Standard Operating Practices for Testing of Maize Entries in All India Coordinate Research Project Trials

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Preface

All India Coordinated Research Project on Maize (AICRP on maize), the first coordinated agricultural research programme in India, has served over six decades to the nation. Maize improvement in India has evolved from the improvement of land races during 1950s to the level of releasing large number of single cross hybrids since the inception of AICRP on Maize in 1957. The merit of the system lies with its ability to address maize research and development requirement for the entire nation through centers distributed across the country. This not only helps to generate technology suited to a particular ecology of the country but also helps to penetrate at the grass root level. Since its inception, AICRP on Maize has contributed 137 composite or synthetic varieties and 292 hybrids of different maturity and uses, which were released and notified for diverse agro-ecological regions of the country. These have been instrumental in enhancing productivity, production and quality of maize. The movement of research through AICRP on maize gradually led to evolution of the project to a full-fledged institute, ICAR-Indian Institute of Maize Research, in the year 2015, a single umbrella to co-ordinate the maize research and development in India.

During 1950-51, India produced only 1.73 million tonnes of maize, which has reached 27.2 million tonnes in 2018-19. This has been possible due to both increase in area as well as productivity of improved cultivars especially single cross hybrids. However, the 2.9 t/ha productivity of India is far behind the global average of 5.6 t/ha. This gap is largely attributed to cultivation of 80% of maize under rainfed ecologies which are more prone to various abiotic and biotic stresses. This realization leads to introduction of climate smart technologies in maize cultivation as well as varietal development. Climate smart cultivars and production technologies will help in crop intensification and wider adaptability to different geographic and climatic regimes of the country. Besides the blow of climatic volatility, biotic stresses, *viz*., insect pests, diseases and weeds which are highly influenced by the changing climate scenario can potentially cause havoc in maize. Population improvement programme initiated in sixties and early seventies for maize diseases and stem borers, which has been extended to screening high yielding cultivars for these biotic stresses. Systematic screening for shoot fly under AICRP has been initiated from 2011 onwards, considering the expansion of spring maize in northern India. Recent invasion and rapid spread of fall armyworm has created panic among maize growers and added new responsibility to AICRP to develop hybrids, which resist this highly destructive pest. Apart from improving genetic base of the crop, various tools of crop production such as nutrient management, crop geometry and conservation agriculture etc. have been developed and tested through AICRP for their regional suitability. There are different standard operating procedures (SOPs) for conducting trials for yield, stress resilience and agronomic superiority in terms of experimental design and data recording. Once a cultivar or source of an important trait is developed through intensive research, it needs to be tested though standard procedures. Further, the products of AICRP whether it is a cultivar, hybrids, or a production or protection technology, these need to reach out to the poor performing maize areas and under privileged section of farmers. To bridge the gap, FLDs under various programmes of GOI are conducted through the AICRP system. The work carried out by the Indian maize community so far has created a far reaching impact on the maize scenario of the country as evidenced by its ever increasing area, production, productivity and demands. To continue the smooth journey of AICRP, it has been a humble effort to bring forth this SOP for uniform conduct of trials, recording of observation and

processing of a huge data set for its further use. The authors hope that this SOP will be useful for both the experienced as well as new maize workers.

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Authors

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I. Maize research in India: Historical perspective and genesis of All India Coordinated Research Project on Maize (AICRP on Maize)

Maize scenario

Maize (*Zea mays* L.) is an important crop of the world, known as 'Queen of cereal' with its highest yield potential amongst the available cereal crops. It is the third most important cereal after rice and wheat and is being grown on 188 million ha area in more than 170 countries across the globe with 1060 million ton of production and 5.6 tonnes/ha productivity (Anonymous 2018a). It is the most versatile crop that can be grown from sea level to 3000 m amsl in tropical, sub tropical and temperate conditions. The USA and China together contribute about more than 38% of area and 58% of the production of the world maize. Major factors favoring for better performance of USA and China primarily includes adoption of single cross hybrids, much of which are genetically modified maize with long crop duration, assured irrigation and high inputs in maize production.

In India, the maize area has reached to around 9.2 million ha with production and productivity of 27.20 million tones and 2.9 t/ha, respectively. The most important use and demand driver of maize in India is poultry feed, which accounts for 47% of total maize consumption. The food consumption accounts for 20% of maize produced, with direct consumption being 13% and that in form of processed food being 7% (Rakshit et al. 2018). Further, it is an important industrial raw material where more than 3000 products are being made from it providing wide opportunity for value addition. The industrial use of maize in India is around 19% of the total maize production. In India, ~81% of maize is grown during kharif season, while rabi maize represents around ~19% of area contributing 29% of maize production. Productivity of rabi maize (4160 kg/ha) is almost double of kharif productivity (2390 kg/ha). This is principally due the fact that over 80% kharif area is cultivated as rainfed crop, which is exposed to both drought (sometime coupled with high temperature) and water logging. In recent past spring maize is gaining popularity in north western plains of Punjab, Haryana and western Uttar Pradesh, besides some parts of Bihar and West Bengal under very high input condition. Besides maize as grain, specialty corns, *viz*., green corn (for roasting purpose), baby corn, sweet corn and popcorn are gaining much popularity in various pockets. Out of these except popcorn, green fodder as byproduct contributes significantly in dairy industry. In recent past maize is quite extensively being cultivated for silage making as well as for green fodder. In certain parts the maize stover is also fed to livestock as low cost nutritious fodder.

Genesis of All India Coordinated Research Project on Maize

India inherited abject poverty and legacy of partition in 1947 when she gained independence from 200 years of British rule. At that time the biggest challenge before the government was to enhance the food production. In 1947 the per capita food availability in India was 407 g/day. During early 1950s, the total average food grain production in our country was 63.18 million t to which contribution of maize was only 4.02 % (Mittal et al., 2016). During this period the maize productivity in India was very low (696 kg/ha) and the maize breeding work was largely confined to the State Departments of Agriculture. In early 1950's, the Government of India imported a number of commercial maize hybrids, mainly from the USA and Caribbean region. These hybrids were evaluated under Indian conditions but acclimatization of these temperate

hybrids was a big challenge. Further, being late maturity these hybrids did not fit well in the existing cropping system. Realizing the importance of agriculture to meet the food requirement, the Government of India decided to revamp the agricultural research. Accordingly the Indian Council of Agricultural Research (ICAR) constituted a high powered committee in 1953 under the chairmanship of Dr. EJ Wellhausen from Mexico and Dr. UJ Grant from Columbia as member. Considering the fact that maize had highest productivity among all cereals and has wide adaptability to diverse environments, the committee gave emphasis on maize in its report submitted in 1954. Based on the recommendation of the Committee, with support of the Rockefeller Foundation, ICAR established the All India Coordinated Maize Breeding Project in the year 1957 with its founder Coordinator, Dr. RW Cummings. This is the first project of its kind. In the initial years, the project was limited to the disciplines of Breeding and Agronomy with 17 centres in major maize growing states of the country. With the support of PL480 of the USA in 1963, the mandate of the project was enhanced by including the disciplines of Entomology and Pathology and renamed as All India Coordinated Maize Improvement Project (AICMIP) (Rakshit et al., 2017). Since its inception concerted efforts have been made towards enhancing the productivity, profitability and competitiveness of maize and maize based farming systems.

The main objectives of project are to constitute, coordinate and organize multi-location and multi-disciplinary trials to develop region specific technologies of maize for farmers. The germplasm development and enhancement has remained as the base line for any crop improvement programme. To strengthen it, the Winter Nursery Center was established in 1962 at Hyderabad, Andhra Pradesh for germplasm development, generation advancement and to enhance breeding efficiency. Hyderabad was identified as most suitable place due to its neutral environment allowing growing of crops across the year. It was followed by establishment of hot-spots sites in 1963 for effective screening against important diseases of maize. However, lack of infrastructure facilities was the major hindrance to increase number of testing locations. In 1960-61 there was only one agriculture university in India i.e. Govind Ballav Pant University of Agriculture & Technology (GBPUAT) at Pantnagar. The need to establish universities in other states were realized and then many more State Agricultural Universities were established. Already identified maize research farms gradually became part of the university research farm and the testing locations turned out to be center under AICRP on Maize. The AICRP on Maize was elevated to the Directorate of Maize Research in 1994 and to the ICAR-Indian Institute of Maize Research (ICAR-IIMR) in 2015 (Rakshit et al., 2017). Director of ICAR-IIMR is de facto Coordinator of AICRP on Maize. Currently the basic, strategic and applied research for overall improvement of maize in India is being coordinated across 32 regular and 26 voluntary centres. Besides, at present, almost all major maize disease has one or more hot-spot sites for effective screening across the country.

Phases of maize research in India

With the inception of AICRP on Maize, maize improvement in India has gone through many phases. Prior to inception of coordinated project in 1957, isolated efforts were being made at various places for maize research and development. Under AICRP on Maize, the major emphasis was laid on introduction of exotic germplasm mainly from North and South America and Caribbean region. This was carried out with the support of the Rockefeller Foundation.

Simultaneously, systematic collection and characterization of indigenous germplasm was also taken up (Rakshit et al. 2017).The initial emphasis was on development of double cross hybrids followed by a shift from the double crosses to open pollinated varieties from 1967 onwards. The shifting from hybrids to composites may be considered as a major setback to the progress of maize research and development in India (Rakshit et al., 2018). The shifting from DCHs to composites was due to none availability of productive inbred lines leading to the uneconomical hybrid seed production.

In 1961, the first set of four double-cross hybrids, *viz*., Ganga 1, Ganga 101, Ranjit and Deccan were released for commercial cultivation in India. These hybrids showed distinct superiority over the existing landraces. Ganga Safed 2, Hi-Starch and Ganga 5 were other prominent hybrids released between 1963 and 1968. Spread of hybrids demanded infrastructural facilities to produce and sell seeds of the hybrids. To address these requirements the National Seeds Corporation (NSC) was established in 1963. In the initial years of NSC, both seed production and certification was carried out by them. However, shortly after that, the certification process was delinked to the Ministry of Agriculture, Government of India. Private seed players were also allowed to sell truthfully labeled (TL) seeds to ensure seeds reach the farmers.

Initially shifting from DCHs to composites and then from composites to three-way crosses and from three-way crosses to combinations of composites, three-way and double crosses was continued till 1993. The improvement gained through composite varieties and multi-parent hybrids was not significant and productivity remained stagnant (around 1.0 t/ha) for many years in this country. Thereafter, in 1990s, the efforts were made to develop single cross hybrids and this was the major intervention in the history of Indian maize programme. During the initial period of hybrid breeding, the private sector was not enthused to develop and produce single crosses due to apprehension of pilferage of parental lines of the hybrids from seed production area. The single cross hybrids developed by the project having better productivity attracted attention of private sector seed agencies to produce seed on royalty basis with nonexclusive right. In the mean time, as obligation under WTO, Government of India enacted two important bills, *viz*., Protection of Plant Verities and Farmers' Rights Act (PPV&FRA), 2001 and Biodiversity Act, 2002. These interventions have attracted the private sector in establishing their own R & D and seed production system. During the period production recorded up to 60% increase, while the area increased by 25% (Rakshit et al., 2017). The landmark achievements in AICRP maize programme since its inception are given in Figure 1.

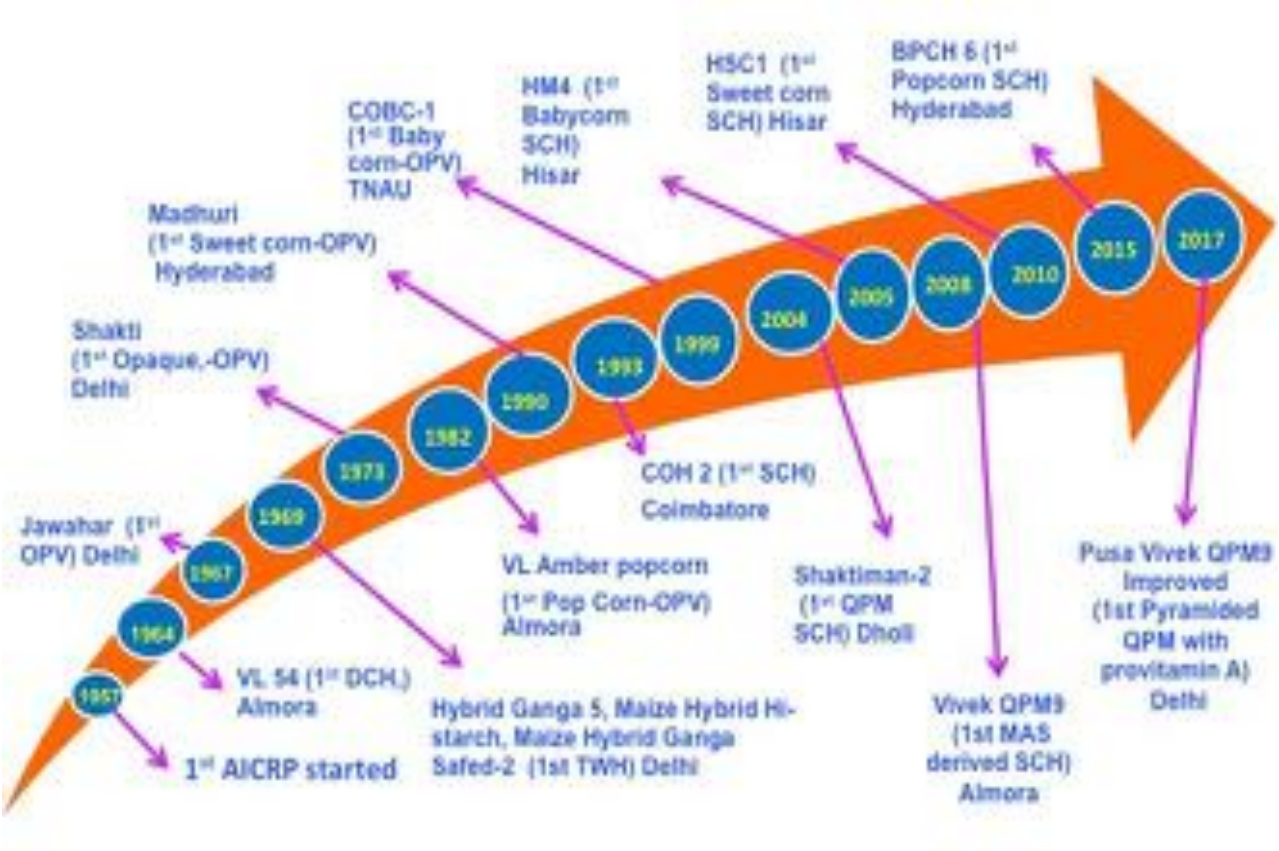

Figure 1. The timeline achievements under AICRP maize programme since its inception

Dawn of single cross hybrid development

During 1950 to 2019 the maize production increased by 15.72 times. The dynamics of maize productivity in India has been explained in Figure 2. Initially before the inception of AICRP (1950-57), the average maize productivity was remained below 1.0 t/ha (712 kg/ha). If we look into the trend of productivity from 1958 to 1970, at some of the years, the average productivity has reached up to 1.0 t /ha or even more. The overall productivity during this period was 958 kg/ha. This was mainly possible due to the development and cultivation of productive DCHs. However, in the next two decades (1971-89), there was stagnation in the yield and not much gain was observed. The average productivity of maize during this period remained 1141 kg/ha. The shifting from hybrids breeding to composites was the main reason for this. In 1990s, again the efforts were made to develop hybrids (mainly single cross hybrids) and with the results of it, in 1993, the first single cross hybrid COH2 of maize was released from TNAU, Coimbatore. Thereafter in 1996, the single cross hybrid Paras was released from PAU, Ludhiana. However, hybrid seed production proved to be a challenge resulting in less acreage under these hybrids. Subsequently, a series of other single cross hybrids such as in 1997, the MMH 69 in late and MMH 133 in early maturity group and in 2000, HHM 2 in medium group were also released. The private hybrids started finding their place in the most productive areas of the country mainly down south (Andhra Pradesh and Karnataka) (Jat *et al*. 2009). Introduction of National Seed Policy in 1988 was a significant policy decision taken by the Government of India. It allowed the

private sector seed companies to produce and sell seeds of public bred hybrids, in original name. Further, private sector was allowed to have access to the parental lines and to the composites, which were earlier accessed by public sector institutes only. This changed the scenario significantly. Some seed companies started their own R&D to develop hybrids and produce certified and truthfully labeled seeds. This helped to meet requirement of quality seeds in the country. Further private bred hybrids/varieties were allowed to be tested under the coordinated trials. With all collaborative efforts from public and private sectors, the maize productivity has been on increasing trends (Rakshit et al., 2017). However, the mission mode strategy to switch over to single cross hybrids in 2006-07 onwards has paid rich dividends. There has been

Table 1. List of regular and voluntary AICRP centers of national maize research network system

Zone	Centers
Northern Hill Zone (NHZ)	*Regular (7)* Bajaura (HP), Kangra (HP), Srinagar (J&K), Barapani (ML), Almora* (UK), Imphal (MN) and Gossaigaon (AS) *Voluntary (4)* Poonch (J&K), Rajauri (J&K), Dhaula Kuan (HP) and Agartala (TR)
North west Plain Zone (NWPZ)	*Regular (4)* Ludhiana (PB), Karnal (HR), Delhi* (DL) and Pantnagar (UK) *Voluntary (5)* Gurdaspur (PB), Kapurthala (PB), Jhansi (UP), Aligarh (UP) and Banda (UP)
North East Plain Zone (NEPZ)	*Regular (7)* Dholi (BR), Sabour (BR), Ranchi (JH), Bhubneshwar (OD), Varanasi (UP), Baharaich (UP) and Kalyani (W B) *Voluntary (5)* Koraput (OD), Medinipur (WB), Kolkata (WB), Majha (WB) and Sriniketan (WB)
Peninsular Zone (PZ)	*Regular (9)* Hyderabad (TS), Karimnagar (TS), Peddapuram (AP), Dharwad (KA), Mandya (KA), Kolhapur (MH), Rahuri (MH), Vagarai (TN) and Coimbatore (TN) *Voluntary (7)* VRDC KSSC Dharwad (KA), Devihosur (KA), Arbahvi (KA), Dhule (MH), Parbhani (MH), Nasik (MH) and Buldana (MH)
Central Western Zone (CWZ)	*Regular (5)* Banswara (RJ), Udaipur (RJ), Chhindwara (MP), Ambikapur (CG) and Godhra (GJ) *Voluntary (7)* Bhiloda (GJ), Dahod (GJ), Ujjain (MP) Indore (MP), Chitrakoot (MP), Jagadalpur (CG) and Kota (RJ)

tremendous increase in recent maize area (9.2 mha), production (27.2 mt) and productivity (2.9 t/ha). This has been possible due to only 30-35% of the total maize area under single cross hybrid. Therefore, the period of 2006-07 onwards may be considered as period of maize revolution in the history of Indian maize growth trajectory (Figure 2). The SCH breeding activities witnessed many positive changes and accomplishments in generating vital scientific information as well as commercial products. Research efforts were focused on the development of vigorous and genetically diverse inbred lines that have good *per se* performance and better heterosis. Due to increase of urbanization, change in food habit and improved economic status, the specialty corn has also gained significant importance in peri-urban areas of the country. Making availability of sufficient quality seed, area increase under SCHs, and application of novel tools and techniques can further enhanced the maize productivity, which can be considered in the form of opportunity as well as challenges.

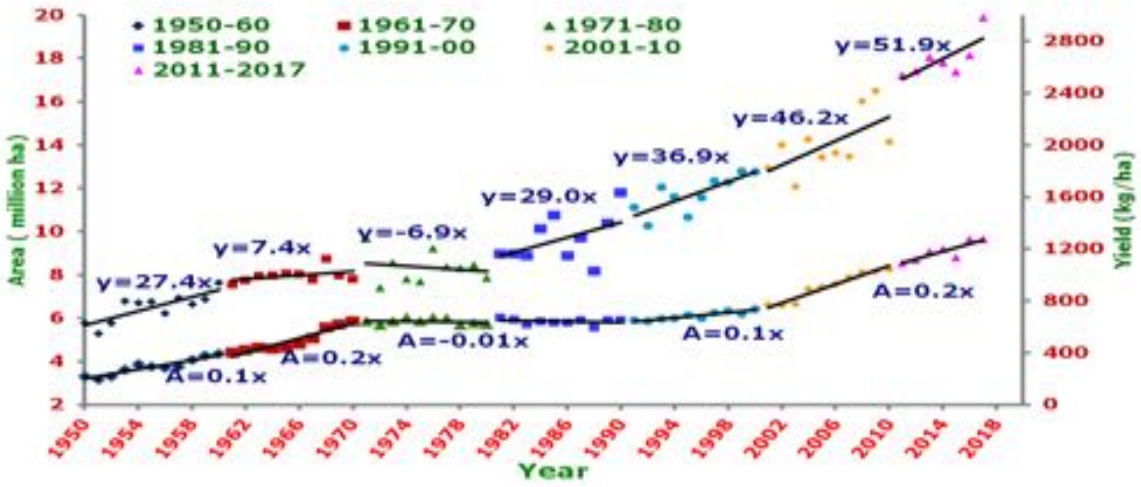

Figure 2. The years-wise trend of maize area (A) and yield (Y) in India since 1950.

Maize research network in India

The All India Coordinated Research Project (AICRP) on Maize research network in India is a unique one in the world maize improvement programme. The main objective of this is to conduct and coordinate multidisciplinary and multi-location research to identify appropriate technologies for different agro-climatic conditions in different parts of the country. The maize growing areas are very diverse in terms of agro-climatic conditions. Thus, the whole country is divided into five major maize growing zones (Figure 3). In each zone, there are different centers involved in research and development of maize as per the regional requirements. As on today, there are total of 32 regular and 26 voluntary centers representing 24 states/union territories of the country (Table 1). It is mandated that any agency developing a maize cultivar needs to test their entries in the AICRP network. The entries

received from public and private partners are tested for yield, reaction to diseases and insect-pest and for agronomic performance and quality parameters. The outcomes of all India testing are rigorously discussed during Annual Maize Workshop. All partners, from public and private sector participate in the discussion and become part of the decision.

The project also has become the mainstream for dissemination of developed technologies to the farmers' fields through Front Line Demonstrations (FLD) and capacity building in form of training and input distribution in the respective states. This involves on farm demonstration of superior production technology in terms of new cultivars or package of practices for different agro-climatic zones of the country. Since inception of the project 429 potentials hybrids and varieties have been released (Table 2). Besides research and development, the maize research network is also contributing directly or indirectly to meet out the seed demand of the notified hybrids of maize.

Table 2. The details numbers of improved maize hybrids and varieties released through AICRP maize research network system till 2019.

Type	**Public sector**	**Private**	**Total**
A. Grain maize			
1. Composite/Synthetic	121	0	**121**
2. Hybrids	134	131	**265**
B. QPM			
1. Composite/Synthetic	5	0	**5**
2. Hybrid	13	0	**13**
C. Pro-vitamin A enriched Hybrid	01	0	**01**
D. Popcorn			
1. Composite/Synthetic	4	0	**4**
2. Hybrids	2	0	**2**
E. Baby corn			
1. Composite/Synthetic	2	0	**2**
2. Hybrids	4	0	**4**
F. Sweet corn			
1. Composite/Synthetic	2	0	**2**
2. Hybrids	4	3	**7**
G. Fodder			
1. Composite/Synthetic	3	0	**3**
Total	**295**	**134**	**429**

Note: Voluntary cenres may change from time to time

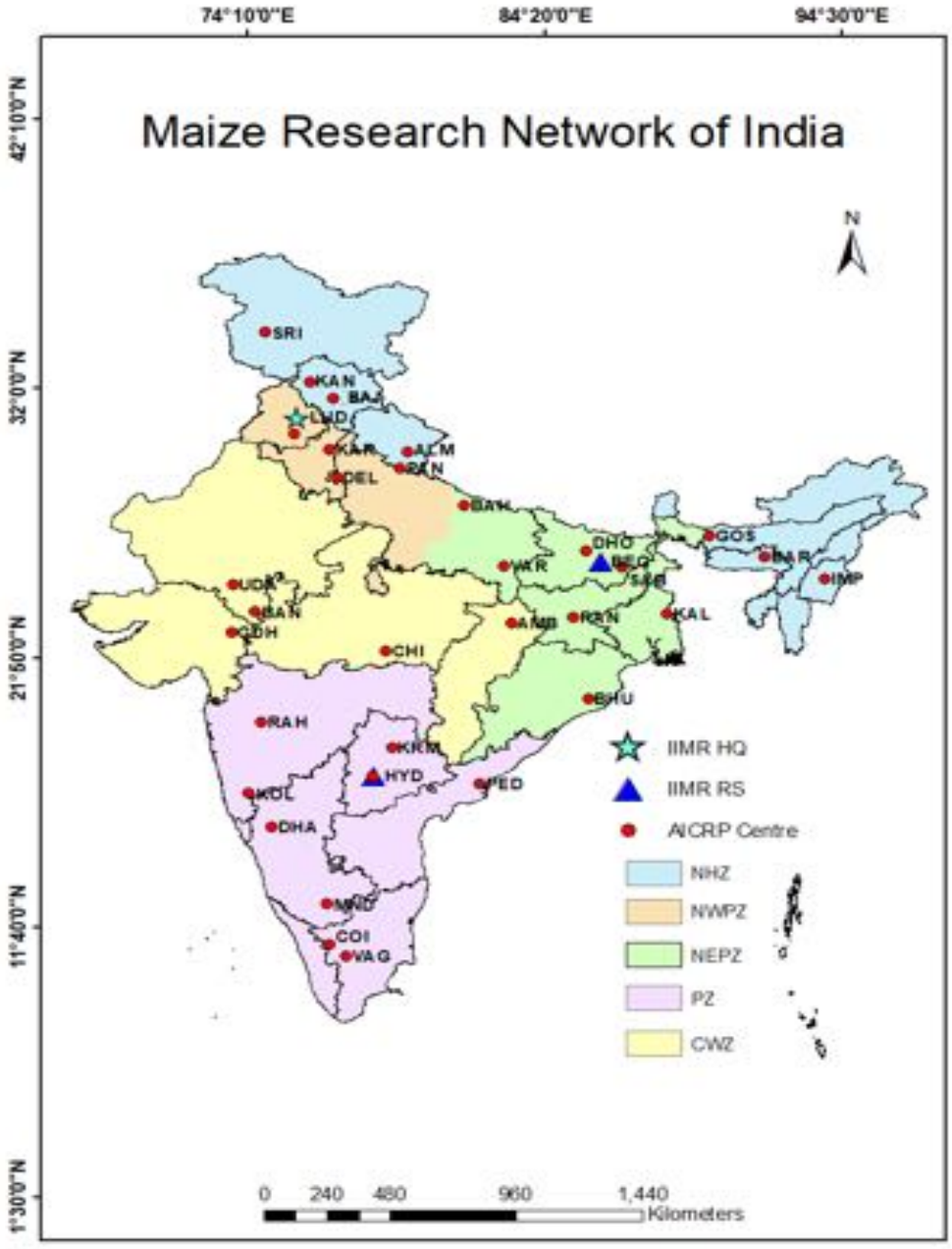

Figure 3. Zones under AICRP on Maize and location of centres

II. General requirements for nomination of maize entries in AICRP testing

Any public R&D organizations like ICAR institutes, AICRP research centers, CAU/SAUs/other universities, State and National Seed Corporation Ltd. and private seed companies or NGOs having established maize R&D programme within the country can nominate their test entries in AICRP on Maize for multi-location evaluation. However, given below are the essential requirements which must be fulfilled before nominating entries for testing:

- The entries to be nominated must have undergone critical evaluation/screening for at least one year in the station/regional trials conducted by the sponsoring organizations using station, zonal and national checks in their trials. The top one or two entries (no limit on private institutions/NGO/Corporation) showing significant yield superiority over the best performing check (5% in late maturity and 10% in rest of the group) can be contributed in AICRP trials by a sponsoring organization.
- All data generated in the pre-coordinated trials on yield and other important agronomic attributes, reaction to insect-pest and diseases and relevant quality parameters are required to be made available to the AICRP on Maize Director at the time of submitting the seeds. The covering letter should be duly forwarded by the head of institute/programme leader. Format of submission of entries is given in Annexure I.
- Private organizations/NGO, state and national seed corporation Ltd. with established R&D units within India need to pay the testing fee @ Rs 75000 + 18% GST per entry/per trial/per year. They need not to pay the testing fee at the time of submitting the seeds. Upon receipt of seeds ICAR-IIMR will provide an estimate of testing fee for the numbers of entry submitted to the sponsoring agency. Upon receipt of the Estimate the sponsoring agency needs to submit the DD/Cheque in favor of Director, ICAR-IIMR, Ludhiana, payable at Ludhiana. All the correspondences and DD/Cheque are to be sent to the **In-charge, Trials & Nursery (AICRP on Maize), Winter Nursery Center, ICAR-IIMR, Rajendranagar, Hyderabad, Telangana 500030** within the 15 days of receipt of the Estimate. If payment is not received within a month of initiation of execution of the trial the data will be withheld and not published. The firm will have to repeat the trials. Public sector organizations (ICAR-Institutes, AICRP partners, SAUs, CAUs, General/deemed universities) are exempted from payment of testing fee.
- The private institutions need to mention the GST No. of the firm and should submit their current DSIR (Department of Scientific and Industrial Research) Certificate at the time of submission of seeds to Incharge, Trials & Nursery, AICRP on Maize, WNC, ICAR-IIMR, Rajendranagar, Hyderabad
- The details of seed quantity for various trials have been given on Table 3. If desired quantity of seed is not submitted the entry will not be included for AICRP testing. Besides, seed must **not be treated** and should meet out the minimum germination of 90% and genetic purity of 98%.
- Last dates for receipt of seeds at WNC, ICAR-IIMR, Rajendranagar, Hyderabad:

  ***Kharif* trials : 10th May**
  ***Rabi* trials : 10th October**
  ***Spring* trials : 31st December**

Seeds should be sent to **In-charge Trials & Nursery (AICRP on Maize), Winter Nursery Center, Maize, ICAR-IIMR, Rajendranagar, Hyderabad, Telangana 500030**

Table 3. The details requirements of seed quantity for various AICRP trials

S.No.	Trial	Year of testing	Seed quantity (Kg)	Mode of conduct
1	National Initial Varietal Trial (NIVT)	1	3.5 kg/Entry/Trial	*Kharif*: Across zone *Rabi*: Across zone except NHZ *Spring*: Only in NWPZ
2	Advance Varietal Trial-I (AVT-I)	2	6.0 kg/Entry/Zone/trial	*Karif*: Zone specific *Rabi*: Across zones except NHZ *Spring*: Only in NWPZ
3	Advance Varietal Trial- II(AVT-II)	3	10.0 kg/Entry/Zone/trial	*Kharif*: Zone specific *Rabi*: Across zones except NHZ *Spring*: Only in NWPZ
4	QPM	1 , 2 , 3	7.0 kg/ Entry	*Kharif*: Across Zone *Rabi*: Across zones except NHZ *Spring*: Only in NWPZ
5	Popcorn	1 , 2 , 3	3.5 kg/ Entry for 1st and 2nd and 6 Kg/entry for 3rd year	*Kharif*: Only in NHZ *Rabi*: Across zone except NHZ
6	Sweet corn	1, 2, 3	3.5 kg/ Entry for 1st and 2nd and 6 kg/entry for 3rd year	*Kharif* : Across Zone
7	Baby corn	1, 2, 3	8.0 kg/ Entry	*Kharif* : Across Zone

III. Trials constitution and conduct: Maize Breeding

Before identification, release and notification of any hybrid/variety, these have to undergo three years of testing in AICRP trials for various breeding, agronomical and diseases and insect-pests performance against the recommended checks. In case of marker assisted essentially derived varieties (EDVs) the requirement of testing is for two years. The three tire systems of multi-location evaluation are as follow:

1. National Initial Varietal Trial (NIVT): First year of testing
2. Advance Varietal Trial-I (AVT-I): Second year of testing
3. Advance Varietal Trial-II (AVT-II): Third year of testing

All the entries received under AICRP are used for constitution of different multidisciplinary trials. The entries received for NIVT are evaluated in breeding and pathology trials. Whereas the advance stages entries i.e. entries in AVT-I/II are evaluated in breeding, pathology and entomology trials. AVT-II (final stage) entries are evaluated in agronomy trials as well. The details of pathology, entomology and agronomy trials are elaborated in subsequent Chapters (VI and VII). The details of different breeding trials along with their experimentation and procedure of conduct are given in Table 4.

All the test entries are evaluated in various trials and compared with the suitable checks. The performing entries are identified and promoted to the next stage of testing based on the set promotion criteria (will be detailed in Chapter V). There are different types of checks such as national, zonal and local checks generally used in each trial. Besides, at the time of identification of the hybrid, the performance of qualifying entry is also taken into consideration. The qualifying entry can be described as the co-entry in the same trial being tested for the same period.

Table 4. The detail numbers of different breeding trials constitute along with their mode of conductance and experimentation

Trial	Year of Testin	No. of rows (4 m)	Rep. No.	Spacing	Plot size (Sq. meter)	Season[#]	Zone
NIVT-Late	I	2	3	60 × 20 cm	4.8	K*+R+S	Across zone
NIVT-Medium	I	2	3	60 × 20 cm	4.8	K+R+S	Across zone
NIVT Early	I	2	3	60 × 20 cm	4.8	K+S	Across zone
AVT-I Late	II	4	3	60 × 20 cm	9.6	K+R*+S*	Zone specific
AVT-I Medium	II	4	3	60 × 20 cm	9.6	K+R+S	Zone specific
AVT-I Early	II	4	3	60 × 20 cm	9.6	K+S	Zone specific
AVT-II Late	III	6	3	60 × 20 cm	14.4	K+R+S	Zone specific
AVT-II Medium	III	6	3	60 × 20 cm	14.4	K+R+S	Zone specific
AVT-II Early	III	6	3	60 × 20 cm	14.4	K+S	Zone specific
QPM-I-II-III	I-II-III	4	3	60 × 20 cm	9.6	K+R+S	Across zone

BC-I-II-III SC-I-II-III	I-II-III I-II-III	2 4	3 3	60 × 15 cm 60 × 20 cm	4.8 9.6	K K	Across zone Across zone
PC-I-II-III	I-II-III	4	3	60 × 20 cm	9.6	K*+R+S	Across zone
OPV-I-II-III	I-II-III	4	3	60 × 20 cm	9.6	K*	Zone specific

[#] Season: Kharif (K), Rabi (R), Spring (S)

***Note:**

- Late trials are not conducted in NHZ in either of the seasons.
- All rabi trials (NIVT, AVT I & II, PC & QPM) are conducted across the zones apart from NHZ (exception: Gossaigaon) and NWPZ
- Spring season trials are conducted only in NWPZ.
- Popcorn trials are conducted during rabi season in all zones except of NHZ & NWPZ, where they are conducted during the kharif and spring seasons, respectively.
- OPV trials are conducted in NHZ only.
- Kharif entries of AVT-I-II for normal and QPM grown under normal conditions are also to be grown under rainfed condition at selected locations. The data generated will be additional information for VIC. In rainfed situation, the sowing will be done on residual soil moisture and thereafter no irrigation will be provided through out the crop season.
- The trials for biochemical assessment of nutritional enriched traits will be conducted only at Delhi and Ludhiana for biochemical evaluation. Data will be taken from selfed cobs only.
- Fertilizer dose – As per state/regional recommendations; the crop needs to be irrigated time to time so that crop does not suffer from water stress.
- In general, late maturity genotypes mean it matures in >95 days, Medium: 85-95 days and early <85 days during kharif season. However it may varies from zone to zone and seasons to season. It is always better to calculate the growing degree days (GDD) to have more realistic and scientific information on flowering and maturity of different genotypes in various ecologies, therefore we recommend to calculate the GDD in all AICRP trials on the basis of following formula:
  GDD = Daily Average Temperature (^{o}C) – Base temperature (Standard: 10 ^{o}C), where,
  Daily Average Temprature (^{o}C) = [(Daily minimum temperature (^{o}C) + Daily maximum temperature (^{o}C)]/2

- Before initiation of trials seeds are treated with a chemical combination of Cyantraniliprole + Thiamethoxam (@ 6 ml/kg). Treated seeds are used to constitute the breeding and agronomy trials. However, for Pathology and Entomology trials untreated seed are used. Hence, untreated seeds are to be supplied by the sponsoring agencies.
- All trials are constituted using the automation system, AICMIP On-line Automation System available at http://aicmip.naarm.org.in/ (Fig.4). Randomized layouts for all treatments are automatically generated for each centre and the seed along with the randomized layout plan are dispatched to AICRP maize centres. The respective centres can also view their layout by logging in to http://aicmip.naarm.org.in/ using their username and password. There is replication wise coding and a separate randomization plan and data recording sheet are generated for each centre.

Figure 4. Home page of AICRP Online Automation System for Maize

- The seed packets in the trials are labelled with the trial name, randomised plot number and replication details.
- NIVT, QPM and Specialty corn trials are sent to only regular centres of AICRP maize, whereas AVT-I and AVT-II trials are sent to both regular and voluntary centres during kharif. However, during rabi season, QPM and PC trials go to only regular, where as both NIVT and AVT-I-II normal field corns trials goes to both regular & voluntary centres. The zone wise details of regular and voluntary centres are already given in Table 1.
- The entries of AVT-I-II in early and medium maturity breeding trial will also to be grown under rainfed condition at selected locations. The data generated will be additional information for VIC. In rainfed situation, the sowing will be done on residual soil moisture and thereafter no irrigation will be provided through out the crop season, i.e. no irrigation after germination.
- The EDVs are tested only for two years under AICRP trials in the proposed ecology(s) along with their original hybrid(s) as comparable check for promotion. All EDVs should be

thoroughly tested for the quality traits claimed with respect to the original hybrid. Preferably, marker assisted back cross breeding (MABB) programme should be initiated within five years from the date of notification of a new hybrid. Season of crosses between recipient and donor will be considered for calculating the five year period. This clause will be applicable for the hybrids to be notified from January 1st, 2021. However, if any programme has started before this date the entries will be considered. In cases, where a hybrid is released for more than five years back, that can also be considered for MABB if the hybrid has wide area of coverage or still very popular among the farmers due to its high yield or any other totally new trait has been introduced through MAS. In general, the development of EDVs should be avoided for the traits where sufficient genetic diversity is already there in natural available germplasm/released hybrids.

Management of the crop: Standard cultural practices shall be followed by the experimenters. For general guideline IIMR Publication No. 2020/2. (Maize production for food, feed and fodder) need to be followed. However, in this regard the state recommendations are also to be taken into consideration. Experimenters need to ensure that entries in breeding trials should not suffer from any biotic and abiotic stress so that their full potential is expressed.

The following points need to be kept in mind while layout and experimentation

(i) The trials should be laid out in such a manner so as to enable in detection of minimum difference of 5-10% in yield at 5% probability level.
(ii) The number of replications to constitute a trials using 'n' number of entries should be such that degree of freedom remain minimum of 14 error for effective evaluation
(iii) Plot size and number of replications will be as per the recommendation for different trials which should be uniformly followed at all the test locations across the country.
(iv) The experiment shall be laid out in a well drained and leveled field. As far as possible all replications should be accommodated in the same field.
(v) Generally, the design of experiment to be followed will be RCBD with specified replication, but in case where the numbers of test entries exceeded 25, then the 'Alfa lattice' design can be followed for effective evaluation and statistical analysis. Further, in case of large number of entries in NIVT the trial may be split into two sets and analyzed together applying appropriate statistical tools. The details of layout and experimentation will always be decided by the coordinator and will be communicated to the testing centers along with the seeds.

The zone and season wise detail of different locations, where the individual breeding trials are dispatched are as follows:

Breeding trials to be constituted and dispatched during Kharif season

1. **Normal field corn**

NIVT-Late (Across the zone)

NWPZ : Ludhiana, Karnal, Delhi, Pantnagar
NEPZ : Dholi, Sabour, Ranchi, Bhubaneswar, Varanasi, Bahraich

PZ : Dharwad, Mandya, Karimnagar, Hyderabad, Coimbatore, Vagarai, Peddapuram, Kolhapur, Rahuri
CWZ : Banswara, Udaipur, Chindwara, Ambikapur, Godhra

NIVT-Medium (Across the zone)
NHZ : Almora, Bajaura, Kangra, Srinagar, Gossaigaon, Imphal
NWPZ : Ludhiana, Karnal, Delhi, Pantnagar
NEPZ : Dholi, Sabour, Ranchi, Bhubaneswar, Varanasi, Bahraich
PZ : Dharwad, Mandya, Karimnagar, Hyderabad, Coimbatore, Vagarai, Peddapuram, Kolhapur, Rahuri
CWZ : Banswara, Udaipur, Chindwara, Ambikapur, Godhra
NIVT –Early (Across the zone)
NHZ : Almora, Bajaura, Kangra, Srinagar, Gossaigaon, Imphal, Barapani
NWPZ : Ludhiana, Karnal, Delhi, Pantnagar
NEPZ : Dholi, Sabour, Ranchi, Bhubaneswar, Varanasi, Bahraich
CWZ : Banswara, Udaipur, Chindwara, Ambikapur, Godhra

AVT-I-II (Zone specific)

NHZ : Bajaura, Kangra, Srinagar, Poonch , Rajauri, Dhaula Kuan, Gossaigaon, Barapani, Imphal, Agartala
NWPZ : Ludhiana, Gurdaspur, Kapurthala, Karnal, Delhi, Pantnagar, Aligarh, Jhansi, Banda
NEPZ : Dholi, Sabour, Ranchi, Bhubneshwar, Koraput, Varanasi, Baharaich, Medinapur
PZ : Hyderabad, Karimnagar, Peddapuram, VRDC KSSC Dharwad, Dharwad, Devihosur, Arbahvi, Kolhapur, Mandya, Vagarai, Coimbatore, Dhule, Parbhani, Nasik, Rahuri, Buldana
CWZ : Banswara, Udaipur, Chindwara, Ambikapur, Godhra, Bhiloda, Dahod, Ujjain, Indore, Kota, Jagadalpur, Chitrakoot

2. OPV trials (only in NHZ)

NHZ : Almora, Bajaura, Kangra, Srinagar, Gossaigaon, Imphal

3. QPM trials
QPM I-II-III (Across the zone)

NHZ: Almora, Bajaura, Kangra, Srinagar, Gossaigoan (Jorhat),
NWPZ: Delh , Ludhiana, Karnal, Pantnagar
NEPZ: Dholi, Ranchi, Bhubaneswar, Varanasi, Bahraich, Sabour,
PZ: Dharwad, Mandya, Karimnagar, Hyderabad, Peddapuram, Coimbatore, Vagarai, Kolhapur, Rahuri
CWZ: Udaipur, Banswara, Chindwara, Ambikapur, Godhra
Note: QPM Quality traits evaluation trials are conducted at IARI, New Delhi and ICAR-IIMR, Ludhiana

4. Specialty corns
Sweet Corn I-II-III (Across the zone)

NHZ: Almora, Bajaura, Kangra, Srinagar, Gossaigoan (Jorhat), Imphal, Barapani
NWPZ: Delhi, Ludhiana, Karnal, Pantnagar
NEPZ: Dholi, Ranchi, Bhubaneswar, Varanasi, Bahraich, Sabour, Kalyani
PZ: Dharwad, Mandya, Karimnagar, Hyderabad, Peddapuram, Coimbatore, Kolhapur, Rahuri,
CWZ: Udaipur, Banswara, Chindwara, Ambikapur, Godhra

Baby Corn –I-II-III (Across the zone)

NHZ: Almora, Bajaura, Kangra, Srinagar, Gossaigoan (Jorhat), Imphal, Barapani
NWPZ: Delhi, Ludhiana, Karnal, Pantnagar
NEPZ: Dholi, Ranchi, Bhubaneswar, Varanasi, Bahraich, Sabour, Kalyani
PZ: Dharwad, Mandya, Karimnagar, Hyderabad, Peddapuram, Coimbatore, Kolhapur, Rahuri
CWZ: Udaipur, Banswara, Chindwara, Ambikapur, Godhra

Popcorn-I-II-III (only in NHZ)

NHZ: Almora, Bajaura, Kangra, Srinagar, Gossaigoan (Jorhat), Imphal, Barapani

*Note: the data for quality traits in specialty trials (SC, PC & BC) will be recorded by following centre, viz., **NHZ**:Srinagar and Almora; **NWPZ**: Ludhiana and Delhi (IARI); **NEPZ**: Varanasi and Dholi; **PZ**:Hyderabad, Mandya, Dharwad, Coimbatore; **CWZ**: Udaipur and Godhra*.

Breeding trials to be constituted and dispatched during Rabi season

1. **Normal field corn (Only NIVT/AVT-I-II late and medium)**

Gossaigaon, Bahraich, Varanasi, Dholi, Sabour, Ranchi, Kalyani, Kolkata, Majhian, Sriniketan, Kalyani, Bhubneshwar, Dharwad, Mandya, Coimbatore, Karimnagar, Peddapuram, Rahuri, Kolhapur, Banswara, Godhra

2. **QPM Trials**

Bahraich, Varanasi, Dholi, Sabour, Ranchi, Kalyani, Bhubneshwar, Dharwad, Mandya, Coimbatore, Hyderabad, Karimnagar, Peddapuram, Rahuri, Kolhapur, Banswara, Godhra

3. **Popcorn-I-II-III**

Dholi, Ranchi, Bhubaneswar, Varanasi, Bahraich, Sabour, Kalyani, Dharwad, Mandya, Karimnagar, Hyderabad, Peddapuram, Coimbatore, Kolhapur, Rahuri, Udaipur, Banswara, Chindwara, Ambikapur, Godhra

Breeding trials to be constituted and dispatched during *Spring* Trials:
Normal field corn, QPM & PC: Ludhiana, Gurdaspur, Karnal, Pantnagar and Delhi, Aligarh

IV. Recording of observations and online submission of data for AICRP maize breeding trials

Once the trials are received, the sowing should be done as per the layout given. The packets received for each trial should be arranged as per the plot numbers given in the layout as well as marked on each packet. For convenience, the serial number may be given to each packet and may be arranged accordingly for sowing. Each block should have one main path (1-1.5 m width) and sub-path (0.50-0.75 m width). The uniform border of 1.5 to 2 m may be given across the experimental field to prevent damage from wild animals and birds. The packet should be drop as per the layout and serial number on main path by moving from left to right direction along the main path and then accordingly the sowing should be done. After planting the trials, the recording of observations starts right from the day of germination. Standard yield and agronomic traits are to be recorded. The experimenters need to mention gross and net plot size very carefully. Yield is to be recorded on net plot basis by leaving one plant at both the border of each row. This is for to mitigate the border effects on yield. Besides, some useful breeding traits like leaf traits (leaf arrangement, width and green darkness); husk traits (husk tightness 1: good; 5: poor, tip filling); grain quality attributes (grain color, grain weight, grain-appearance); ear traits (ear length, girth, row arrangement/no., and kernel/row etc.) are also to be recorded. These traits may be recorded and put in remarks for further selection of suitable genotypes. Generally the characters on which data shall be recorded would be specified in advance in the work plan of annual maize workshop. The data sheet of complete traits along with the layout can be downloaded from online link http://aicmip.naarm.org.in/. The traits to be recommended in breeding trials vary from type of trial. These are elaborated below:

Normal Field corn trial

1. *Initial plant stand (No./plot)*: This can recorded when there is initial establishment of the seedlings i.e. 21 days after the germination (DAG). The data on initial plant population should be submitted online within 10 days of its recording.
2. *Days to 50% anthesis* (in no. of days): It should be recorded when anthesis (pollen shedding in upper 1/3rd part of the tassel) appears in 50% of the plant population in a plot for a given entry. The data on days to anthesis should be submitted online within 10 days of recording. Day number cannot be in fraction.
3. *Days to 50% silking (No. of days)*: It should be recorded when silk appears (up to 3.0 cm) in 50% of the total plants population in a plot for a given entry. The data on days to anthesis should be submitted online within 10 days of recording. Day number cannot be in fraction.
4. *Plant height (cm)*:It should be recorded from base of the plant (soil surface) to up to flag leaf/the point from where tassel start. This trait may be recorded in ten random plants of a plot at the time or just before to physiological maturity. Actual data for 10 plants may be updated and system will automatically calculate the average (this provision will be introduced in AICRP Automation system shortly, till then use manual average values).
5. *Ear height/placement (cm)*:It should be recorded from base of the plant up to base of the upper most ear placement at physiological maturity. This trait is to be recorded in same ten random plants of a plot which were selected for recording the plant height. Actual data for 10 plants may be updated and system will automatically calculate the average (this provision

will be introduced in AICRP Automation system shortly, till then use manual average values).

6. *Days to maturity (Days)*: This trait can be recorded once 75% of dry husk is attained. At this stage efforts are to be made to check for appearance of black layer at the tip base of kernel from lower side of the cob. For recording black layer 10 random plants are to be used. Actual data for 10 plants may be updated and system will automatically calculate the average (this provision will be introduced in AICRP Automation system shortly, till then use manual average values).
7. *Plant population at harvest (No./Plot)*: Total number of plants per plot per replication at the time of physiological maturity are to be recorded.
8. *Ear count at harvest (No./plot)*: Total number of ears per plot per replication are to be recorded at the time of harvesting.
9. *Shelling percentage (%)*: It has to be recorded in actual by selecting continuous 10 plants starting from beginning in second row of each entry in a plot leaving the border plant. Their ears are to be harvested. Immediately these ears are to be weighed and shelled in bulk. Grain weight and moisture percentage are to be recorded simultaneously. The shelling percentage can be calculated by taking the ratio of grain weight and ear weight multiplied with 100. Shelling % age need to be reported minimum for two replications.
10. *Fresh ear weight at harvest (kg/plot)*: Immediately after above activity all ears are to be harvested on plot basis. Ear weight per plot per replication for each genotype is to be immediately recorded.
11. *Grain Moisture at the time of harvesting (%)*: Grain moisture content in the kernels as recorded in Sl. No. 9 above may be reported using grain moisture meter.
12. *Grain weight (kg/plot)*: The ideal way of calculating yield is to shell all ears in a plot and then weigh them to calculate the yield on plot basis at given moisture percentage. Care should be taken that moisture content and plot yield should be taken at the same time. However, due to scarcity of time and labour if it is not possible to do whole grain shelling then it can be estimated from the shelling percentage and fresh ear weight at a given moisture percentage. The coordinating center will calculate the grain yield while analysis. Need to record the moisture percentage very meticulously.

Note: The most important thing is that, the plot fresh ear/grains yield and moisture percentage should be measured immediately after the harvest. If in any unavoidable circumstance it is not possible to record all these two traits together immediately after the harvest, then later on when time permit, they all should be recorded at one time for reporting.

In addition to the above, few other mandatory traits need to be recorded in QPM/nutritional enriched and popcorn trials.

QPM /other nutritional enriched trial

All above traits Sl. No. 1-12 are to be recorded for QPM and quality trials. Additionally entries will be subjected to biochemical tests. For this purpose the biochemical evaluations of entries are to be done in separate trials which would be conducted at New Delhi and Ludhiana only. All nutritional enriched traits should be evaluated only in the self ears.

1. For QPM entries, the tryptophan content in endospermic protein (percentage of protein) must be ≥ 0.60%, which will be estimated using calorimetric/HPLC (Sarika et al., 2018). However a pilot experiment needs to be carried out for screening diverse QPM germplasm for tryptophan content on whole grain basis. Once it is done, the revised value for tryptophan content on whole grain basis may be decided.
2. For pro-vitamin A enriched materials, pro-vitamin A content should be >5.0 ppm in kernels stored for minimum of three months. The shelfed ears should be harvested and dried along with the husk in dark conditions to attain around 12% moisture content; thereafter they should be stored in room condition for minimum of three months. Pro-vitamin A will be estimated using HPLC (Zunjare et al., 2018).

Popcorn trial

All traits Sl. No. 1-12 in case of normal grain trials are to be recorded for popcorn trials. Additionally entries will be subjected to popping tests. For popping around 500 grains per replication from selfed ears need to be taken. Grains are to be dried properly. It may be noted that popcorn grains are smaller and roundish in shape. This needs to be checked first. After proper drying (~12% moisture) the grains are to be put in portable popping machine and following data are to be recorded.

1. *Popping percentage*: It is ratio of numbers of kernels popped to the total numbers of 500 selfed kernels used for popping multiplied by 100 to give popping percentage.
2. *Popping volume (cc/g)*: This is measure by using a measuring cylinder of appropriate capacity and should be recorded the volumes before and after popping of 500 selfed kernels. Weight of 500 kernels be recorded before popping to calculate popping volume in cc/g.
3. *Popping expension ratio*: This is calculated by taking the ratio of volume of popped kernels/volume of total kernels before popping from above given trait no. 2

Sweet corn

Sweet corn trials are harvested within around 18-20 DAP. Traits Sl. No. 1, 2, 3, 4, 5 & 7 in case of normal grain trials are to be recorded for sweet corn trials. Only the observations mentioned to be recorded at the time of physiological maturity should be recorded here just before harvesting the green ears. Additionally following traits will be recorded:

1. *TSS during harvesting of green ear*: For this purpose Digital Brixmeter is to be used to measure TSS. It should be recorded in five selfed ears in each replication approximately 18-20 days after pollination (DAP) i.e. mid R_4 stage. Only few drops of juices needed to be taken from well developed kernels in the middle of the ear. After this the cobs are to be mixed with other harvested cobs to get data for next two traits.
2. *Fresh green ear weight at harvest (kg/plot) with husk*: Fresh green ears are to be harvested from net plot. Fresh weight with husk is to be recorded immediately after harvest. Data to be recorded on net plot basis. Selfed cobs for above after recording TSS are to be included in this. In due course in AICRP automation system provision for each plant data will be created and system will automatically calculate the average values. Till then average of TSS value will have to be calculated manually.

3. *Fresh green ear weight at harvest (kg/plot) without husk*: Fresh green ears as above are to be dehusked immediately and weight are to be taken. Data to be recorded on net plot basis. Selfed cobs for above after recording TSS are to be included in this.
4. *Green ear count at harvest (No./plot)*: This is to be recorded immediately after harvest.
5. *Moisture percentage*: This is to be recorded immediately after harvest using a specialized moisture meter.

Baby corn trial

Baby corns are harvested within 2-3 days of silk emergence. Before that the trial is to be de-tasselled immediately after emergence of tassel. In addition to traits Sl. No. 1, 3, 4, 5 in case of normal grain trials. However, the traits to be recorded at the time of physiological maturity should be recorded here at just before harvesting of baby corn. Following traits are to be recorded for baby corn trials:

1. Plant population per plot – to be recorded just before or during the time of baby corn harvesting.
2. Date(s) of harvest of un-pollinated baby corn and total number of baby corn harvested (No./plot).
3. Fresh weight of baby corn per plot with husk (Kg) – Rounded to 0 decimal.
4. Fresh weight of baby corn per plot without husk (Kg) – Rounded to 0 decimal,
5. Length of baby corn (cm) – Average length of 5 baby corns from base to tip is to be recorded and rounded to 0 decimal.
6. Diameter of baby corn (cm) – Average diameter at the middle of 5 baby corns is to be recorded and rounded to 0 decimal.

Note: for points number (3, 4, 5,6): The baby corn has to be harvested continuously everyday for the period of approximately 15 days in a baby corn trial. The data on number of baby corn harvested, fresh weight with husk and without husk and length of baby corn (at least 3 baby corns) on each day from each plot need to be recorded in the observation. Total baby corn numbers, total fresh weight with husk, total fresh weight without husk and average length and diameter need to be calculated after completion of harvest and submitted as one data point per plot. In due course in AICRP automation system provision of each harvest will be added and system will automatically calculate the cumulative values. Till then above mentioned procedure will be followed.

Data Entry and Upload

The data generated for the traits listed for each trial are to be entered in the exclusive datasheet generated for each centre. The trials wise data sheet for location can avail from http://aicmip.naarm.org.in/. The datasheet so generated complete in itself. If any changes in the datasheet are made except for the cells to which data to be entered, experimenters will not be able to upload the datasheet. Apart from this the data must be entered in the specified units only. All experimenters dealing with the execution of trials can create their own user ID and Password. However, for any guidance they can contact to the Director for further information.

Before uploading the datasheet experimenters need to fill up some basic information as described in Figure 5. Without filling these experimenters cannot submit datasheet. While filling up this due care needs to be taken as this information will be base information for the calculation of total grain yield on hectare basis. Time to time experimenter may upload the data, while subsequent submission will delete previously submitted data. At the time of submission the experimenter will receive a summary report (Fig 6). He needs to ensure that submitted data is in format and there is no typographical mistake while entering the data. This can be cross checked from the range and average for each trait. The datasheet so submitted is final and cannot be modified by the experimenter unless rejected by experiment in-charge**. Last date for submission of *Kharif* trials data is December 31st and for *Rabi* trials it is 31st July of every year.** The online procedure for uploading the data would be similar for all disciplines, only the observations/units will be differ as per the discipline.

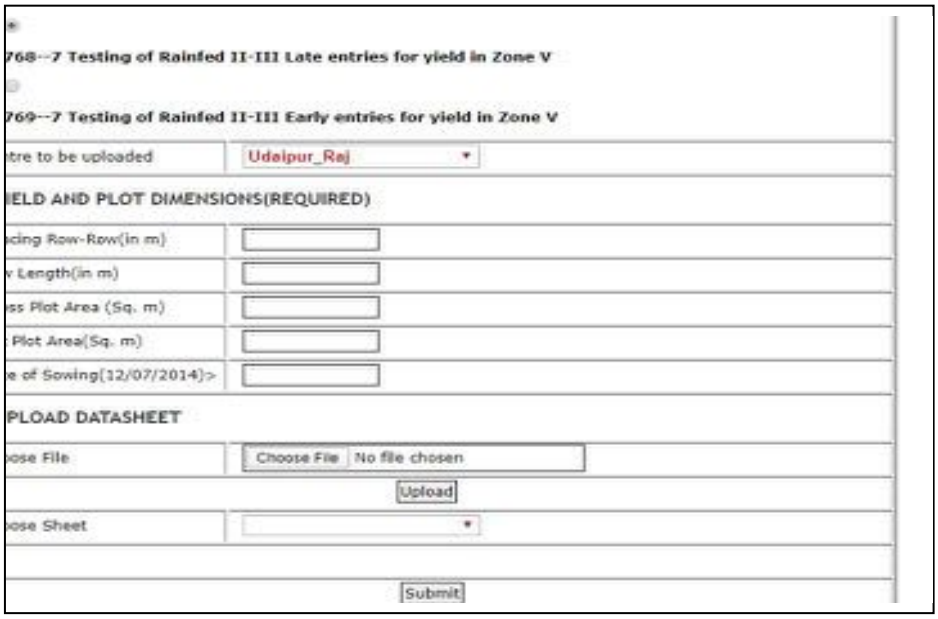

Figure 5. Screenshot of the information required before uploading the data by respective centres

Figure. 6. Summary of data to be submitted for review

V. Criteria for data rejection, promotion and identification of entries in AICRP testing

Monitoring and acceptance/rejection of trial data

All the trials are monitored by a team of multidisciplinary members constituted by the Director. They will visit the trials at flowering to grain filling stage of the crop. The team will review execution of trials as per the layout given to the centre, maintenance of field data book and recording of data. Monitoring team report will be prepared by the team and submitted to the Director in the given format (Annexure II). Once the online data submission from various AICRP partners is completed, it shall be critically examined by the various Experiment In-charges (Principal Investigator) from the coordinating unit. The data are reviewed at two stages, first at before analysis and second is after the analysis. Any discrepancy in the data from any centres will be communicated to experimenter for clarification and further necessary action. On several set parameters a trial may be rejected:

(i) Data may be rejected based on the recommendations of the monitoring team.
(ii) A trial may be rejected if the trial mean yield is found less than the state average yield.
(iii) The data of a trial at a location can be rejected if their CV falls below/above the set limit, e.g., if CV <5% for irrigated as well as rainfed ecologies, or >20% in irrigated and >30% rainfed ecologies. For Breeding and Agronomy trial CV for grain yield will be the main guiding criteria for trail rejection, while for Entomology and Pathology trial it will the LIR/Disease score.
(iv) If the plant population of a trial is less than 80% of the standard population expected.
(v) In any trials if performance of the checks is unusually low and unrepresentative of the general check performance the trial will not be considered.
(vi) Any other serious flaw in data recording/reporting.
(vii) In all the trials minimum three locations (CV within limit) data per zone will be required for the promotion of the entry, failing which the trials will be reconstitute in the next year.
(viii) In future location heritability may also be included in accepting or rejecting trial data.

Criteria of promotion of entries

1. Entries must be numerically superior over the best check in a zone for yield and should have non-significant differences in yield from the best entry (rank 1st) of the trial at CD (P=0.05).
2. In early and medium trials, besides yield, the test entry should not exceed the relevant best check by 2.0 days in days to 50% anthesis.
3. In QPM, all entries will be compared with best check except for NHZ (Zone I) where the test entries found to be early based on days to 50% anthesis criteria will be compared with Vivek QPM 9.
4. In sweet corn and baby corn trials, fresh green ears and baby corn yield without husk, respectively, will be considered for promotion of entries.
5. The disease reaction of test entries to the disease of national average will be considered for promotion. If an entry is showing susceptible or moderately susceptible reaction in the scale of 1-9 to a prevalent disease for a zone it will not be promoted. However, for sweet corn and

baby corn entries disease resistance will not be a strict criterion as the crop is harvested before entry reaches maturity.

6. EDVs should be statistically on par with the original cultivar. However, the pooled value of two years testing average of the EDV should not be numerically inferior to the original variety. In that case it will not be recommended for identification.
7. In any case if check belongs to early group and entry is from medium maturity the grain yield superiority should be ≥20%, and if test entry is in late maturity and check is early superiority should be ≥25%. In case of comparison between medium maturity check and late maturity entry the superiority will be ≥15%. However, for comparison of quality parameters, the corresponding check value along with the set limit will be considered.
8. In QPM, Provitamin-A enriched hybrids and speciality corn, *viz*., sweet corn and popcorn, besides yield, following quality parameters are also to be considered while promotion:

i) In QPM or any other bio-fortified hybrids, besides the yield superiority over the suitable check, the hybrid should have target quality trait(s) within the set limit like in QPM (tested for percentage tryptophan & lysine in endospermic protein), the percentage tryptophan and lysine content in test entry should be ≥0.60% and ≥2.5% (in percent endosperm protein), respectively.

ii) Provitamin-A enriched hybrids: The provitamin –A content should be ≥ 5.0 ppm in selfed kernels stored for minimum of three months

iii) Sweet corn –The TSS values measured using Brixmeter should be ≥15%

iv) Popcorn: Popping percentage should be ≥ 85%, with minimum expansion ratio of 1:15

9. Insect resistance will be an additional trait to be considered at the time of identification of entries.
10. Kharif entries in advanced trials (AVT I-II) and QPM group, along with yield data under normal condition, their yield performance under rainfed situation will also be considered. If any entry performs on par with best check under normal situation and under rainfed better than the best entry/check for normal situation, the same entry will be promoted. Similarly, under controlled drought situation if such data is generated and such entries will be promoted. Such data generated will be additional information for VIC and will receive special attention.
11. If an entry is statistically on par with the best check (including qualifying checks) but has additional features like tolerance to abiotic stress, relevant to the region/agro-ecology for which no resistant/tolerant hybrid is available the entry may be identified. Similarly such an entry statistically on par with the best check (including qualifying checks) and showing ≤ 5. % grain yield penalty under rainfed condition will be identified.

Process of identification of variety for release by VIC committee

A varietal identification committed (VIC) is constituted under the chairmanship of Deputy Director General (Crop Sciences), ICAR and Director, Maize as Member Secretary along with the various experts as members. Entry completing three years (two years in case of EDVs) of testing will be considered by the VIC provided the concerned breeder(s) submit a copy of proposal (soft or hard) to Director, maize in appropriate proforma (Annexure III) at least one week before the VIC meeting, which is generally held on the first day of the three day Annual Maize Workshop. The analyzed data will be uploaded on IIMR website for VIC proposal in 15

days prior to workshop. Any proposal submitted during workshop will not be considered in VIC meeting.

The candidate entry will be eligible for identification based on the following criteria:

1. Three years of yield data from co-ordinated trials under given ecology should be available or entry should complete its three years of testing in AICRP trials. In case of EDVs it is two years along with the original variety as check.
2. At least two year data on disease and pest reaction generated at hot spot under artificial epiphytotic conditions in the AICRP trials.
3. At least one year data on agronomic performance with special reference to response to population density and fertilizer dose. The proposed hybrid should be statistical superior for its agronomic performance over the best check.
4. Availability of enough pure seed of parental lines (approx. 20 kgs female, 10 kgs male) and hybrid (50 kgs).
5. The entries with negative superiority over best check in final year of testing will not be considered for identification.
6. In case of hybrids to be compared with hybrid check the yield superiority must be ≥5% for identification (in late maturity) and ≥ 10% for all others. In case of comparison of hybrid with composite as check yield superiority in hybrid over composite should be ≥20%. In case comparable check is not available in the same maturity group yield performance will be compared with comparable check from other maturity group. However, in case check belongs to early group and entry is from medium maturity the grain yield superiority should be ≥20%, and if test entry is in late maturity and check is early superiority should be ≥25%. In case of comparison between medium maturity check and late maturity entry the superiority will be ≥15%. However, for comparison of quality parameters, the corresponding check value along with the set limit will be considered.
7. If an entry is statistically on par with the best check (including qualifying checks) but has additional features like tolerance to abiotic stress, relevant to the region/agro-ecology for which no resistant/tolerant hybrid is available the entry may be identified. Similarly such an entry statistically on par with the best check (including qualifying checks) and showing ≤ 5. % grain yield penalty under rainfed condition will be identified. Similarly an entry showing suitability for a specific cropping system of the region may also get priority. However, these need to be established with appropriate experimental evidences.
8. In QPM or any other bio-fortified hybrids, besides the yield superiority over the suitable check, the hybrid should have target quality trait(s) within the set limit like in QPM (tested for percentage tryptophan & lysine in endospermic protein), the percentage tryptophan and lysine content in test entry should be ≥0.6 % & ≥2.5 % (in percent endosperm protein), respectively.
9. The one year gap relaxation during the period of testing and submission of proposals for VIC may be considered by the Director. However, there should be valid reason for this and written permission for this will have to be taken from the Director Maize before the designated VIC meeting.

VI. AICRP Trials constitution and conduct: Maize Pathology

Released zone specific or region specific high yield potential varieties with superior grain yield, should also have resistance/moderate resistance (MR) against major maize diseases of national/zonal/regional importance. Towards this direction all entries received for testing in NIVT on wards for all types of corn are evaluated for major maize diseases under artificial epiphytotic conditions at hotspot locations**.** The maize pathology trials are constituted from the untreated seeds. Relevant susceptible/resistant checks are used along with the entries being tested in breeding trials. The constituted trials are dispatched to various hot-spots sites across the country. Depending upon the number of entries in a trial, a suitable experimental design such as CRBD (~25 test entries/trial) or Alfa lattice design (>25 test entries/trial) are uses with two replications having 2.5m row length each. Disease wise trials are planted along with recommended resistant and susceptible checks for target disease. The seed quantity required for various level of trials are detailed in Table 2Separate seeds for pathology trials need not to be sent. The downloading of datasheet, feeding and submission of data in online automation system are similar as explained in breeding trials including the last date of data submission. The season wise details of the pathology trials, hot-spots locations and resistant and susceptible checks for different diseases in various zones are given below in Tables 5, 6, 7, 8. Further, the details of disease rating scale, inoculation and scoring time for various maize diseases have been given in Table 9.

Kharif Season trials

Table 5. Hot-spots locations during kharif season for various maize diseases screening in India

Sl. No.	**Zone**	**Disease**[#]	**Locations**
1.	Northern Hill Zone (NHZ)	TLB	Almora, Bajaura, Barapani, Imphal
		BLSB, BSR	Dhaulakuan
2.	North West Plain Zone (NWPZ)	MLB	Delhi, Karnal, Ludhiana
		BLSB	Delhi, Karnal, Pantnagar
		C Rot	Ludhiana
3.	North East Plain Zone (NEPZ)	MLB	Dholi
		BLSB	Sabour
4.	Peninsular Zone (PZ)	TLB	Dharwad, Mandya, Rahuri
		BLSB	Peddapuram
		C Rot	Coimbatore, Hyderabad
		SDM	Mandya
5.	Central Western Zone (CWZ)	FSR, CLS, RDM, MCN	Udaipur

[#] Maydis leaf blight (MLB); Turcicum leaf blight (TLB); Banded leaf sheath blight (BLSB); Charcoal rot (ChR); Polysora rust (PR); Fusarium stalk rot (FSR); Bacterial stalk rot (BSR); Sorghum downy mildew (SDM); Rajasthan downy mildew (RDM); Curvularia leaf spot (CLS); Maize cyst nematode (MCN)

Table 6. Resistant and susceptible checks for various diseases in AICRP maize pathology trials

Sl. No.	Genotype	Center to supply	Name of Disease[#]	Quantity of seeds
Resistant Checks				
1.	ADV 7022	Advanta Ltd.	MLB, TLB, BLSB, CLS, BSR, ChR, FSR, CR, SDM, RDM, PFSR	6 kg
2.	VAMH 12014	TNAU, Coimbatore	MLB, TLB, BLSB, CLS, BSR, ChR, FSR, CR, RDM	6 kg
Susceptible Checks				
3.	RCRMH 4-1 (Medium)	UAS, Raichur	MLB, BLSB, CLS, BSR, CR, SDM, RDM, MCN	6 kg
4.	Surya	Udaipur	MLB, TLB, ChR, SDM, RDM, CLS, FSR	6 kg
5.	Bajaura Early Composite	Bajaura	TLB, BLSB, BSR	2 kg
6.	Dhari Local	Almora	TLB	2 kg
7.	Buland	PAU, LDH	TLB, ChR, SDM	2 kg
8.	CM 202	IIMR, WNC, Hyderabad	TLB	2 kg
9.	CM 500	-Do-	SDM, FSR	2 kg
10.	CM 600	-Do-	MLB, BLSB, BSR	2 kg

[#] Maydis leaf blight (MLB); Turcicum leaf blight (TLB); Banded leaf sheath blight (BLSB); Charcoal rot (ChR); Polysora rust (PR); Fusarium stalk rot (FSR); Bacterial stalk rot (BSR); Sorghum downy mildew (SDM); Rajasthan downy mildew (RDM); Curvularia leaf spot (CLS); Post flowering stal rot (PFSR); Common rust (CR); Maize cyst nematode (MCN)

Rabi /Spring season trials

Table 7. Hot-spots locations during Rabi season for various maize diseases screening in India

S. No.	Zone	Disease[#]	Locations
1.	Northern Hill Zone (NHZ)	TLB	Gangtok
2.	North West Plain Zone (NWPZ)	C. RUST	Karnal
		ChR	Ludhiana
3.	North East Plain Zone (NEPZ)	TLB	Dholi, Sabour, Kalyani
		MLB	Kalyani
4.	Peninsular Zone (PZ)	ChR	Coimbatore, Dharwad, Hyderabad, Rahuri
		TLB	Mandya, Peddapuram
		SDM	Mandya
5.	Central Western Zone (CWZ)	FSR	Udaipur

[#]Maydis leaf blight (MLB);Turcicum leaf blight (TLB); Charcoal rot (ChR); Fusarium stalk rot (FSR); Sorghum downy mildew (SDM); Common rust (CR)

Table 8. Resistant and susceptible checks used for various diseases in AICRP maize pathology trials

Sl. No.	Genotype name	Center /Organization	Diseases[#]	Seed quantity
Resistant check				
1.	DKC 9165 (IM 8119) Late	Monsanto India Ltd.	TLB, ChR	2 kg
2.	PM14205L (Late)	PHI Seeds Pvt. Ltd.	TLB, ChR	2 kg
3.	BLH 102 (Medium)		TLB, ChR	2 kg
4.	PM142096M (Medium)	PHI Seeds Pvt. Ltd.	TLB, ChR	2 kg
5.	DMRH 1301 (Medium)	IIMR Ludhiana	TLB, ChR, SDM	2 kg
6.	Bio9544 (Medium)	Bioseed Pvt. Ltd.	TLB, ChR, SDM	2 kg
Susceptible Check				
7.	Buland (Medium)	PAU, Ludhiana	TLB, ChR, SDM	2 kg
8.	MMH 15-9 (Medium)	TCA, Dholi	TLB, ChR, SDM	2 kg
9.	31Y45	Pioneer	ChR	1 kg

[#]Turcicum leaf blight (TLB); Charcoal rot (ChR); Polysora rust (PR); Sorghum downy mildew (SDM)

At the time of submission of data, the following format duly filled must be submit to the coordinator/PI Maize Pathology

Season	:	*Kharif*/*Rabi*/ *Spring*	Replication	:	2
Date of Sowing	:		No. of Rows/ rep	:	1
Date of Inoculation	:		Row Length	:	2.5 m
Name of Susceptible check	:		Date of Observation	:	
Name of Resistant Check	:		Date of Harvesting	:	

Table 9. The details of disease rating scale, inoculation and scoring time for various maize diseases

S.No.	Disease Name	Inoculation time	Rating Scale	Observation time
1	Maydis leaf blight	30-35 days after sowing	1-9	30-35 days after inoculation
2	Turcicum leaf blight	30-35 days after sowing	1-9	30-35 days after inoculation
3	Banded leaf sheath blight	30-35 days after sowing	1-9	30-35 days after sowing
4	Charcoal rot	50-55 days after sowing	1-9	40 to 45 days after inoculation (At harvesting stage)
5	Fusarium stalk rot	50-55 days after	1-9	40 to 45 days after

		sowing		inoculation (At harvesting stage)
6	Polysora rust	40-45 days after sowing	1-9	40 -45 days after inoculation
7	Common Rust	40-45 days after sowing	1-9	40-45 days after sowing
8	Bacterial stalk rot	Pre-silking stage around 55-60 days after sowing	1-9	15 days after inoculation
9	Sorghum downy mildew	8-10 days after sowing) at 2.00 to 3.00 am	1-100 % (Disease incidence)	20 days after inoculation and 30 days after inoculation
10	Rajasthan downy mildew	7-10 days after sowing at 2.00 to 5.00 am	1-100 % (Disease incidence)	30 and 45 days after inoculation
11	Curvularia leaf spot	45 days after sowing	1-9	20, 35 and 50 days after inoculation
12	Maize cyst nematode	Sick plot	0-9 cyst/plant	45 days after sowing

General care to be taken while screening under artificially created disease epiphytotics:
Uniform method of disease screening under sick plot and/or artificially created disease epiphytotics should be followed. Grain culture technique for inoculums production should be uniformly followed for creation of TLB, MLB, CLS, BLSB epiphytotics at all hot spot locations.

Summary of screening techniques for different diseases of maize
1. *Maydis leaf blight*: Pathogen culture mixed with sterilized sorghum grains should be kept for their growth in chamber for a period of three weeks. When the pathogen grows over the grain, grind it in a food chopper and store at 6-9°C. Inoculation is done in 30-35 days crop by placing a small quantity of sorghum grains culture into the whorl on a cloudy day or towards evening to avoid mortality by direct exposure to sun sight. There should be sufficient moisture and humidity in the field or field should be irrigated at a regular interval. The inoculation should be repeated after 8 days of interval. The scoring should be done after appearance of full symptoms of disease or at post flowering stage.

2. *Turcicum leaf blight*: Inoculum is increased on whole sorghum grains. Grains should be soaked up to about one inch deep in a flask for 4-6 hrs. After which the excess water is drained off. Then potato dextrose is added into it to provide a thin coating on the grains. The flasks containing the sorghum grain are autoclaved and then seeded with the fungus. The flask is shaken once in 2-3 days to facilitate growth on the grains. After incubation for about a fortnight, material is ready for inoculation. Two teaspoonful of the grain are mixed with 1⁄2 liter of water and blended for two minutes in a blender. After straining, the suspension is diluted by adding three parts of water. This diluted suspension is used for inoculating the plants

3. *Banded leaf and sheath blight*: Sick plots are being developed at hot spot locations for BLSB by incorporation of *Rhizoctonia solani* in the soils and following maize mono-cropping for last several years. However, the artificial inoculation can also be done by growing pathogen in barley grains. Barley grains are soaked for 24 hours, and then after drained off excess of water, poured 40 gm of it in 250 ml flask and autoclave at a pressure of 1.05kg/sq cm for 30 minutes. Homogenize two-three days old growth of pathogen grown on potato dextrose agar in sterile water and seed. Incubate it at 27 °C for ten days. Thereafter barley grain culture can be immediately used for inoculation or can be air dried at room temperature and stored in paper bags (but not in plastic or butter paper) or in the flask themselves at 15 °C for subsequent use. Inoculations should be done during the rainy season (July and August) on 30 to 45 day old plants with grain culture (using four grains) inserted between stalk and sheath at second or third intermodal level from soil.

4. *Charcoal rot*: Since germplasm screening in a sick plot is very much accepted for disease screening against soil borne diseases, therefore, screening for resistance against charcoal rot can easily be done in sick plots (SP). In the absence of sick plot, the toothpick inoculation is followed under the coordinated programmes. Round bamboo toothpicks about 6.5 cm long are boiled for three times (about 1 hour each time) in tap water to remove toxic substances. After each boiling, they are thoroughly washed in fresh water and dried in the sun. When these are dried, they are loosely packed in bundles and put into the glass jars/ bottles with enough potato dextrose broth (one- third length of toothpicks). The jars with the toothpicks are autoclaved immediately after the broth is added. Later on the sterilized toothpicks are inoculated with the pathogen culture. The growth of the fungus covers the toothpicks in around 10 days, and then thereafter ligibili is ready for use.

5. *Fusarium stalk rot*: Same as for Charcoal rot.

6. *Polysora rust*: Naturally infected leaves showing large number of uredopostules may be collected from different places so that all the prevalent races in the areas may be utilized for screening the materials against the prevalent fungus. The infected leaves thus collected should be macerated thoroughly in between two palms of the hands dipped in a water bucket until the water gets sufficiently colored. The plants can be inoculated by spraying this water through knapsack sprayer. The uredospores can also be collected on butter paper by tapping the severely infected leaves with fingers and then stored in glass vial or glass tube. The uredospores, thus obtained may be kept for longer period in the freezer at temperature i.e. 5-7°C and can also be easily carried out to some distant places for inoculation purposes.

7. *Common rust*: Same as Polysora rust

8. *Bacterial stalk rot*: Hypodermic syringe method of inoculation is the best for bacterial stalk rot pathogen. One milliliter of bacterial suspension is injected in the plant hole by a hypodermic syringe. After inoculation, the plants are frequently irrigated to maintain high humidity and soil moisture which is important for disease development. If necessary, one week after, the second inoculation may be done in the third internodes from ground.

9. *Sorghum downy mildew*: Sorghum plants showing systemic of downy mildew in the farmer's fields are collected during morning hours, preserved in polythene bags and brought to the laboratory. Conidiophores and conidia from the white bloom found on the lower surface of the leaves are washed with a fine jet of distilled water and conidial suspension is collected from it. By 2.00 AM, the inoculation team assembles in the field with cleaned sprayers, torches and buckets. By 2.30 AM the diseased leaves with good sporulation are searched and washed in the water @ 15 leaves per liter in the buckets. This operation is completed by 3.00 AM. Then the collected spore suspension in different buckets is thoroughly mixed and made up to 25 liters. The 25 liters of conidial ligibili is collected from 375 diseased leaves. The inoculation is completed by 4.00 AM with hand compression sprayer. Between 6.00 AM to 6.00 PM, water spray is given to the inoculated plot to create the required humidity. The spreader rows of highly susceptible variety should also be sown around the field plots about 15-20 days before of test entries. Inoculation of these spreader rows is done by following the above artificial inoculation procedure.

10. *Rajasthan downy mildew*: Since this pathogen does not form oospores on maize, hence sick plot technique does not work. The conidial suspension are filled up in dropping bottle for inoculation by putting drops in whorls at seedling stage (6-7 days old) during 3-5 AM. This should be done for 4-5 days regularly to avoid any escape. After 15-20 days symptoms become visible.

11. *Curvularia leaf spot*: Mass multiplication of culture is done on half cooked sorghum grains. After evaporating the excess moisture from surface, the grains are put in 500 ml conical flasks and plugged properly. These are autoclaved for two hours at 15 lbs pressure and inoculated with pure culture of *Curvularia lunata* when it gets cooled down at room temperature. After completion of ligibi growth which may take 15-20 days at room temperature, these grains are washed four times in RO water to get conidial suspension for inoculation. The washed grains are spread in a tray to get mass of conidia again.

VII. AICRP Trials constitution and conduct: Maize Entomology

AICRP maize entomology trials

1. Evaluation of maize AICRP entries against *Chilo partellus (Swinhoe)* under artificial infestation (AVT I and II) during kharif season

Locations: Northern Hill Zone: Imphal, North East Plain Zone: Dholi, North West Plain Zone: Karnal, Ludhiana, Peninsula Zone: Coimbatore, Hyderabad and Kolhapur and Central Western Zone: Udaipur

Number of Entries: Entries of AVT I and II of normal corn, QPM & Specialty corns

Layout: Row number: 1, Row length: 2.0 m; Replications: 2; Spacing: 75 × 20 cm/60 × 25 cm

Experiment Design: CRBD if test entries ≤ 25, Alfa lattice design if ≥ 25

Date of Infestation: Release of 10-12 neonate larvae or 15-20 black head stage eggs into the whorl of maize plant at 12 days after germination

Observations: Leaf injury rating on 1-9 scale at 35-40 days after infestation (Sarup *et al*.1977)

The resistant, moderately resistant and susceptible entries are defined by LIR 1-3, >3-6 and >6-9 respectively.

2. Evaluation of maize AICRP entries against *Spodoptera frugiperda* (J. E. Smith) under natural/artificial infestation (AVT I and II) during Kharif and Rabi

Locations: Imphal, Dholi, Coimbatore, Hyderabad, Kolhapur and Udaipur

Number of Entries: Entries of AVT I and II of normal corn, QPM & Specialty corns

Layout: Row number: 1, Row length: 2.0 m; Replications: 2; Spacing: 75 × 20 cm/60 × 25 cm

Experiment Design: CRBD if test entries ≤ 25, Alfa lattice design if ≥ 25

Observations: Whorl feeding injury rating on 1-9 scale (modified Davis scale) at 2, 4 and 8 weeks after germination; Percent plants infested at 2, 4 and 8 weeks after germination; Ear damage rating at harvest on 1-9 scale (Davis scale)

3. Evaluation of maize AICRP entries against Pink stem borer, *Sesamia inferens* under artificial infestation for AVT I & AVT II during Rabi season

Locations: Kolhapur, Hyderabad and Coimbatore

Number of Entries: Entries of AVT I and II of normal corn, QPM & Specialty corns

*Layout***:** Row number: 1, Row length: 2.0 m; Replications: 2; Spacing: 75 × 20 cm/60 × 25 cm

*Experiment Design***:** CRBD if test entries ≤ 25, Alfa lattice design if ≥ 25

Date of Infestation: 12 days after germination; Release of 10-12 neonate larvae/plant;

*Observations***:** Leaf injury rating on 1-9 scale at 35-40 days after infestation (Reddy *et al*.2003).

4. Evaluation of maize AICRP entries against *Atherigona sp.(*AVT I and II) using fish meal technique during Spring season

Locations: Karnal and Ludhiana

Number of Entries: Entries of AVT I and II of normal corn, QPM & Specialty corns

*Layout***:** Row number: 1, Row length: 2.0 m; Replications: 2; Spacing: 75 × 20 cm/60 × 25 cm

*Experiment Design***:** CRBD if test entries ≤ 25, Alfa lattice design if ≥ 25

*Method of Infestation***:** Natural (Fish meal technique) at the time of sowing

*Data to be recorded***:** Number of plants with dead hearts formed/total number of plants at 14 and 21 days after germination

Maize insect-pests

Stem borers [*Chilo partellus* (Swinhoe) and *Sesamia inferens* Walker] are the most destructive insect pests affecting productivity of maize particularly in India. . Dead hearts, foliar damage and stem tunneling are the major damage symptoms by stem borers that cause severe yield loss causing 25-40% yield losses depending of level of infestation and phonological stage of the crop. Shoot fly, *Atherigona* sp is another injurious pest which infests maize during spring in northern parts of India. In addition to the above insect pests from kharif 2018 an invasive pest, fall armyworm [*Spodoptera frugiperda* (J. E. Smith)] has emerged as another major pest of maize in almost all the maize growing regions of the country across the seasons.

1. Spotted stem borer, Chilo partellus (Swinhoe)

Mass rearing of *C. partellus* on natural diet is cumbersome and excessive handling predisposes the larvae to mechanical injury. Hence, artificial diet is preferred over natural food. The widely accepted procedure of mass rearing of *C. partellus* on artificial diet is the method developed by Siddiqui *et al*. (1977) which is given in Table 10.

Table 10. Artificial diet of *Chilo partellus* according to Siddiqui *et al*. (1977)

Ingredient	**Quantity (g)**
Green Gram powder	75,0
Wheat powder	20.0
Yeast powder	5.0
Ascorbic acid	1.7
Methyl paraben	0.8
Sorbic acid	0.4
Multivitamin	1 capsule
Vitamin E	0.4
Streptomycin sulphate	0.5
Agar-agar powder	6.0
Formaldehyde 40%	1.0
Distilled water	390 ml

Screening under natural infestation is unreliable and takes long time to identify lines with stable resistance. Therefore, artificial infestation techniques have been standardized for evaluating maize germplasm against stem borers. Under artificial infestation, 10-12 neonate larvae are to be released slowly into the whorl of the plant with camel hair brush or 15-20 black head stage eggs on butter paper are to be placed in plant whorls by pinning on the leaf of 10-12 day old maize plants. These are sufficient to cause appreciable leaf feeding and dead heart formation depending on resistance response of the entries. A second infestation is to be carried out if rainfall occurs after the first release. Bazooka or larval dispenser can also be used to infest plants with neonate larvae. Artificial infestation in the field is generally carried out in the evening times to avoid larval mortality due to high temperatures.

2. Pink stem borer, Sesamia inferens Walker

Mass rearing of pink stem borer on natural food is time consuming due to regular change of plant whorl/ cut pieces of stem. Artificial diet is an important pre requisite for mass rearing which

provides the base for insect Host Plant Resistance studies. The compositions of artificial diet are given in detailed in Table 11.

Table 11. Artificial diet of *Sesamia inferens* according to Reddy *et al*. (2003)

Ingredient	**Quantity (g)**
Fraction A	
Green gram grain flour	75
Maize grain flour	20
Brewers Yeast	8
Sorbic acid	1
Vitamin E	0.3
Methyl parahydroxy benzoate	2
Ascorbic acid	1.7
Sugar	15
Casein	5
Cholesterol	1
Dried maize leaf and stem powder	15
Common salt	0.3
Distilled water (ml)	400
Fraction B	
Agar agar	12
Distilled water	250
Formaldehyde 40% (ml)	1

Screening under artificial infestation is required to confirm resistance observed in natural pest infestation. Maize plants of 10-12 days old are to be infested artificially with 10-12 neonate larvae to separate resistant and susceptible genotypes. Maize plants of 10-15 day old are most critical growth stage which results in maximum dead-heart formation and grain reduction. Neonate larvae can be released with the help of larval dispenser. There is often an accumulation of water in the plant whorl and in order to avoid larval drowning, the whorl should be gently tapped before infestation. Artificial infestation in the field is generally carried out in the evening times to avoid larval mortality due to high temperatures.

Evaluation of plant reaction to borer damage

Stem borers attack in maize causes leaf damage, dead heart formation, stem, cob and tassel tunneling. Leaf injury which is the first larval feeding symptoms are directly related to yield loss under severe infestation. The most critical damage has been found to be the destruction of growing point which results in dead heart formation. Leaf Injury rating scale on 1-9 scale is recorded 30-35 days after infestation for *C*. *partellus* and *S*. *inferens* respectively (Table 12&13).

Table 12. Leaf Injury rating scale for spotted stem borer, *Chilo partellus* (Sarup *et al*. 1977)

Rating	**Description**
1	Plants showing no infestation
2	1-2 leaves with pinholes

3	3-4 leaves with holes
4	1/3 leaves showing infestation
5	Half the number of the leaves with infestation
6	2/3 leaves with infestation symptoms and the holes becoming windows
7	Leaves with long window and plant growth is stunted
8	Almost all leaves displaying heavy infestation and plant growth is stunted
9	Dead heart formed

Table 13. Leaf Injury rating scale for pink stem borer, *Sesamia inferens* (Reddy *et al*. 2003)

Rating	**Description**
1.	Apparently healthy plant
2.	Plant with parallel, oval or oblong holes, slightly bigger than pin sized (2-3 mm) on 1-2 leaves
3.	Plant with more elongated holes (4-5 mm or match stick head sized) or shot holes on 1-2 leaves
4.	Plant with injury (oval holes, shot holes and slits of 1-4 cm) in about 1/3 of total number of leaves and midrib damage on 1-2 leaves
5.	Plants with about 50% leaf damage, oblong holes, shot holes, slits and streaks of 5-10 cms and midrib damage on leaves
6.	Plants with a variety of leaf injuries to about two thirds of the total number of leaves (ragged appearance) or one or two holes or slits at the base of the stem (> 10 cms streaks are observed)
7.	Plants with every type of leaf injury and almost all the leaves damaged (ragged or crimpled appearance), with tassel stalk boring or circular dark ring at the base of stem
8.	Plants with stunted growth in which all the leaves are damaged
9.	Plants with dead heart

In both the above cases the resistant, moderately resistant and susceptible entries are defined by LIR 1-3, >3-6 and >6-9 respectively.

3. Fall armyworm, Spodoptera frugiperda (J. E. Smith)

Fall armyworm (FAW) can be cultured artificially. *T*he compositions of artificial diets are given in detailed in Table 14.

Table 14. Three potential diet ingredient options used presently for rearing FAW

S.No	**Ingredients**	**CIMMYT Quantity g or ml per 3 L diet**	**ICIPE Quantity g or ml per 3 L diet**	**ARC-RSA Quantity g or ml per 3 L diet**
Fraction A				
1.	Maize leaf powder	75.6 g	75.0 g	-
2.	Common bean powder	265.2 g	187.5 g	-
3.	Chickpea	-	-	250 g

4.	Wheat germ	-	150.0 g	225 g
5.	Brewer's yeast	68.1 g	-	45 g
6.	Torula yeast	-	32 g	-
7.	Milk powder	-	57 g	45 g
8.	Ascorbic acid	7.5 g	9 g	-
9.	Sorbic acid	3.9 g	4.5 g	-
10.	Methyl-p hydroxybenzoate	6.0 g	7.5 g	-
11.	Vitamin E capsules	6.3 g	-	-
12.	Multivitamin drops	-	3.0 ml	-
13.	Sucrose	105.9 g	-	-
14.	Distilled water	1,209.3 ml	1350 ml	1500 ml
Fraction B				
1.	Agar (Tech No.3)	37.8 g	34.5 g	50 g
2.	Distilled water	1,209.3 ml	1200 ml	1000 ml
3.	Sorbic acid	-	-	7.5 g
Fraction C				
1.	Formaldehyde 40%	6.0 ml	6.0 ml	1.0 ml
2.	Suprapen p (Tetracycline)	-	7.5 g	-
3.	Nipagen	-	-	3 g
4.	Ether	-	-	75 ml

Sources: CIMMYT diet – adapted from Tefera *et al*. (2011); ICIPE diet – Sevgan Subramanian (ICIPE, Kenya), personal communication; ARC-RSA diet – Erasmus Annemie (ARC-Grain Crops, RSA), personal communication.

a. Screening under natural infestation

Natural infestation is usually conducted by selecting an area with a predictable, high level of FAW infestation, commonly referred to as a "hot spot" area. Natural infestation may be used effectively by adjusting planting dates so that the desired growth stage for infestation coincides with peak periods of pest incidence. Test entries are to be surrounded by susceptible entries. Sowing of susceptible entries may be staggered to provide sufficient insect inoculums. However, natural infestation makes it difficult to achieve sufficient uniformity in the distribution of the infestation, or to control the level of infestation among the screening materials. Screening under natural infestation should be done under conditions where insect population is nearly stable across the seasons.

b. Screening under artificial infestation

The most reliable method of screening maize genotypes against FAW is through artificial infestation technique under confined insect net house. During screening under artificial conditions, 15–20 neonate larvae per plant (Davis *et al*., 1996) are to be released manually or with modified bazooka insect applicator (Wiseman and Gourley, 1982) into the whorls of each maize plant at 10-12 DAG. Neonate larvae are to be released early in the morning (between 7 and 10 a.m.) or late afternoon (after 4 p.m.), to avoid exposing the neonates to harsh, sunny

conditions that could desiccate the larvae before they are conditioned to the micro climatic conditions.

c. Evaluation of plant reaction to FAW

Rating scales are commonly used to quantify the performance (resistant or susceptible) of the plant(s) after infestation in a screen/ net-house conditions. The degree of leaf feeding damage are visually rated thrice *i.e.* at $7^{th,}$ 14^{th} and 28^{th} day after infestation using a modified scale of 1–9 described by Ni *et al*. (2011) (Table 15) based on the rating scale described by Davis and Williams (1992) (Table 16 ; Fig. 7). Ear damage rating to be taken based on Davis and Williams (1992) at harvest (Table 17). Further data on total number of damaged plants and total number of damaged leaves/ plants will also be taken for considering resistance/susceptibility criteria.

Table 15. Germplasm rating based on foliar damage (Ni *et al*., 2011)

Score	Damage symptoms/ Description	Response
1	No injury or few pinholes	Resistant
2	Few short holes (also known as shot holes) on several leaves	Resistant
3	Short holes on several leaves	Resistant
4	Several leaves with short holes and a few long lesions	Resistant
5	Several holes with long lesions	Moderately Resistant
6	Several leaves with lesions <2.5 cm	Moderately Resistant
7	Long lesions common on one half of the leaves	Susceptible
8	Long lesions common on one half to two thirds of leaves	Susceptible
9	Most leave with long lesions, and complete defoliation was observed	Susceptible

Table 16. Germplasm rating based on foliar damage (Modified from Davis and Williams, 1992)

Score	Damage symptoms/ Description	Response
1	No visible leaf feeding damage	Highly resistant
2	Few pinholes on 1-2 older leaves	Resistant
3	Several shot-hole injuries on a few leaves (<5 leaves) and small circular hole damage to leaves	Resistant
4	Several shot-hole injuries on several leaves (6–8 leaves) or small lesions/pinholes, small circular lesions, and a few small elongated (rectangular-shaped) lesions of up to 1.3 cm in length present on whorl and furl leaves	Moderately Resistant
5	Elongated lesions (>2.5 cm long) on 8-10 leaves, plus a few small- to mid-sized uniform to irregular-shaped holes (basement membrane consumed) eaten from the whorl and/or furl leaves	Moderately Resistant
6	Several large elongated lesions present on several whorl and furl leaves and/or several large uniform to irregular-shaped holes eaten from furl and whorl leaves	Susceptible
7	Many elongated lesions of all sizes present on several whorl and furl leaves plus several large uniform to irregular-shaped holes eaten from the whorl and furl leaves	Susceptible

8	Many elongated lesions of all sizes present on most whorl and furl leaves plus many mid- to large-sized uniform to irregular-shaped holes eaten from the whorl and furl leaves	Highly Susceptible

1

2

3

4

5

6

9	Whorl and furl leaves almost totally destroyed and plant dying as a result of extensive foliar damage	Highly Susceptible

7 **8** **9**

Figure 7. Whorl feeding injury at various disease scales for Fall armyworm Damage

Table 17. Ratings on damage caused by FAW on corn ear and kernel where FAW is already present on plants (Davis and Williams, 1992)

Score	Damage symptoms/ Description	Response
1	No damage to the ear	Resistant
2	Damage to a few kernels (<5) or less than 5% damage to an ear	Resistant
3	Damage to a few kernels (6-15) or less than 10% damage to an ear	Resistant
4	Damage to 16-30 kernels or less than 15% damage to an ear	Moderately Resistant
5	Damage to 31-50 kernels or less than 25% damage to an ear	Moderately Resistant
6	Damage to 51-75 kernels or more than 35% but less than 50% damage to an ear	Susceptible
7	Damage to 76-100 kernels or more than 50% but less than 60% damage to an ear	Susceptible
8	Damage to >100 kernels or more than 60% but less than 100% damage to an ear	Susceptible
9	Almost 100% damage to an ear	Susceptible

4. Screening technique of Atherigona spp

Screening of genotypes against shoot fly species cannot be done under artificial conditions as it is very difficult to rear shoot fly in the laboratory. At the hot spot locations such as Delhi and

Ludhiana, screening is carried out under natural conditions by Fish Meal Technique during spring season.

Adequate shoot fly density for resistance screening can be achieved by manipulating the sowing date and spreading fishmeal (which attracts the shoot flies) in the field. Shoot fly abundance can be monitored through fishmeal-baited traps to determine the periods of peak abundance of the shoot fly.

This technique is useful for increasing shoot fly abundance under field conditions, involves planting four rows of a susceptible genotype sown 20 days before the sowing of test material. Fishmeal is spread uniformly one week after seedling emergence or kept in plastic bags in the rows to attract shoot flies from the surrounding areas. Once a generation of the shoot fly is completed and the emerging flies infest the test material.

Data to be taken on number of plants with eggs, plants with dead hearts, total number of eggs and the total number of plants with dead heart at 14 and 21 days after seedling emergence. Shoot fly damage rating scale (Sharma et al., 1992) (Table 18):

Table 18. Modified Rating scale of Sharma et al., 1992 for shoot fly in maize

Scale	Damage symptoms/ Description	Response#
1	<10% plants with dead hearts	Resistant
2	11-20% plants with dead hearts	Moderately Resistant
3	21-30% plants with dead hearts	Moderately Resistant
4	31-40% plants with dead hearts	Moderately susceptible
5	41-50% plants with dead hearts	Moderately susceptible
6	51-60% plants with dead hearts	Susceptible
7	61-70% plants with dead hearts	Susceptible
8	71-80% plants with dead hearts	Highly Susceptible
9	>80% plants with dead hearts	Highly Susceptible

Response observed in maize

Susceptibility index to classify maize genotypes against shoot fly is calculated as elaborated below.

S.I. = $A_{X1} + A_b/A_{X2} + A_d/A_n$

A_{X1} = Number of plants oviposited/Total number of plants

A_b = Number of dead hearts/ Number of plants oviposited

A_{X2} = Total number of eggs/ Number of plants oviposited

A_d = Per cent Dead hearts

A_n = Per cent plants infested

The germplasm recording SI within mean susceptibility index of the trial + standard deviation of the ratings in the trial are designated as moderately resistant, while germplasm on left and right side of the values are classified as resistant and susceptible germplasm, respectively.

VIII. AICRP Trials constitution and conduct: Maize Agronomy

Agronomy trials mainly deal with sowing time, genotypes, plant population, crop geometry, fertilizers and manures, water management, and development and validation of cropping and farming systems.

Experimentations

Before a new variety, fertilizer, herbicide, fungicide, insecticide or growth hormone is recommended to farmers, it is necessary to test its potency under laboratory or field conditions including farmers' field. Agronomy trials are classified into:

1. Laboratory experiments,
2. Pot culture experiments,
3. Field experiments,
4. Green house experiments.

There are number of experimentation designs that are used for agronomic trials, selection of which depends on the number of treatments under study and type of study to be undertaken. Most commonly used designs are Completely Randomized Design (CRD), Completely Randomized Block Design (CRBD), Split Plot Design (SPD) and confounding. Criteria for selection of design are as follows:

- *Completely randomized design (CRD)*: It is to be used when experimental material is limited and homogenous as in pot culture experiment.
- *Completely Randomized Block Design (CRBD)*: When fertility gradient of the field is in one direction complete randomized block design is used for experimentation.
- *Factorial RBD*: When more than one factor are studied simultaneously with the equal precision.
- *Split Plot Design*: When two or more than two factors are studied with varying precision.
- *Split-slit plot design*: When more than two factors are studied with varying precision.

Layout of the field

It is a logical arrangement of plots and allocation of treatments with a view to obtain data for deriving valid conclusion. While laying out the field one should ensure that little variation should be between two plots within a block/replication and allocate the maximum part of variation in the experimental area to blocks. For layout of the experiment the baseline is to be fixed mostly parallel to the bund. Then another line is to be fixed and for having a right angle, the principle of Pythagoras is used (Fig. 5).

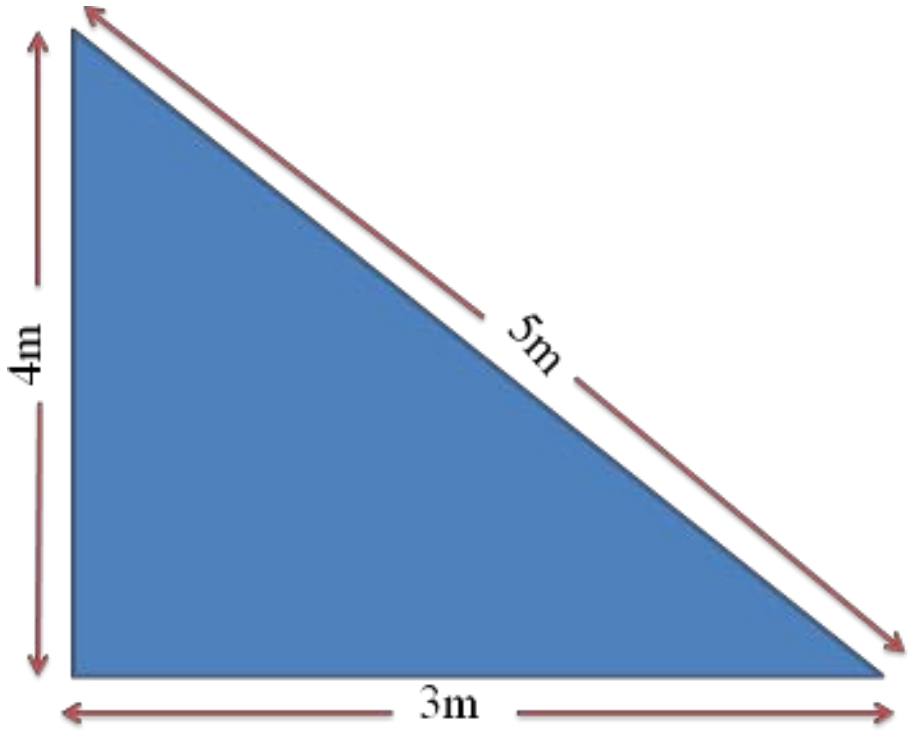

Figure. 5. Pythagoras theorem for drawing straight baseline.

Deciding plot size

In maize experiment if 8 treatments are to be tested with 4 replications, as recommended spacing for maize is 60 cm × 20 cm and generally 6 rows are taken in gross plot, the width of one plot will be (60 cm × 6) 360 cm or 3.6 m. Hence, the plot size will be (6.0 m × 3.6 m) 21.6 m^2 when row length is 6 m. Once plot size is decided, area can be calculated easily. When each plot size is 21.6 m^2, the net area required for 32 (8 × 4) plots will be 691.2 m^2. Generally a space of 0.75-1.0 m in irrigation and fertilizer experiments and 0.50-0.75 m in other experiments is to be kept between two adjacent plots. Further, a buffer space of 1.0 to 1.5 m is to be left between two replications in irrigation and fertilizer experiments, and for other experiments 0.5 to 1.0 m .

Points to be considered for layout of the field experiments

1. **Size and shape of plots** – It is better to decrease the plot size and have more replications to increase precision of the experiment. Shape of the plot may be square, rectangular or narrow long strip.
2. **Arrangement of plots** – The arranged plots should be homogenous and should not be widely separated.
3. **Arrangement of blocks** – Blocks should be arranged across the soil fertility gradient just reverse to the arrangement of plots.

Important Maize Agronomic experiments

Almost all the centers of AICRP carry out the agronomic research on maize and maize based cropping systems. The agronomic research trials in AICRP on maize during kharif, rabi and spring are focused on nutrient and planting density optimization for different maturity pre-

released maize hybrids, precision nutrient management, tillage optimization, integrated nutrient management, enhancing water-use efficiency in rainfed maize, weed management, efficient water management through drip irrigation for spring maize. The maize agronomic trials (MAT) are formulated by keeping the current and long-term challenges of maize in the mind.

Important consideration in maize agronomic experiments:

1. The experiments on tillage, residue management specially are to be taken on the fixed plot over the years to observe the effect of such treatments.
2. The experiment on cropping system shall also be fixed at least for one year on the fixed site and treatments of succeeding crops should be superimposed.
3. The effect of agro-chemicals like herbicide needs to be assessed in cropping system mode and the site of treatment imposition shall also be fixed for all crops.
4. The plant population can be perfectly managed by sowing the seed at half distance in planting density experiments and density can be maintained by uprooting extra plant at 15 days after sowing.
5. Wherever >5 entries (check + test entries) are there in AVT-II Agronomy trial, these will be tested at only recommended density in factorial RBD at two nutrient levels (100% RDF; 150 % of RDF) so that trial can be managed properly.
6. The observation of data recording in agronomic experiments needs to be followed as per the plan.

The various data on growth and yield attributes, yields, economics and soil properties should be recorded as per the standard uniform protocols to get better comparison of results. A uniform protocol for recording the observations is mentioned here under.

Crop observations to be recorded in agronomic trials

Growth traits

Plant stand ('000/ha): The total numbers of plants at 21 DAS to be counted using a quadrate of one square meter from three random places in each experimental unit. The values are averaged to get the number of plant/m^2 and the calculated for one hectare and expressed as thousand plants/ha at 21 DAS as initial plant stand. At harvest, the plants are counted from net plot area and expressed in thousands/ha. If plant population is <80% of requisite population trial will be rejected.

*Plant height (cm):*The plant height of five tagged plants are to be measured at various growth stages such as Knee height, flowering and physiological maturity stage from the ground level to up to the base of the fully opened leaf at pre-flowering and up to the base of tassel at flowering and physiological maturity stage. The plant height of the five plants to be averaged from each experimental unit and expressed in cm.

*Dry matter accumulation (g/plant):*A total of 3-5 plants are to be cut from crown at different growth stages (knee height, flowering and physiological maturity) from each experimental unit and to be chopped into pieces and after sun drying to be putted for oven drying at 65°C for 48

hrs and weights to be recorded by using electronic balance. The above-ground dry matter accumulation is to be averaged and expressed as g/plant.

Leaf area (cm^2/plant): The leaf area meter is to be used for destructive measuring of leaf area wherever available. However, non-destructive leaf area meter available shall be preferred. In absence of sophisticated instrument leaf area of maize can also be measured. For this, the leaf area of 3-5 to be measured by counting number of fully opened leaves and measuring the maximum length and width of the 3-5 leaves. The number of leaves, width and length thus obtained in each experimental unit to be averaged and put in the following formulae to get leaf areaand expressed in cm^2/plant.

Leaf area/plant (cm^2) = length x width x no. of leaves/plant x factor*

*The factor is the row spacing in meter like 0.74, 0.70, 0.67 etc.

Leaf area index: Leaf area index expresses the ratio of total leaf area (one side only) to the total ground area in which the crop is grown. The leaf area to be measured by using the leaf area meter to calculate the leaf area index using the following formula:

$$\text{Leaf area index (LAI)} = \frac{\text{Total leaf area/plant } (cm^2)}{\text{Ground area occupied/plant } (cm^2)}$$

The canopy analyzer can also be used for non-destructive measurement for LAI.

Crop growth rate (g/plant/day): The crop growth rate (CGR) can be worked out on the basis of dry matter accumulation at 30 days interval with the help of following equation:

$$\text{CGR} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where,

W_1 : dry weight at first stage (g)

W_2 : dry weight at second stage (g)

T_1 : Days at first stage

T_2 : Days at second stage

The CGR can be expressed g/plant/day.

Relative growth rate (mg/g/day): The relative growth rate (RGR) expresses the dry weight increase in a time interval in relation to initial weight. It is to be calculated from the measurements taken at time T_1 and T_2. In fact, RGR value is the slope of the line when Log W is plotted against T. The RGR value was calculated by using following equation:

$$\text{RGR} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \quad \text{mg/g/day}$$

Physiological traits

Days to tasseling:

The number of days to 50% tasseling was determined by the number of days taken from sowing date to the 50% of the total number of plants per plot showed the tassel emergence.

*Days to silking:*The number of days to 50% silking to be determined by the number of days taken from sowing date to the 50% of the total number of plants per plot showed the silk emergence.

*Days to physiological maturity:*Physiological maturity is marked by the formation of small black layer in the hilum region of the seed, which is generally observed at brown husk stage of the crop.

Reproductive period: The reproductive period of the maize crop in each experimental unit are calculated by subtracting the days to physiological maturity from days to tasseling.

*SPAD:*The reading of the SPAD values as measure of greenness can be measured using the SPAD meter at various critical growth stages in middle leaf of three plants of each experimental unit. At 90 DAS, the readings are to be taken from cob leaf. The values of three leaves were averaged to get SPAD value in each experimental unit.

NDVI: The reading of the normalized differential vegetation index (NDVI) values to be measured using the green seeker by keeping 30 cm distance from plant at various critical growth stages in each experimental unit.

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Canopy temperature depletion (℃): The canopy temperature depletion (CTD) to be measured by using the sky spy integrated Everest make infrared thermometer which gives CTD by deducting the canopy temperature from ambient temperature given at the same time. The CTD thus obtained to be expressed in ℃.

Yield attributes

Ear/plant: The ears of maize from the net plot are to be counted. The plants/plot is divided by the ear/plot to get number of ears/plant.

Bareness: The bareness percentage in each experimental unit shall be calculated by using the following equation:

$$\text{Barenness (\%)} = \frac{\text{Plants/plot} - \text{Cobs/plot} \times 100}{\text{Plants/plot}}$$

Ear Length: The 5-10 ear to be selected randomly at the time of the harvest and after the removing of husk their length to be measured from the base to the tip and averaged out of the samples.

Ear girth:

The girths of 5-10 randomly selected cobs to be measured at three places namely, near the butt, in the middle and at the top with the help of a measuring tape and the values thus obtained to be averaged.

Grain rows/ear: The total number of grain rows shall be counted from the same ears previously selected for weight can be threshed and number of grain rows need to record. The average value to be expressed as number of grains rows/ear.

Grains/row: The number of grains/row of the 5-10 randomly selected rows of ear shall be counted and averaged to get the grains/row in each experimental unit.

Grains weight/ear: The weight of grains from 5-10 randomly selected plants shall be weighed after shelling them separately. The weight of five ears is to be averaged to get grains weight/ear.

1000-grains weight: One thousand grains from sun-dried grain produce are taken from each experimental unit and weighed to get 1000-grains weight.

Shelling percentage: The procedure for calculating shelling percentage is well explained in breeding trials, the same should be followed here using the formula:

$$\text{Shelling (\%)} = \frac{\text{Weight of grains (g)} \times 100}{\text{Weight of whole ears (g)}}$$

Yields

Ear yield (kg/ha):
After separating from stover, all the ears from each plot shall be dried in the sun and yield to be calculated by weighing with electronic balance. The ear yield should be expressed as kg/ha.

Grain yield (kg/ha):
After separating ear sheath, shelling to be done using hand maize sheller/plot sheller. The moisture percentage in the grain shall be recorded at the same time of recording the grain yield. The grain yield needed to be adjusted to 15% moisture content (MC) and expressed as kg/ha. The yield with corresponding MC recorded at the time of weighing the grain yield in each experimental unit to be used in the following formulae for calculation of grain yield of maize at 15% MC and to be expressed in kg/ha.
Grain yield at 15% MC= (Yield at recorded MC*(1-MC at harvest/100)*100/85

Baby corn yield: The yield of the baby corn with and without husk at each picking shall be recorded separately from net plot of each experimental unit. Baby corns are harvested within 2-3 days of silk emergence. Before that the trial is to be de-tasselled immediately after emergence of tassel. The baby corn has to be harvested continuously everyday for the period of approximately 15 days in a baby corn trial. The data of each picking for with and without husk to be summed to get baby corn yield and to be expressed as kg/ha.

Sweet corn yield: The sweet corn ears with and without husk need to be harvested from net plot of each experimental at 18-20 days after pollination and needs to be weighed and summed to get the sweet corn yield/ha and can be expressed as kg/ha of t/ha.

Stover yield (kg/ha): The maize stover to be cut from ground level from the net plot and after sun drying need to weighed by spring balance and yield to be expressed in kg/ha.

Biological yield (kg/ha): The weight of total harvested produce from net plot of each treatment (ear + stover) are to be recorded after sun drying and expressed as biological yield kg/ha.

Maize equivalent yield: The productivity of the cropping system should be measured as maize-equivalent yield (MEY) after adding economic equivalent yield as maize of other crop in the cropping system. For example, the productivity of maize–wheat cropping system is calculated in terms of MEY by using following expression:

$$\text{MEY (\%)} = \text{Maize yield} + \frac{\text{Wheat yield (kg/ha)} \times \text{Wheat price/kg}}{\text{Maize price/kg}}$$

Harvest index: The harvest index to be computed by dividing economic yield (grain yield of maize) by the respective biological yield (total produce) and was expressed as percentage.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (kg/ha)} \times 100}{\text{Biological yield (kg/ha)}}$$

Economic parameters

The economics for the cost of cultivation, gross and net return and net return/rupee invested to be worked out on the basis of prevailing market rates of the inputs and minimum wages of the labours announced as per the respective state/central government.

Cost of cultivation (Rs/ha): The price of the inputs prevailing at the time of their use is to be utilized for determining the cost of cultivation which is to be given in rupees per hectare. Total cost included in the cost of input such as seeds, fertilizers, residue, organic manures, agrochemicals, irrigation and various cultural operations like ploughing, sowing, weeding, harvesting, threshing, etc. The rental value of land shall also be taken into consideration for cost of cultivation calculation.

Gross return (Rs/ha): The minimum support prices of maize and market price of stover after its harvest to be used for the cultivation of gross return.

Net return (Rs/ha): The net returns shall be calculated by using the following formula:
Net return = Gross return – Cost of cultivation

Benefit cost ratio:

$$\text{Benefit cost ratio} = \frac{\text{Net return (Rs/ha)}}{\text{Cost of cultivation (Rs/ha)}}$$

Plant nutrient analysis

Plant samples of stover and grain collected at harvest to be dried in hot air oven at 60°C for 12 hours. These oven-dried samples of plants and grains are grinded by Grinder/Mill and passed through 40 mesh sieve and shall be used for chemical analysis.

Nitrogen estimation in plant and maize sample: Nitrogen concentration needs to be estimated by following modified kjeldahl method. A plant sample of 0.5 g is digested with concentrated H_2SO_4 (15 ml) in the presence of sodium sulphate (10 g) and copper sulphate (1 g). The digested and diluted sample (150 ml) needs to be distilled in presence of 40% NaOH (120 ml) in a distillation unit. The ammonia gas evolved is collected in boric acid solution (25 ml). Titration is to be done against standard sulphuric acid (0.05 N) along with a blank run simultaneously. The N concentration in plant sample can be calculated as follows:

Amount of N in the sample (S) = (ml of acid used for sample – ml of acid used for blank) × Normality × 14 × 10 – 3

$$\text{N in sample (\%)} = \frac{\text{S} \times 100}{\text{Sample weight in g (0.5)}}$$

N uptake shall be calculated by using the following expression:
N uptake (kg/ha) in grain/stover = [% N in grain/stover X grain/stover yield (kg/ha)]
Total uptake of N (kg/ha) = N uptake in grain + N uptake in stover

Phosphorus concentration: Phosphorus concentration in maize, straw and grain sample is determined by vanadomolybdo phosphoric acid yellow color method. The intensity of yellow color developed is measured at 470 nm wave length using spectrophotometer. Total P uptake (kg/ha) to be calculated by following expression:
P uptake (kg/ha) in grain/stover = [% P in grain/stover × grain/stover yield (kg/ha)]
Total uptake of P (kg/ha) = P uptake in grain + P uptake in stover

Potassium concentration: Potassium concentration in maize, straw and grain sample is determined using flame photometer as per method given by Jackson (1973). Potassium uptake is to be calculated by multiplying K content with the dry matter yield.
K uptake (kg/ha) in grain/stover = [% K in grain/stover × grain/stover yield (kg/ha)]
Total uptake of K (kg/ha) = K uptake in grain + K uptake in stover.

Determination of Cu, Zn and Fe concentration: The copper (Cu), Iron (Fe) and zinc (Zn) contents in maize grain can be determined by di-acid digestion as per the procedure described by Prasad *et al*. (2006) using Atomic Absorption Spectrophotometer and expressed on mg/kg dry matter basis.

Crude protein content (%) in grain: Crude protein content in maize grain is obtained by multiplying N concentration with a coefficient factor of 6.25 (AOAC, 1960). This factor is based on the nitrogen content (16.0%) of the maize protein.

Soil physical properties

Soils need to be sampled before imposing the experimental treatments (after harvest of uniformity trial) and at the harvest of the crop for analysis of various physical, chemical and biological properties of the soil. These properties are useful for tillage, organic manuring and residue management treatments.

Bulk density: The bulk density of soil at the end of the experimentation period is measured using core sampler method (Bodman, 1942). Before start of the experiment, 10 random samples are to be collected from experimental site using a core sampler. After harvest, soil samples need to be collected at desired depths (0–10, 10-20, 20-30, 30-40, 40-50 and 50-60 cm) with core sampler from three places in each plot. The triplicate soil samples for respective depths need to be dried in the hot air over at 105^0C for 48 hours for estimation of dry weight. The bulk density shall be calculated as follows:

$$\text{Bulk density (g/cc)} = \frac{\text{Mass of soil on oven dry weight basis (g)}}{\text{Core volume (cc)}}$$

Soil strength: The strength of the soil can be measured using digital cone penitrometer or impact penetrometer. The measurement is needed to be done for each experimental. The penetration resistance values thus obtained need to be averaged in respective experimental unit for 10 cm interval and expressed in kilopascal (kPa).

Soil moisture: The soil from desired depths (0-15, 15-30 and 30-45 cm) to be collected using a core sampler or tube sampler at critical crop growth stages like knee high, tasseling and grain filling stage. The soil samples to be oven dried at 105°C for 48 hours for gravimetric soil water content determinations by using following equation:

$$\text{Moisture content (\%)} = \frac{(\text{Weight of moist soil - Wight of oven dried soil}) \times 100}{\text{Weight of oven dried soil (g)}}$$

Soil chemical properties

The observation on soil available nutrients is one of the important parameters in maize experiments involving fertilization, density, residue and reduced tillage treatments. The soil is to be sampled using core/tube sampler from desired depths in all experimental units. Each soil sample needed to be obtained by mixing together three random soil cores taken from individual plots. Samples from individual plots shall be thoroughly mixed, air-dried, and grinded to pass through a 250 μm sieve. Air-dried samples needed to be placed in plastic bags and stored at room temperature for analysis of available N, P, K, Fe, Zn, Cu and Ph of the soil.

Soil Ph: Soil Ph of the air dried soil sample can be measured by dipping of Ph meter in soil (Prasad et al., 2006).

Total carbon and organic carbon (%): For organic carbon estimation in soil, samples are to be dried, grinded and passed through 2 mm sieve. A sieved 300 to 330 mg sample needed to be weighed and transferred into quartz crucible and treated with 2.5 ml of hydrochloric acid and kept for 4 hours before drying these in hot air oven for 16 hours at 60 to 70 ^{0}C. The dried samples can be analyzed by automatic C-S analyzer. The organic carbon can also be estimated using Walkeley and Black method (1934).

Available N, P and K (kg/ha): The soil samples are to be collected from three different depths (0-15, 15-30 and 30-45 cm soil profile) at the start and at the end of experimentation. The collected soil samples are air dried, ground and pass through 250 µm mesh sieve and analyzed for available N, P and K. The available N shall be estimated by using of alkaline $KmnO_4$ method suggested by Subbiah and Asija (1956) and expressed in kg/ha. The available P content in soil shall be estimated with Olsen's method (Olsen *et.al*., 1954). Normal ammonium acetate extraction (flame photometer) can be used for estimation of available K (Jackson, 1973) and expressed in kg/ha.

Ammonical and nitrate nitrogen: The soil from desired depths (0-15, 15-30 and 30-45 cm) needed to be collected using a core/tube sampler at before sowing and after harvesting along with critical crop growth stages (30, 45, 65 and 90 days after sowing). The moist soil need to be transferred to the laboratory and refrigerated till the analysis are over within 2-3 days. A total of 5 g moist soil shall be used for analysis of ammonical nitrogen (NH_4^+) and nitrate (NO_3^-) by extracting it with potassium chloride. The supernatant can also be analyzed by FOSS make Flow Injection Auto-analyzer for getting NH_4^+ and NO_3^- in soil which can be adjusted for moisture content estimated by gravimetric method. Thus, the soil NH_4^+ and NO_3^- nitrogen are expressed in mg/kg of soil on dry weight basis or kg/ha.

Cu, Zn and Fe: The available Zn, Cu, and Fe and other micronutrient can be estimated through DTPA extraction method (Lindsay and Norvell, 1978) and the supernatant to be analyzed through Atomic Absorption Spectrophotometer and the results to be expressed as mg/kg of the soil.

Soil biological properties

The soil from 0-15, 15-30 and 30-45 cm depth are need to be collected at flowering and after harvesting of the crop using tube auger and immediately transfer to laboratory for analysis and can be and refrigerated till the analysis is over. The various biological properties can be analyzed as follows:

*Microbial Biomass Carbon:*Microbial biomass carbon (MBC) in soil can be determined by fumigation-extraction method (Jenkinson and Powlson, 1976). For this purpose, 3.5 g of moist soil needed to be fumigated with chloroform ($CHCl_3$) in vacuum desiccators and extracted with 0.5 *M* K_2SO_4 (soil: solution of 1:2.5). A duplicate soil sample as such (non-fumigated) should

also be extracted with 0.5 *M* K_2SO_4 in a similar fashion. Both the extracts of non-fumigated and fumigated soil shall be subjected to wet oxidation. About 10 Ml of the extract treated with 2 Ml of 0.2 *N* $K_2Cr_2O_7$, 10 Ml of conc. H_2SO_4 and 5 Ml of H_3PO_4 and the mixture to be digested at 100°C for 30 min under refluxing condition. Samples are allowed to cooled and titrated with a solution of 0.005 *N* ferrous ammonium sulphate using diphenylamine as an indicator. The MBC to be computed by subtracting the amount of organic carbon in fumigated soil from that of non-fumigated one and it can expressed on oven dry weight basis. The amount of the MBC in soil can be calculated as follows:

$$\text{Microbial biomass carbon} = (OC_F - OC_{UF}) / K_{EC}$$

Where, OC_F and OC_{UF} are the organic carbon extracted from fumigated and un-fumigated soil, respectively (expressed on oven dry basis), and K_{EC} is the efficiency of extraction. A value of 0.25 is considered as a general K_{EC} value for microbial extraction efficiency and used for calculation.

Enzyme Activities in Soil

Dehydrogenase: Determination of dehydrogenase activity in soil shall be done by the method given by Klein *et al*. (1971). For this purpose, air-dried soil sample (1.0 g) are to be taken in an air-tight screw capped test tube of 15 Ml capacity. The soil samples in the tubes needed to be saturated with 0.2 Ml of 3% triphenyl tetrazolium chloride (TTC) solution. Then, 0.5 Ml of 1% glucose solution can be added to each tube followed by gentle tapping of the bottom of the tube to drive out all trapped oxygen, so that a water seal is formed above the soil. The tubes shall be incubated at 28±0.5^{o}C for 24 h. After incubation, 10 Ml of methanol is added to the tubes, shaken vigorously and then allowed to stand for 6 h. The clear pink coloured supernatant can be withdrawn and their absorbance is recorded spectro-photometrically at a wavelength of 485 nm (blue filter). The amount of triphenyl formazon (TPF) formed in each sample are to be calculated from the standard curve drawn in the range of 10 mg to 90 mg TPF Ml^{-1}. Dehydrogenase activity shall be expressed as µg TPF formed g^{-1} soil h^{-1}.

ß-Glucosidase: ß Glucosidase activity can be assessed by measuring of the *p*-nitrophenyl released after incubation of the samples with *p*-nitrophenyl *ß* D glucoside (0.025M) for one hour at 37^{0}C; absorbance which can be measured at 490 nm (Eivazi and Tabatabai,1988).

Observations on weeds

The observation of the weed flora is very important in weed and tillage management experiments. The analysis in weed management experiments shall be targeted on before application of treatments, after effect of the treatment and at harvest. These observations can also be linked with critical growth stages of maize like seedling, knee high, tasseling and grain filling.

Composition of weed flora: The composition of weed flora as broad-leaved, grassy and sedges in the different treatment at desired stage (20, 40 DAS and at harvest) need to be recorded at three spots in each experimental unit using a quadrate of size 0.25 (50 × 50 cm) or 1.00 (100 × 100 cm) m^2. The average of these three observations shall be used to express composition of weed flora in the area of 0.25 or 1.00 m^2.

Weed population: An area of 0.25 or 1.00 m^2 are to be selected randomly at two spots by using the quadrate. The data on weed population is to be recorded at different intervals from this area. This need to be expressed as numbers per square meter for broad-leaved, grassy and sedges separately.

Weed dry matter: Weeds collected from 0.25 or 1.00 m^2 area are to be first sun dried and kept in an electrical oven at 70^o C till the weight became constant. Dry weight recorded from sampled area from each plot to be expressed as g/m^2 and kg/ha.

Weed control index (WCI): The weed control index can be calculated by using the following formula:

$$WCI = \frac{DMC\text{-}DMT}{DMC}$$

Where,

DMC = Dry mater of weeds in un-weeded control

DMT = Dry matter of weeds in a treatment

Weed index (WI):

Weed index to be worked out using the following formula:

$$\text{Weed Index} = \frac{X\text{-}Y}{X} \times 100$$

where,

X=Yield from weed free plot

Y= Yield from a treated plot

NPK concentration and uptake by weeds: The samples of weeds from each plot need to dry in the electric oven at 70^0C for 72 hours after sun drying for five to six days. The samples needed to be ground in a Willey Mill and passed through 0.5 mm mesh sieve. A sample weighing 0.5 g each are used for determination of N, P and K concentration. The uptake is determined by multiplying concentration of nutrients to the dry matter of the weeds.

IX Conduct of rainfed and water logging trials

Around 80% of total maize area in India is cultivated in rainfed ecologies. The rainfed ecosystems are highly variable and unpredictable in nature, as well as are more prone to high and low moisture stresses. Therefore, development of genotypes that can perform reasonably well in drought and or water logging or in combined drought and excess water stress conditions is the most important objective of any maize breeding programme (Kumar et al., 2016). The priority should be to select the genotypes which perform better in normal conditions and shows relatively better performance in any other abiotic stress(s) as additional advantage. This would be helpful to sustained maize productivity in diverse types of ecologies as well as in seasons.

Keeping this in mind, the kharif entries of AVT-I-II of normal field corns and QPM are to be grown under well watered conditions as well as under rainfed and water logging conditions at selected locations. The data generated will be used an additional information for VIC. In rainfed situation, the sowing will be done on residual soil moisture and thereafter no irrigation will be provided throughout the crop season.

Conduct of trial

Rainfed (Drought stress)

Entries: Kharif entries at AVT-I and II of normal corn and QPM.

Experiment Design: CRBD when nos. of entries are ≤ 25; Alfa lattice: > 25 (Design would be same as for normal condition)

Experiment layout: Replications – 3; Rows/Replication – 4; Rows length – 4 m; Spacing – 70 cm × 25 cm

Locations: Rainfed (Drought stress): Almora, Srinagar, Bajaura, Vagarai, Karimnagar, Kolhapur, Godhra, Bhiloda and Udaipur

Water logging

Entries, experimental design, and layout will be similar as of rainfed trials

Locations: Dholi, Begusarai, Varanasi and Pantnagar

The observations recorded under normal field corns trials (explained in chapter-IV) are to be recorded in drought as well as in water logging trials. However, in additional to that, the SPAD readings, stay green traits (present/absent), and tip filling (1-5 score) in both drought as well as in water logging stresses and Brace roots at critical growth stages (Reached up to nos. of nodes), seedling death rate (in percentage) in only water logging trials are to be recorded.

The following cares should be taken while conducting these experiments:

1. The trials for drought stress should be conducted at locations which are more hot-spot for low moisture stress/are in more drought prone area. The soil should be of medium texture loamy type.
2. Similarly, for evaluation of entries for water logging stress, the sites which are more prone to flood/water logging stress are to be selected. The soil should be of medium texture loamy type.
3. In case of drought, the stress will be ensured by avoiding external irrigation in the experiment after the germination. The sowing of experiments would be on residual soil moisture content. However, if there is no rain one irrigation to ensure proper germination may be given.
4. Similarly, the water logging stress may be ensured at least at seedling stage (25 days after germination) by stagnating water in field for ten days up to 5cm above the soil surface. This

can be done through managed water logging stress when there is no heavy rain. Further, proper bunding in water logging experiments is mandatory.

5. Minimum of three locations per zone are mandatory for conducting these experiments.
6. It is mandatory to the experimenter to determine the level of stresses at critical stages of crop growth e.g. water logging stress (seedlings stage, flowering and grain filling stage); Drought stress (Flowering, and grain filling stage). If there are no specific instruments available for this then, simply they may determines this by taking the soil moisture content observations at critical stages under both normal and stress conditions.
7. All the criteria of trial rejection will remain same as for normal field trials, except the CV limit, and maximum limit for CV would be 30% ($P = 0.05$) in both rainfed as well as water logging trials

X. Major Guidelines for FLDs (As per NFSM cell, Ministry of Agriculture), TSP and other outreach programme

Front Line Demonstration (FLD)

1. The FLDs must be focused on the <1 t/ha or least productivity districts of the region.
2. The varieties which are within 3 years (5 years for problematic areas, *viz*., hills, saline, alkaline soil, etc.) form the date of notification/ release/ identification should only be included in the demonstration purpose and those varieties in the borderline should be avoided.
3. 10% of the FLDs should be on bioforitfied crops.
4. All the FLDs must be conducted in close supervision of SAUs/KVK/ICAR institute.
5. Farmers practice, crop production and protection technologies used in FLDs should be obtained in the progress report. The reasons for the yield gap between FLDs and farmer practice must be mentioned in the report.
6. No chemical fertilizer is allowed as input under FLD programme. However, payment to various farm operations / farm services and other critical inputs (seed, bio-fertilizers, lime, gypsum, and micronutrients, etc) are allowed. Farmers have to apply the recommended doses of fertilizers.
7. The FLD programme should be conducted in a cluster of 10 ha as per already circulated guidelines.
8. Field days should be regularly organized and prior information should be sent to DAC&FW and Director, ATARI of ICAR with copy to pdmaize@gmail.com and totdmr12@gmail. Com
9. The details of FLD beneficiary –farmers along with contact number and Aadhar should be furnished to DAC&FW.
10. The details of physical and financial targets (Agency-wise and location-wise) for laying out the FLDs on *Kharif* crops to be organized by participating centres may be communicated to the Crops Division of Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Delhi latest by 30th April and by 30th August for Rabi crops.
11. The item-wise detailed break-up of the expenditure for organizing a Frontline Demonstration in one hectare of maize is given as under:

Sl. No.	**Component**	**Rs/ha**
1.	Cost of critical inputs (seeds/ biofertilizers/PP chemicals/ herbicides) to supplement the cultivation charges	5100
2.	Organization of Field Day	250
3.	Display board and publicity material (posters/pamphlets/leaf lets etc.)	250
4.	Visit of scientists excluding TA/DA, but hiring of Taxi/POL etc.	300*
5.	Contingencies/typing of results/ minutes etc.	100
Total		**6000**

*Nodal FLD implementing Institute/Directorate may retain 50 percent of the amount for effective monitoring of FLDs across the country.

Reporting of FLD: Reporting for FLD should be done in the following proforma.

Details of the input distribue (to be given 15 days after input distribution

Name of the implementing agency : **……**

S. No.	State	Districts	Name of the farmers with address	Gender, SC/ST/ OBC/General	Contact No.	FLDs to be conducted (ha)	Aadhar No	Input given (Name, price and quantity)

FLD peformance. (to be given 15 days after harvest of the crop),

Name of the implementing agency : **……**

Sl. No.	Name of the farmer	Address (name of village)	Adhar no.	New technology demonstrated in FLDs	FLD conducted Area (ha)	Farmer practice details (variety, production and protection practice)	Yield (q/ha)		Gains (%)	Response of the farmers (accepted/ rejected) with reasons
							Farmers practice	FLD		
1										

Note for FLD programme:

1. 3-4 Good quality photograph will be required alongwith final report
2. Report on Field Day having number for farmers participated along with photograph should be given

Tribal Sub-plan (TSP) activities

As per the review meeting of TSP under chairmanship of Secretary DARE and DG ICAR on 6TH April, 2018, major activity under TSP will include:

1. Capacity building and training
2. Seed: production, storage, bank and village
3. Infrastructure for grain storage
4. Demonstrations on the poultry and goat production
5. Interventions and demonstrations for post-harvest technologies/primary processing
6. Demonstrations on integrated farming
7. Linkage to Gramin Retail Infrastructure
8. Study of agriculture and allied production and management system, marketing and value addition

Reporting TSP Programme report (Quarterly basis)

Output 1 (Farm material distribution): Number of farmers benefitted /Individual farmers / farm families benefitted/ Supply of farm inputs/ seeds/ farm tools/ Honey production/ pollinators boxes/ inputs for / bio-fertilizer/ biopesticides etc.

SL. No.	Description	Unit	Q1/Q2/Q3/Q4 Targets	Q1/Q2/Q3/Q4 Achievements

Output 2 (knowledge and skill dissemination): Number of demonstration trials/ field days/ kisan goshdhis/ trainings/ plant protection technology demonstration/ biofertilizer/ biopesticides technology

SL. No.	Description	Unit	Q1/Q2/Q3/Q4 Targets	Q1/Q2/Q3/Q4 Achievements

Final TSP programme report

Beneficiary details of the TSP programme.

S. No.	State	District	Sub-district	Village	Individual section amount	ST population benefitted

Report on input distribution programme.

S. No.	State	Districts	Name of the farmers with address	Aadhar No	Contact number	Input given (Name, price and quantity)
1						

Report on the FLD under TSP Programme Sl.	Name of the farmer	Address (name of village)	Adhar no.	New technology demonstrated in FLDs	FLD conducted Area (ha)	Farmer practice details (variety name/ practice)	Yield (q/ha)		Gains (%) 11
							Farmers practice	FLD	

No.									
1									

mportant note for TSP programme

- Whole money to be spent by 31st November and report is to be sent by 31st December.
- Along with final report 5-7 good quality photograph for each activity are required
- It is desired to give information on activity in print and electronic media, and the same may be appended with the report.

Annexure I

Format to propose maize hybrids/varieties for testing in AICRP-Maize trials

*Late >95; medium>85<95; early <85

S. no.	Hybrid	AICRP (Maize) Centre/organization	Parentage	Source germplasm	Maturity (days)*	Trial name	season	Seed Quantity (Kg)
1								
2								

Year-wise data on yield and other attributes (Station/zonal trials)

S. no.	Hybrid	Yield (kg/ha)	% superiority over checks	Reaction to diseases and insect-pests	Quality	Any other
Year 1						
1						
	Checks					
Year 2						
1						
	Checks					

Note: At least one-year data needs to be give

Name of the proposer:

Designation:

Address:

Email/mobile:

Private sector: kindly append a copy of DSIR certificate

Signature of head with date

Annexure-II

ICAR-INDIAN INSTITUTE OF MAIZE RESEARCH, NEW DELHI
ALL INDIA COORDINATED RESEARCH PROJECT ON MAIZE (ICAR)
REPORT OF THE MONITORING TEAM:
Season:

S.NO	Particulars	Details
1.	Name of the center	
2.	Name of the discipline	Plant Breeding
3.	Name of the University/Institute	
4.	Monitoring Team	
5.	Date of visit of monitoring team	
6.	Stage of crop	
7.	Scientist associated with conduct of trials	
8.	No. of coordinated trials a. Allotted b. Conducted c. Rejected	
9.	No. of Zonal Trials a. Allotted b. Conducted c. Rejected	
10.	No. of station trials	
11.	Data Recorded (as per the plan or not)	
12.	Overall grading of centre(Excellent/Very good/ Good /Average/Poor)	

. No.	Trial Name	Date of sowing	Layout & Plan of work		Trials management (Spacing, fertilizer, weeding)	Plant stand (High/ Optimum/ Low)	Growth & expression (Very good/ Good/ Average/ Poor	Entries with their plot no. in each replication observed comparatively superior during visit in various trials.	Entry/ entries observed with undesirable traits	Overall remarks
			Approved technical programme (No. of rows/ entry, row length, No. of reps.)	Deviation if any						
A. Coordinated Trials										

SI. No.	Trial Name	Date of sowing	Layout & Plan of work		Trials management (Spacing, fertilizer, weeding etc.)	Plant stand (High/ Optimum/ Low)	Growth & expression (Very good/ Good/ Average/ Poor	Entries with their plot no. in each replication observed comparatively superior during visit in various trials	Entry/ entries observed with undesirable traits	Overall remark
			Approved technical programme (No. of rows/ entry/ No. of treatments, row length, No. of reps.)	Deviation if any						
B. Zonal Trials										

SI. No.	Trial Name	Date of sowing	Layout & Plan of work		Trials management (Spacing, fertilizer, weeding etc.)	Plant stand (High/ Optimum/ Low)	Growth & expression (Very good/ Good/ Average/ Poor	Entries with their plot no. in each replication observed comparatively superior during visit in various trials	Entry/ entries observed with undesirable traits	Overall remark
			Approved technical programme (No. of rows/ entry/ No. of treatments, row length, No. of reps.)	Deviation if any						
C. Station Trials										

13. Details on seed production
14. Brief note on meteorological conditions during crop period
15. Staff (Scientific and technical) Post sanctioned and filled

16. General remarks/ suggestion on the overall implementation of the technique programme.

17. Major constraints faced by the centre

( ) ( ) ( ) ( ))

Signature of monitoring team

ICAR-INDIAN INSTITUTE OF MAIZE RESEARCH, NEW DELHI
ALL INDIA COORDINATED RESEARCH PROJECT ON MAIZE (ICAR)
REPORT OF THE MONITORING TEAM:

S.NO	Particulars	Details
1.	Name of the center	
2	Name of the discipline	Plant Pathology & Nematology
3	Name of the University/Institute	
4	Monitoring Team	
5	Date of visit of monitoring team	
6	Stage of crop	
18.	Scientist associated with conduct of trials	
19.	No. of coordinated trials d. Allotted e. Conducted	
20.	No. of Zonal Trials d. Allotted e. Conducted f. Rejected	
21.	No. of station trials	
22.	Data Recorded (as per the plan or not)	
23.	Overall grading of centre(Excellent/Very good/ Good /Average/Poor)	

ALL INDIA COORDINATED RESEARCH PROJECT ON MAIZE (ICAR)
REPORT OF THE MONITORING TEAM:

Name of the center:
Name of coordinated trials allotted: Date of sowing of inferior row (Downy Mildews):

Name of the discipline: Plant Pathology & Nematology No. of coordinated trials conducted : Date of sowing of test row:

Scientist associated: Station trials: Date of Inoculation:

No.	Expt. Title	Layout & plant of work		Diseases (Name of disease will as per the hot-spots location)									
		Approved technical programme	Deviation of in any	Date of disease appearance	Disease incidence a. >80% b. 50% c. <50%		SDM/ BSDM/ RDM	TLB	MLB	PFS R	RUST	Nematode	Overall Remarks
					Susceptible check	Test row							
Coordinated Trials													
1.	NIVT Late maturity	Rep.-2 Row length-2.5m , 1 row											
2.	NIVT Medium	-Do-											
3.	NIVT early	-Do-											
5.	AVT-I-II Late	-Do-											
6.	AVT-I-II Medium	-Do-											
7.	AVT-I-II Early	-Do-											
9.	Specialty Corn SC+BC, PC QPM	-Do-											

Technique used for screening	:	

No. of irrigation provide etc.	:	

24. Brief note on meteorological conditions during crop period

25. General remarks/ suggestion on the overall implementation of the technique programme.

26. Major constraints faced by the centre

( ) ( ) ( ) ( ))

Signature of monitoring team

ICAR-INDIAN INSTITUTE OF MAIZE RESEARCH, NEW DELHI
ALL INDIA COORDINATED RESEARCH PROJECT ON MAIZE (ICAR)
REPORT OF THE MONITORING TEAM:
Season:

S.No.	Particulars	Details
1.	Name of the center	
2.	Name of the discipline	Entomology
3.	Name of the University/Institute	
4.	Monitoring Team	
5.	Date of visit of monitoring team	
6.	Stage of crop	
7.	Scientist associated with conduct of trials	
8.	No. of coordinated trials g. Allotted h. Conducted i. Rejected	
9.	No. of Zonal Trials g. Allotted h. Conducted i. Rejected	
10.	No. of station trials	
11.	Data Recorded (as per the plan or not)	
12.	Overall grading of centre(Excellent/Very good/ Good /Average/Poor)	

13. Brief note on meteorological conditions during crop period
14. Overall remark/ suggestions on implementation of technical programme
15. Major constraints faced by the centre
16. Staff Details (Technical and scientific): Sanctioned and filled

( ) ( ) ( )
Signature of team member

AICRP Trials for screening of germplasm against *Chilo partellus*					
1.	**Coordinated Trial**	**Date of Germination**	**Date of Release of pest**	**Date of Observation (LIR)**	**Remark**

	AVT-I-II Late				
	AVT-I-II Medium				
	AVT-I-II Early				
	QPM Specialty corn BC SC PC				
S2.	**Evaluation of Inbred Lines**				
3.	**Station Trials**				

Multi-location Entomological Experiments					
Evaluation of Insecticides	**Date of Germination**	**Date of Spraying**	**Date of Release of pests**	**Date of Observation (LIR)**	**Remark**
Spray before pest release					
Spray after pest release					
Evaluation of Biocontrol agents in the field	**Days after Germination (DAG)**	**Date of Egg Masses exposed**	**Date of collection of eggs from field**	**Observation-Percent parasitization of eggs**	
a. Egg Parasitism	10				
	20				
	30				
	40				
	50				
	60				
b. Larval Parasitism	**Days after Germination (DAG)**	**Date of Dissection of infested plants**	**No. of larvae recovered from 20 plants**	**Percentage of larvae parasitized**	
	40				

	50				
	60				
	70				

Observation on assessment of crop losses caused by *Chilo partellus*					
S. No.	**Name/No. of field**	**Area of field**	**Date of germination**	**Date of observation**	**Remarks**
1					
2					

ICAR-INDIAN INSTITUTE OF MAIZE RESEARCH, NEW DELHI
ALL INDIA COORDINATED RESEARCH PROJECT ON MAIZE (ICAR)
REPORT OF THE MONITORING TEAM:
Season:

S.NO	Particulars	Details
1.	Name of the center	
2.	Name of the University/Institute	
3.	Name of the discipline	Agronomy
4.	Monitoring team	
5.	Date of visit of monitoring team	
6.	Stage of crop	
7.	Scientist associated with conduct of trials	
8.	No. of coordinated trials j. Allotted k. Conducted l. Rejected	
9.	No. of Zonal Trials j. Allotted k. Conducted l. Rejected	
10.	No. of station trials	
11.	Data Recorded (as per the plan or not)	
12.	Overall grading of centre(Excellent/Very good/ Good /Average/Poor)	

SI. No.	Trial Name	Date of sowing	Layout & Plan of work		Trials management (Spacing, fertilizer, weeding etc.)	Plant stand (High/ Optimum/ Low)	Growth & expression (Very good/ Good/ Average/ Poor	Comparative Treatment observation during the monitoring	Overall appraisal of the experiment/ remark (Excellent/ Very good/ Good/ Average/ Poor)
			Approved technical programme (No. of rows/ entry/ No. of treatments, row length, No. of reps.)	Deviation if any					
A. Coordinated Trials									

SI. No.	Trial Name	Date of sowing	Layout & Plan of work		Trials management (Spacing, fertilizer, weeding etc.)	Plant stand High/ Optimum/ Low	Growth & expression (Very good/ Good/ Average/ Poor	Comparative Treatment observation during the monitoring	Overall appraisal of the experiment/ remark (Excellent/ Very good/ Good/ Average/ Poor)
			Approved technical programme (No. of rows/ entry/ No. of treatments, row length, No. of reps.)	Deviation if any					
A. Station Trials									

13. Brief note on meteorological conditions during crop period
14. Overall remark/ suggestions on implementation of technical programme
15. Major constraints faced by the centre

17, Staff Details

	Staff Position	Sanctioned	Staff in position with name
(a)	Scientific staff		

(b)	Technical/Supporting Staff		

( ) ( ) ( )

Signature of team members

Annexure III

Proforma for Submission of Proposals for Identification of Crop Varieties/ Hybrids by Workshops (For VIC)
&
Proforma for Submission of Proposals for Release of Crop Varieties/ Hybrids to Central Sub-Committee on Crop Standards Notification and Release of Varieties (For release and notification through CVRC)

Note: Format of proposal for VIC and CVRC remained same but following documents need to be attached along with the VIC proposals while submitting for release and notification:

1. Attach the IC number certificate for hybrid and parental lines issued by NBPGR
2. DNA finger printing information for hybrids as well as their parental lines
3. Proceedings of VIC

The 40 copies of a proposal for release and notification of a hybrid should be routed through Director, Maize and submitted to ……..

***Kharif*/*Rabi*/Spring Hybrid ……. Proposed for …..Zone**

ICAR-Indian Institute of Maize Research, Ludhiana-141004

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Zone wise summary of the proposal

Proforma for Submission of Proposals for Identification of Crop Varieties/ Hybrids by Workshops

1	Name of the crop and species	:	*Zea mays* (L.)
2	a) Name of the variety under which tested in AICRP trials	:	
	b) Proposed name of the variety	:	
3	Sponsored by (institute)	:	
4	a) Institution or agency responsible for developing variety (with full address)	:	
	b) Name of the person who helped in the development of the variety Developers Collaborators	:	
5	a) Parentage (with details of its pedigree including source from which variety/Inbred/ A, B and R lines of hybrid has been developed)	:	
	b) Source of material in case of introduction	:	
	c) DNA profile of variety/hybrid/inbred/A, B, R line of hybrid vis-à-vis check variety/ line		
	d) Breeding method used	:	
	e) Breeding objective	:	
6	State the varieties which are most closely resemble the proposed variety in general characters	:	
7	Recommended productions ecology (Rainfed/Irrigated; high/low fertility; season)	:	
8	Specific area of its adaptation (zones and states for which variety is proposed) and recommended productions ecology	:	
9	Description of hybrid/variety	:	
	a) Plant height	:	
	b) Distinguishing morphological characters	:	
	c) Maturity (range in number of days) (from seedling/ transplanting to flowering, seed to seed)	:	
	d) Maturity group (early, medium and late wherever such classification exists)	:	
	e) Reaction to major diseases under field and controlled conditions (reaction to physiological strains/ races/pathotypes/ bio-types to be indicated wherever possible)	:	
	f) Reaction to major pests (under field and controlled condition including store pests)	:	
	g) Agronomic features (e.g. resistance to lodging, shattering, fertilizer responsiveness, suitability to early or late sown conditions, seed rate etc.)	:	
	h) Quality of produce	:	
	Grain quality	:	
	Fodder quality	:	
	i) Reaction to stresses	:	

10	Description of the parents of the hybrid	:	A line/Inbred 1 **Female**	B line/Inbred 2 **Male**	R line
	a) Plant height (cm)	:			
	b) Distinguishing morphological characters	:			
	c) Days to flowering Anthesis Silking	: :			
	d) Days to maturity (range in number of days – from seed to seed)	:			
	e) Is there any problem of synchronization? If yes, method to overcome it	:			-
	f) Reaction to major diseases (under field and controlled conditions, reaction to physiological strains/ races/bio-types/ pathotypes to be indicated wherever possible)	:			
	g) Reaction to major pests (under field and controlled conditions including store pests)	:			
	h) Agronomic features (e.g. resistance to lodging, shattering, fertilizer responsiveness, suitability to early or late sown conditions, seed rate etc.)	:			
	i) Reaction to stresses	:			
11	a) Yield data in coordinated trials (breeding, agronomy, pathology, entomology, quality etc) regional/inter regional district trials year wise (levels of fertilizer application, density of plant population and superiority over local control/standard variety to be indicated (to be attached)	:			
	b) Yield data from national, demonstration/large scale demonstrations (to be attached)	:			
12	a) Agency responsible for maintaining breeder seed	:			
	b) Quantity of breeder seed in stock (kg) Variety A line B line R line Hybrid	:			
13	Specific recommendations, if any, for seed production (e.g. staggered sowing, plating ratio of parental lines of hybrids in foundation and certified seed production, probable area of seed production)	:			
14	Vivid presentation (field view, close-up of single plant and seed/economic parts)				
15	Package of practices along with attainable yield levels				
16	Any other pertinent information	:			

Proposed Hybrid:

Checklist for proforma for submission of proposal for Identification of Crop Varieties/ Hybrids by Workshops

Details/document	Attached	
Parentage with details of its pedigree including source from which variety/Inbred/A, B and R lines of hybrid has been developed		
Source of material in case of introduction (IC/EC numbers provided by NBPGR)		
Flow chart of details of development of variety/ parental lines of hybrids		
Molecular/ DNA profile of variety/hybrid/A, B, R line of hybrid vis-à-vis check variety/ line (details of unique amplicons that distinguishing markers along with photographs		
Detailed description of hybrid/variety		

Detailed description of the parental lines of hybrid		
Yield data and other data on diseases, insect-pest, quality etc. from coordinated trials		
Yield data from national, demonstration/large scale demonstrations		
Specific recommendations, if any, for seed production (e.g. staggered sowing, plating ratio of parental lines of hybrids in foundation and certified seed production, probable area of seed production etc.)		
Vivid presentation (field view, close-up of single plant and seed) with the help of photographs of the variety)		
Package of practices		
Proforma signed by all co-authors and Head of Organization		
Any other pertinent information		

Signature of Head of Institution

Table 1. Summary yield data of Coordinated Varietal Trials

Name of proposed variety/Hybrid:-						Adaptability Zone –	
						Production conditions- ***Kharif*/*Rabi***	
Item	Year of testing	No. of trials/locations	Proposed variety/ Hybrid –	National Check –	Zonal Check 1 -	Zonal check 2	Qualifying checks/entries
Mean yield (kg/ha) a) Zonal b) across Zones (If applicable)	*Kharif*, 2016						
	Kharif, 2017						
	Kharif, 2018						
Weighted Mean							
% increase in yield based on Weighted Mean							
Percentage increase or decrease over the checks & qualifying varieties	*Kharif*, 2016						
	Kharif, 2017						
	Kharif, 2018						
Overall % superiority							
Frequency in the top five group (pooled for three years)							

Note:

1. Qualifying variety is one which has completed three years of testing in coordinated trials (NA)
2. Centre- wise and year –wise data must be appended, otherwise proposal will not be considered (**attached in annexure –II**)

Table 2. Adaptability to Agronomic Variables

Name of proposed variety/Hybrid:			Adaptability Zone –	
			Production condition-	
Density Experiments	Fertilizer experiments	Proposed variety	National Check –	Zonal Check 1 -
83,000	Yield (kg/ha) under Recommended Dose (**100%**)			
	Yield (kg/ha) under high dose (**150%**)			
	Percentage gain or loss under other doses			
1,00,000	Yield (kg/ha) under Optimum density (**100%**)			
	Yield (kg/ha) under high density (**150%**)			
	Percentage gain or loss under other doses			

Overall mean yield (kg/ha) CD at 5 %			
% superiority of ……..over all the checks varieties			

***Note: Optimum plant density is recommended**

Table 3A. Reaction to major diseases

The Reaction to various diseases under artificial epiphytotic conditions at hot spot locations in proposed Zone- **Northern Hill Zone (NHZ)** is given below

Name of proposed variety/Hybrid:					Adaptability Zone **-**		
					Production condition- ***Kharif***		
Disease name	Conditions	Year of testing	Proposed variety/ Hybrid	National Check –	Zonal Check 1 -	Zonal check 2	Qualifying checks/entries
TLB (1-9)	Hot spot locations under artificial epiphytotic conditions	*Kharif*, 2016					
		Kharif, 2017					
		Kharif, 2018					
		Mean					
BLSB (1-9)	Hot spot locations under artificial epiphytotic conditions	*Kharif*, 2016					
		Kharif, 2017					
		Kharif, 2018					
		Mean					

Table 3. Reaction to Major diseases

The Reaction to various diseases under artificial epiphytotic conditions at hot spot locations in other Zones ie. **Penninsular Zone (PZ)** is given below

Name of proposed variety/Hybrid:-						Adaptability Zone ----------		
						Production condition- ***Kharif***		
Disease name	Year of testing	Conditions	Scale of rating Item	Proposed variety/ Hybrid	National Check –	Zonal Check 1 -	Zonal check 2	Qualifying checks/entries
TLB (PZ)	*Kharif*, 2016	Hot spot locations under artificial epiphytotic conditions	1-9					
	Kharif, 2017							
	Kharif, 2018							
	Mean							

Table 4. Reaction to Insect Pests

Name of proposed variety/Hybrid:-					Adaptability Zone: North West Plain Zone (Other than proposed zone)		
					Production condition- ***Kharif***		
Insect name	Conditions	Year of testing	Proposed variety/ Hybrid	National Check –	Zonal Check 1 -	Zonal check 2	Qualifying checks /entries
C. partellus (LIR 1-9)	Hot spot locations under Artificial epiphytotic conditions	Kharif, 2016					
		Kharif, 2017					
		Kharif, 2018					

***Based on Leaf injury rate (LIR 1-9)**

Table 5. Data on Quality Characteristics

Quality Characterstics	**Item**	Year of testing	Proposed variety/ Hybrid	National Check –	Zonal Check 1 -	Zonal check 2	Qualifying checks/ entries
Parameter -1		*Kharif* 2016					
		Kharif 2017					
		Kharif 2018					
		Mean					
Parameter -2		*Kharif* 2016					
		Kharif 2017					
		Kharif 2018					
Parameter -3		*Kharif* 2016					
		Kharif 2017					
		Kharif 2018					

Table 6 Data on other important characters

Name of proposed variety/Hybrid:-						Adaptability Zone –		
S.No.	Item		Year of testing	Proposed variety/ Hybrid	National Check –	Zonal Check 1 -	Zonal check 2	Qualifying checks/entries
1.	Plant height (cm)		*Kharif*, 2016					
			Kharif, 2017					
			Kharif, 2018					
			Mean					
2.	Days to flowering	Anthesis	*Kharif*, 2016					
			Kharif, 2017					
			Kharif, 2018					
			Mean					
		Silking	*Kharif*, 2016					
			Kharif, 2017					

			Kharif, 2018					
			Mean					
		ASI	*Kharif*, 2016					
			Kharif, 2017					
			Kharif, 2018					

#S.No.	**Characteristics**	**Hybrid (…….)**	**Female (……..)**	**Male (……)**

		Mean						
3.	Ear height (cm)	*Kharif*, 2016						
		Kharif, 2017						
		Kharif, 2018						
		Mean						
4.	Ear placement ratio	*Kharif*, 2016						
		Kharif, 2017						
		Kharif, 2018						
		Mean						
5.	Moisture % at harvest	*Kharif*, 2016						
		Kharif, 2017						
		Kharif, 2018						
		Mean						
6.	Plant Stand at harvest (‘000/ha)	*Kharif*, 2016						
		Kharif, 2017						
		Kharif, 2018						
		Mean						
7.	Days to maturity (75% dry husk)	*Kharif*, 2016						
		Kharif, 2017						
		Kharif, 2018						
		Mean						
8.	Grain Shelling (%)	*Kharif*, 2016						
		Kharif, 2017						
		Kharif, 2018						
		Mean						

1	Leaf: angle between blade and stem (on leaf just above upper ear)			
2	Leaf: attitude of blade			
3	Stem: anthocyanin colouration of brace root			
4	Tassel: time of anthesis			
5	Tassel: anthocyanin colouration at base of glume			
6	Tassel: anthocyanin colouration of glumes excluding base			
7	Tassel: anthocyanin colouration of anthers			
8	Tassel: density of spikelets			
9	Tassel: angle between main axis and lateral branches			
10	Tassel: attitude of lateral branches			
11	Ear: time of silk emergence			
12	Ear: anthocyanin colouration of silks			
13	Leaf: anthocyanin colouration of sheath			
14	Tassel: length of main axis above lowest side branch			
15	Plant length up to flag leaf			
16	Plant: ear placement			
17	Leaf: width of blade			
18	Ear: length without husk			
19	Ear: diameter			
20	Ear: shape			
21	Ear: number of rows of grains			
22	Ear: type of grain			
23	Ear: colour of top of grain			
24	Ear: colouration of glumes of cob			
25	Kernel: row arrangement			
26	Kernal: poppiness			
27	Kernal: sweetness			
28	Kernal: waxiness			
29	Kernel: opaqueness			
30	Kernel: shape			
31	Kernel: 1000 kernel weight			

DUS characteristics of the Proposed Hybrid/ Variety (……..) and its Parents

#is as per S.No. PPV&FRA

Table: Location wise yield data (Kg/ha) of proposed hybrid for three years of testing…… NHZ (Z-I).

-Field demonstartion data

-Photographs of Proposed Hybrid and parents (Ears, grains, plants in field

-Pedigree details of Hybrid and inbred lines

PACKAGE OF PRACTICES

Average Yield (kg/ha) :

S.No.	Items		Agronomic Practices
1	**Time of sowing**		
2	**Fertilizer application**	:	
3	**FYM Basal (at the time of sowing)** **Zinc Deficiency**		
4	**Seed Rate** **Spacing** **Method of sowing**	**:**	
5	**Weeding**	**:**	
6	**Top dressing and Earthing up**	**:**	
7	**Plant Protection measures**	**:**	
8	**Irrigations**	**:**	
9	**Bird scaring**	**:**	
10	**Maturity and harvesting**	:	

Annexure-IV

Performa for registration of genetic stock/elite inbred lines at NBPGR

Form A
Application for Registration of plant Germplasm
(To be submitted to The Director, NBPGR, New Delhi-110012)
Please refer to guidelines for filling the application form and codes

---

1. Application status (code) N | R

2. Crop name

3. Botanical name

4. Crop group (Code)

5. Biological status of the material to be registered

6. Identity

7. Criteria for registration[Unique feature(s) maximum three]

I.

II

1. **Whether registered or rejected**

8. Nature of genetic material (code)

9. Quantity deposited (Actual)

10. Value referred to (Code) SC | CM | AC

11. Basis of eligibility (Code) AR | PR | CT | OT

12. Has it been registered /protected anywhere

13. Manuscript (One-page note on proposed germplasm enclosed

14. Particulars of the scientist(s)/person(s)/ ligibility /farmer/farming community who developed germplasm/genetic stock*

Name (Dr/Ms/Mr.)

Designation

Address

Tel: Fax: E-mail

Mobile No.:

(*Please attac e(s) and address(es) of co-authors (persons responsible).*

15. Name and address of the corresponding person (Developer/Depositor)

Name (Dr/Ms/Mr)

Designation

For Use of NBPGR

(i) Application number

(ii) Date of application

(iii) Whether new or revised? N | R

(iv) If revised, Date of 1st Application

(v) If validation test suggested whether report attached

(vi) Action taken
a) Forwarded for registration
b) Sent for validation
c) Incomplete, sent for revision

(viii) Date of registration or rejection

(ix) Registration Number ***INGR No.***

(x) Validation tes Y | N

(xi) Notified on:

(xii) Remarks:

Address

Tel/Mo Fax: E-mail:

16. (A) Passport information of germplasm

IC/EC No.	Other Identity Source	Place of origin	Tehsil/Distt/Province	Genes if any identified

*Farmers/community Contribution, if any,

(b) Pedigree of the genetic stock

Pedigree **Breeding method (Code)**

17. Salient Characteristics/ Chief botanical and morpho-agronomic description* (attach details)

S. No.	Trait Description
1.	

18. Usefulness of identified germplasm/Genetic stock

19. Year of seed production 20. Location of seed production 21. Quantity of seed available 22. Seed viability (%)

23. Additional information/Remarks (if any)

24. Recommendation of institute's Germplasm Identification Committee

UNDERTAKING

1.*I/We undertake to ensure deposition of seed/genetic material for long term conservation of the aforesaid germplasm/genetic stock at the National Genebank, NBPGR and also its sustainable use by maintaining appropriate quantity of Active/Working Collection and providing access as appropriate on prior informed consent and on mutually agreed terms.I/ We also agree to provide any further information or data pertaining to the description and unique characteristics to the ICAR/NBPGR in a transparent manner.*

2. I/We assure genetic purity and truthfulness of seed material supplied with the application.

3. I/We assure that such germplasm does not contain any gene or gene sequence involving terminator technology.

SIGNATURE OF THE ASSOCIATES

Signature

Full Name

Designation &Address

SIGNATURE OF THE DEPOSITOR

Signature

Full Name

Designation &Address

PROFORMA FOR PASSPORT INFORMATION

Supplying/co-operating Institute: **Date:**

S. No.	National Identity	Collector No.	Donor Institute	Donor /other Identity	Crop Name	Common Name	Taxon-omic Code	Pedigree	Source	Biological Status	Country of Origin	Location	Latitude	Longitude	Altitude	Remarks

Source: In = Institute/NRC/IARCs; F= Famer; M= Market; NGO= Non-Govermmental organizations; OT= others
Biological status: W= wild; RC= Released cultivar; LR= Landraces; BL=Breeding line; Mu= Mutant; GS= Genetic stock; OT = others
Country of origin; Please provide ISO codes

CHECK-LIST FOR SCREENING OF APPLICATIONS

The Member Secretary, PGRC at NBPGR shall screen all application Annexure and make recommendations to the PGRC for *inter alia* the following points:

S.No.	Item	Yes/No
1.	Whether this is a new application?	
2.	Whether this is a revised application?	
3.	Whether same or similar material has been registered earlier?	
4.	Whether unique or distinguishing characteristics of potential value merit consideration for registration?	
5.	Whether documentary evidence or data (as per the guidelines) is provided in support of the claim on potential value of germplasm?	
6.	State any other economic potential value of germplasm, if possible	
7.	Whether applicant, institution, university or centre has given a commitment for maintenance and supply of germplasm for use?	
8.	Whether appropriate size of germplasm sample for long-term storage at National Genebank or for conservation and maintenance of active collections at the concerned NAGS has been sent?	
9.	Whether the applicant has sent maintainer line of the CMS line to the National Genebank?	
10.	Whether all the proposers signed the declaration regarding evaluation of the germplasdm/ genetic stock under hot spots/ under artificial (epiphytotic) conditions	
11.	Whether acknowledgement receipt of germplasm from concerned NAGS for deposition and establishment is attached, wherever required?	
12.	Whether detailed address of the corresponding person is given?	
13.	Whether Recommendations of IGIC (Institute Germplasm Identification Committee) attached?	
14.	Whether competent authority of the institute has duly endorsed the application?	

(Signature of the Applicant)

CHECK-LIST FOR REVIEWER /EXPERT FOR RECOMMENDATION

Recommendation

(i) Importance of trait : Scientific/Commercial/Academic

(ii) Data sufficient as per guidelines (See Section 4 of ligibility criteria of guidelines) : Yes/No

(iii) Validation test required : Yes/No

(iv) Recommended for registration : Yes/No

Signature of the Expert
(with seal)

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