Palak
	Lettuce	Summer squash	Radish (Pusa Chetki)
	Coriander		
	Garden Pea		
Maize	**Mid Oct- Nov**	**Nov-March**	**April-Mid June**
	Radish (Pusa Mridula)	Parsley, Celery	Palak
	Palak	Carrot	Coriander
Maize	**Mid Oct-Feb**	**March-mid June**	
	Potato	Okra	
	Celery	Bottle gourd	
	Parsley	Brinjal	
	Chinese cabbage	Chilli	
	Lettuce	Cowpea	
		Cluster bean (Pusa Navbahar)	
	Mid Oct-mid March	**Mid March –mid June**	
	Celery	Okra	
	Parsley	Bottle gourd, Luffa, Cucumber	
	Other exotic vegetables	Cowpea	
	Chinese cabbage	Amaranths	

Annexure III. Maize Production Technology for Haryana

- The long duration single cross hybrids of maize have potential to yield more than 7 t/ha at farmer field having 10 t/ha yield potential t experimental farm.
- The hybrids mature in 100 – 110 days in Haryana conditions.
- The hybrids have given around 10 t/ha yield under experimental conditions and are released and notified for commercial cultivation.

Desirable characters:

- ✧ More than 110 days
- ✧ 16-18 rows, 30-35 grains/row
- ✧ Test weight: 260-280 g (*kharif*)

Minimum yield:

- ➢ 500 grains/cob = 125 g/cob
- ➢ 24000 plants/acre: 30 q/acre

Production Technology

Sowing time:

15 June to first week of July, the crop establishment before onset of the monsoon gives best result.

Seed rate:

8 kg/acre

Seed treatment:

Gaucho/Imidachlorpid: 5 ml/kg (A packet along with seed may be provided by the seed supplier which comes around 40 ml per acre seed).

However, the Fall Army Worm (FAW) is so far not a problem in Haryana. But as preventive measure, the government can go for seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 4ml/kg as national policy.

Sowing:

60 cm row to row and 25 cm plant to plant by dibbling or by planter on the ridges

Weed control:

- ➢ Application of Atrazine 50% WP @ 800 g/acre in 400 litre water within 0-3 days of crop sowing
- ➢ Apply herbicide when there is sufficient moisture in the soil.
- ➢ Do not disturb the soil after herbicide application.
- ➢ Apply Tembotrione 42% SC @ 115 ml/acre or Topramezone 33.6% SC @ 30 g/acre or 2,4-D Amine 58% SL @ 350 ml/acre as post emergence herbicide at 20-35 days after sowing.

Fertilizer:

a) Before Sowing: 1 bag DAP, 36 kg MOP and 10 kg zinc sulphate and FYM if possible @ 6 t/ha.
b) 6-8 leaf stage or 20 days after sowing: 40 kg urea
c) At 40 days after sowing: 30 kg urea
d) At flowering/ 60 days after sowing: 40 kg urea

Irrigation management:

Critical stages: seedling, 6-8 leaf stage, flowering and grain filling

If rains do not occurs at these stages, irrigation to be given. Before top dressing of urea, the moisture content in the field needs to be ensured and if no rains irrigation is to be applied.

NOTE: For maize promotion & incentive to farmers at least seeds and herbicides needs to be given by Government.

Annexure IV. Interface meetings of working group with stakeholders

A. Panchkula, 17thJuly, 2019

The first meeting of the working group on the "Promotion of the maize cultivation in Haryana" was held at Kissan Bhawan, Panchkula with the industries including feed, starch, machinery, poultry and seed operative in the region. Innovative maize farmers were also present in this meeting. The meeting started with presentation by Dr. Sain Dass, Chairman of the working group on maize for diversification in Haryana to save water and profitability. The technology options and market demand was discussed in this presentation. It was assessed that there is enough demand for maize in the state to sustain the growth of existing and increasing feed sector especially for poultry and for starch and other industries.

Good innovative machinery of maize from sowing to harvesting available in Ludhiana needs promotion through the Haryana Agro-industry Corporation. These machineries are affordable and can be placed in the custom hiring centre in this well mechanized state of the country. The silage of maize also has good potential and government needs to look into establishment of silage hubs through suitable incentives. The seed industry was also receptive and told that they are looking forward to explore possibilities for establishment of seed hub in Haryana. The assured market in the state for maize can really help farmer to opt maize for cultivation. Dr. Ramesh Kumar Yadava, Chairman, HKACPC, Dr. R.S. Balyan and Dr. Shyam Bhaskar from the HKACPC, Mr. Gupta, Haryana Government, Dr. Sain Dass, Chairman working group and Dr. Jawala Jindal, Dr. Anjani Kumar, Dr. R.K. Yadav and Dr. Shankar Lal members of the working group and attended this meeting.

B. Karnal: 30thAugust, 2019

Dr. Ramesh Kumar Yadava, Chairman, HKACPC, Dr. Sain Dass, Chairman of working group on "Promotion of the maize cultivation in Haryana", Dr. R.S. Balyan and Dr. Shyam Bhaskar from the HKACPC and Dr. Jawala Jindal and Dr. Shankar Lal Jat member of the working group attended the meeting held with farmers of Yamunanagar, Karnal, Panipat districts at the Horticulture Training Institute, Karnal. Dr. Sain Dass made a presentation on the changes in the maize production practices and its profitability on behalf of the working group to the farmers.

It was observed that farmers are ready to switch from paddy to other crops provided with good technology and ensuing good market for

the produce. Advance seed requirement of better single cross maize hybrids released by CVRC/SVRC for North Western Plain Zone Haryana need to be given by government to make the diversification successful. As maize is a multi-season crop, therefore, government procurement or assistance according to season and for fetching remunerative prices of specialty maize also needs attention. Special price for organic maize production establishing its hub needs to be explored for enhancing profitability and ensuring quality produce for the consumers.

Maize machinery to be included in the 80% subsidy and these to be made available in custom hiring centres. Resistant varieties need to be used and promoted and ridge planting is to be done in high rainfall areas. Handholding of farmers to adopt best management practices for maize production needs training of extension officers and farmers. Ensure regular visits of farmer's fields by experts during maize production to till harvesting of crop.

C. NIFTEM: 31st August 2019

Dr. Sain Dass, Chairman of working group on maize for diversification in Haryana, Dr. Shyam Bhaskar from the HKACPC and Dr Jawala Jindal, Dr. R.K. Yadav and Dr. Shankar Lal Jat member of the working group attended the meeting held with farmers of Jind, Hisar, Sonipat districts at the National Institute of Food Technology Entrepreneurship and Management, Sonipat. Dr. Sain Dass made a presentation on the twin strategy for diversifying National Capital Region and far-off region using maize on behalf of the working group to the farmers. The farmers found that technology changes and availability of the machinery will really help in enhancing the maize acreage in the state.

They demanded for maize machinery subsidy in person or for custom hiring centres. Use of all stakeholders in maize promotion like private organization SAUs, KUK, NGOs, Bhartiya Kisan Sangh etc needs to be consumed. Continuous information training needs to be there with stakeholders participating in meeting. Affordable quality baby corn and sweet corn seed needs to be ensured for enhancing the production and competitiveness in the international market. The hubs made for baby corn as Atterna and for sweet corn as Manuli needs to be replicated in other NCR adjoining areas of the state. The crop is coming to harvesting stage and maize threshers/combine harvester to be made available by the government in the diversification areas before harvesting stage for easy shelling.

Cold chain and small-scale industry establishment for specialty maize industry establishment needs to be promoted for making it a success. A pop corn production hub can also be established in the NCR region as India is importing almost whole requirement of its pop corn, which will ensure better quality pop corn availability at affordable prices to the consumers. Alike 40-60% grant in other machinery, grand subsidy in maize machinery to be ensured. Seed to seed mechanization machinery to be made available at each blocks custom hiring centre. The committee also visited the farmer field at Rai and found that the crop should not be planted in water logging and saline soil areas to make it a success.

D. Karnal: 4th September 2019

A meeting of the working group on promotion of maize cultivation in Haryana with the state government officials, KVK officials and the research scientists was held on 4th September 2019 at Horticulture Training Institute, Karnal. Dr. Sain Dass, Chairman of working group, Dr.R.S. Balyan and Dr. Shyam Bhaskar from HKACPC and Dr. Jwala Jindal, Dr. R.K. Yadav and Dr. Shankar Lal member of the working group attended the meeting. The officials of state department of horticulture and agriculture, KVK officials and scientist of CCHAU, Karnal were present in the meeting to give input for maize based crop diversification.

In the beginning, Dr. Sain Dass Chairperson WG made a presentation on maize to save water for crop diversification. The presentation included the input received from the farmers and industries and were discussed with the officials in details. It was emerged that the demand of maize is enormous for feed and starch industries in the state and there is need to increase production to save water and enhance farm profitability. For this purpose, first of all we have to change the mindset-of the stakeholders. The timely availability of single cross hybrid seed, conduct of large scale FLDs under NFSM by the state government are needed for better adoption of maize. Organizing Maize Divas (day) in maize areas in May-June by inviting good private seed companies and assigning them the maize villages to adopt for diversification.

There is need for promotion of contract farming involving seed and feed/starch industry. HSDC&NSC-should also join land for single cross hybrid seed production of public bred cultivation. Innovative linkage is to be established for profitable maize specialty corn production to reduce cost and enhance profitability. Baby corn and sweet corn need to be promoted through Horticulture department. FIELD DAYS to be conducted on demonstration areas for large scale farmer's awareness programme. Large scale block-wise training programme for scientific maize cultivation be conducted by government and CRS fund of the private companies need to be roped into it. Since maize became a non-traditional crop in the Haryana, there is need to establish a complete training of the officials and farmers on best crop management aspect because giving seed will not ensure the crop diversification.

The niche area targeting, like non flood prone and non-saline areas need to be identified for maize cultivation. Steps are required for discouraging of diversification like water pricing and energy pricing etc. The rice promotion need be discouraged by state government in newer areas like Rewari and adjoining districts. Fodder and silage production of maize from the livestock sustainability point of view should be promoted in the state of Haryana. Separate Farmer producer organizations (FPOs) needs to be made for maize promotion. Government should promote QPM for food and feed industry. Joint efforts need to be made across the departments of agriculture, horticulture and veterinary for promotion of maize in Haryana as its working model establishment.

A Brief About Members of Working Group

Dr. Sain Dass

Dr. Sain Dass, Former-Director Maize-ICAR and presently Advisor hybrid crops, Hindustan Insecticide Ltd. and an outstanding maize scientist having >45years experience in hybrid technology, is rightly known as *Maize Man of India*. He served as advisor hybrid crops to NSC, GoI & Rajasthan; consultant to international organizations like ICARDA and IFPRI; EC member National Food Security Mission, GoI, independent board Director for SFCI; member research review committees of different ICAR institutes. He was also president of Indian Maize Development Association. His scientific leadership and pioneer research efforts, credited to him for the development of India's first single cross hybrid (SCH) & technology of yellow QPM, baby corn and white grain, changed the scenario of area, production and productivity of maize that have made India not only self-sufficient ensuring the food, feed, nutritional and livelihood security but exporter as well. He has developed and released >30 hybrids of maize, the seeds of which are produced by >20 companies through MOUs for the benefit of the farmers in the country. He visualized crop diversification exemplary through sweet corn and baby corn (Sonipat, Haryana) and QPM seed villages (West Bengal and Rajasthan). As strong proponent of single cross hybrid technology, he has streamlined the national maize program, motivated young maize breeders and scientists, and reinforced faith of farmers in the hybrid technology and culture. His efforts for maize R&D have boosted the growth of maize related industries (seed, poultry, starch etc).

Dr. Shankar Lal

Dr. Shankar Lal, Scientist (Sr Scale) Agronomy, the native of Chittorgarh, Rajasthan and gold medallist in PhD from ICAR-Indian Agricultural Research Institute, Pusa, New Delhi, working at ICAR-Indian Institute of Maize Research (IIMR), New Delhi for the last 10 years, has developed technologies for conservation agriculture based intensive maize production system. He has published >90 h-index rated research papers. He is also leading outreach activities of IIMR and has travelled across India for creating awareness and providing management tools for alien invasive pest fall armyworm. Beside crop production technology, he has also been member associate of team for the development of 9 maize hybrids of baby corn and pop corn. He is actively involved in development of inter institute collaboration and developing linkages with stakeholder for the promotion of maize. He is currently heading project on soil health and micro-biome in conservation agriculture funded by National Agriculture Science Fund, ICAR. Dr. Shankar is recipient of FAI Golden Jubilee Award for excellence in Fertilizer Use Research, Dhiru Moraraji Memorial Award, Appreciation Certificates from Govt of Afghanistan, Shreeram Puruskar, IIMR best Scientist Award etc.

Dr. Anjani Kumar

Dr. Anjani Kumar, prior to joining at present as Research Fellow at International Food Policy Research Institute (IFPRI), worked as Principal Scientist (Ag. Economics) at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad. Earlier, he also served as Principal Scientist at National Centre for Agricultural Economics and Policy Research, New Delhi and as Sr. Agricultural Economist in the Asia Office of International Livestock Research Institute, Nairobi. He has worked as a Consultant for some national and international institutions including FAO and World Bank. He made significant contributions to agricultural economics and policy research and wrote >90 research papers in national and international research journals on various agricultural development issues. He has also contributed >50 papers/chapters in important books and proceedings. His contributions have been well recognized and he is a Fellow of the National Academy of Agricultural Sciences (NAAS) of India. He has bagged good number of awards from national and international institutions and is also a recipient of the prestigious Rafi Ahmed Kidwai Award.

Dr. R. K. Yadav

Dr. Ramesh Kumar Yadav, Principal Scientist-Vegetable Science born on 1st January, 1976 at Gorakhpur UP, is presently working in Division of Vegetable Science, ICAR-IARI, New Delhi. He completed graduation and Post Graduation from GB Pant Univ. of Agri. & Technology, Pantnagar. He joined ARS in1999 at ICAR Research Complex for NEH Region, Barapani, Meghalaya. He has developed two tomato varieties, namely Maniliema & Megha Tomato-3 and one Colocasia variety Mega Taro-1. Presently, working at IARI New Delhi he has developed YVMV resistant okra variety Pusa Bhindi-5, high yielding Bathua variety Pusa Green and tomato hybrid DTPH-60 for protected condition and spinach variety Pusa Vilayati Palak. He has guided one Ph.D. and six M.Sc. students at IARI, New Delhi. He popularized the IARI vegetable varieties/hybrids in resource poor and underdeveloped areas of Mewat region of Haryana during 2011-14. He has published 65 research papers, 33 popular articles, one book, 20 book chapters, 3 research bulletins, 7 training manuals and 9 leaflets. He has received ICAR Merit cum Mean scholarship during his graduation, Young Scientist Award for the year 2008-09 by Council of Science & Technology, Department of Science &Technology, Govt. of Uttar Pradesh. He is Fellow of Indian Society of Vegetable Science since 2019.

Dr. Jawala Jindal

Dr. Jawala Jindal, working as Senior Entomologist (maize) at Punjab Agricultural University, Ludhiana. He did his studies at PAU, Ludhiana and received Dr. A. S. Atwal gold medal for being adjudged best all round post graduate student of the university. The >15 recommendations from research work are to his credit. Most prominent one are management of maize stem borer, Chilo partellus with biocontrol agent Trichogramma chilonis, and the seed treatment for the control of shoot fly in spring sown maize. He has >100 publications to his credit, including 54 research papers in international and national Journals. He is actively engaged in UG teaching and guiding PG student research along with direct involvement with the farmers by demonstrating the developed technology at their fields. He received several appreciation letters from officers and awards for his research work in different conferences. At presently, he is involved in developing and strengthening IPM for different insect pests of maize crop.

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