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Saffron (*Crocus sativus* L.) Crop Insurance to Mitigate ill Effects of Climate change - a Priority of Jammu and Kashmir State

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A B S T R A C T

Climatic abnormalities observed in Kashmir over a couple of years (2014-17) has put saffron farming system under great distress leading to reduction in overall production from 16.5 M.T recorded in 2013 to almost 1.5 M.T recorded in 2017 and thus warrants to bring saffron cropping system under crop insurance cover so as to save saffron growers from annual exchequer loss of Rs 210 cores. Guidelines for weather based and yield based crop insurance policies for saffron have been framed but the schemes are not under operation till date and warrants prioritization of state policy makers.

Introduction

After implementation of National Saffron Mission in 2010 by Agriculture Production Department J and K Saffron farming system a legendary crop of Jammu and Kashmir state was on rise up till 2013, as overall Saffron production of state increased from 9.46 M.T to 16.5 M.T with an increase in average productivity from 2.5 to 4.4 kg/ha (Nehvi and Salwe, 2017). However, excess precipitation observed in 2014 by 53% (280 mm as against requirement of 183 mm) during sprouting stage (August-October) lead to decline in saffron production of J and K state by 70% (4.5 M.T as against 15 M.T recorded during 2013). Similarly, precipitation deficit during sprouting stage recorded by 56.9 % in 2016 and 100% in 2017 lead to decline in saffron production by 91% during 2017 (from 16.5 M.T recorded in 2015 to 1.5 M.T recorded in 2017). Excess summer precipitation associated with high humidity has become concern of saffron growers as during 2015 saffron growers lost about 30% of corms due to corm rot caused by fungal infestation as saffron area recorded 400% more precipitation from May to July (550 mm as against normal precipitation of 110 mm) Figure 1 and 2 (Salwe *et al*., 2016). All these factors have resulted in annual exchequer loss to the tune of Rs 225 cores during 2017 affecting about

17000 saffron families involved with saffron farming system directly or indirectly. Alarming situation made farmers despondent about future of saffron and thus introduction of crop insurance policy for saffron is the only way to make saffron growers confident about future of saffron under changed climatic conditions of Kashmir.

Materials and Methods

Weather Based National Crop Insurance Programme (NCIP) For Saffron.

Premium

To gain the confidence of farmers dealing with any legendary cropping system it is legitimate duty of Government of that particular state to notify a crop insurance scheme. Accordingly Agriculture Production Department notified implementation of National Crop Insurance Programme (NCIP)-/Rashtriya Fasal Bima Karyakram –Weather Based Crop Insurance Scheme(WBCIS)-component in J and K State during the year 2014-15 as per the guidelines and operational modalities fixed by Department of Agriculture and Cooperation, MOA,GOI vide letter No. 13015/02/2012-Credit-II, dated 04.02.2014. Trigger points for different phonological stages of saffron were identifies as base line values for water and temperature requirements (Salwee *et al*, 2018).The strike values were calculated on the basis of deficit and excess rainfall and decrease and increase in day temperature. Pay out rates were calculated on the basis of cost of cultivation and the extent of damage during particular phonological stage. As per the operational guidelines of NCIP, the total premium will be shared as per details in Table 1.

Adoption level

The scheme will be applied to the Jammu and Kashmir and saffron crop will be taken up for insurance on pilot basis. The period of coverage for saffron crop will be from 1st August, to 31st May. All the farmers including small and marginal, women, Schedule Caste, Sharecroppers, tenant farmers growing the Notified Crops in the Notified Area are eligible and will be covered under the scheme if they availed Seasonal Agriculture Operations (SAO) loans from financial institutions (i.e. Loanee farmers) or non-loanee farmers who opt for the Scheme. About, 1000 Ha of Saffron crop area in 18 agricultural circles viz., Zantrag, Khrew, Wuyan-A. Wuyan-B, Sharshali-A, Sharshali-B, Jawbehara, Lethpora-A, Lethpora-B, Lethpora-C, Samboora, Parigam, Konibal-A, Konibal-B, Chandhara, Namblabal, Drangbal and Kadlabal will be allotted to different National insurance implementing agencies. They will be made responsible for wide publicity regarding the scheme in their respective areas of jurisdiction to create awareness among the farmers and lay down of the entire requisite infrastructure of Automatic Weather Stations (AWS). The already installed AWS, if any, by IMD/SAUs in the notified areas will be used as RWS for implementation of the scheme

Pradhan Mantri Fasal Bima Yojna (PMFBY)

In 2017, State Agriculture Production Department notified Pradhan Mantri Fasal Bima Yojna (PMFBY., 2016) for saffron Insurance to support sustainable production of saffron by way of - a) providing financial support to farmers suffering crop loss/damage arising out of unforeseen events b) stabilizing the income of farmers to ensure their continuance in saffron farming c) encouraging farmers to adopt innovative and modern agricultural practices d) ensuring flow of credit to the agriculture sector; which will contribute to saffron farming security. For assessment of yield losses crop cut experiments is mandatory to be carried by

Insurance companies in collaboration with a team of technical experts to be designated by the Nodal officer at district level. As CCEs is not available for saffron therefore SKUAST-Kashmir developed guidelines for Crop Cut Experiment (CCEs) for saffron.

For designing CCEs in saffron following methodology was taken into consideration viz;

- Basic Principles.
- Steps in different activities in Crop Cut Evaluation
- Procedure for Selection of saffron growers plot (experimental site) for taking crop cut
- Experimental materials required
- Locating an Experimental Plot for Crop Cutting Experiments (Square plot of Size 5x5m)
- Flower Picking and other operations (Nehvi *et al*., 2018)

Results and Discussion

Weather Based National Crop Insurance Programme (NCIP) For Saffron

Trigger weather

In saffron availability of moisture during sprouting stage is considered the trigger weather to induce saffron flowering on account of development of adventitious roots that helps in better sprout activation. Trigger Weather is pre-defined and notified w.r.t a particular weather parameter, and is being fixed keeping in mind the broad moisture/water or other weather parameter requirement of a particular crop. During this period saffron crop should receive 2290 $m^3$of water per hectare to ensure quick and timely sprouting leading to high productivity (Nehvi *et al*., 2017).

Saffron flowering is another most critical phonological stage and is mostly influenced by high aerial temperatures (>20^0C) and low night temperatures (<6^0C). Although flower ontogenesis process is completed after the plant receives desired moisture but deviation of maximum and minimum temperatures from desired levels during flowering period (October) results in delayed flowering (I^{st} week of November) leading to flower abortion within the cataphyll shoots. In Kashmir, saffron would usually flower during 2^{nd} week of October recording day and night temperatures within permissible limits i.e 17^0C -19 ^{0}C during day and 8 ^{0}C to 11 ^{0}C during night.

However climate change observed in the last couple of years recorded conducive temperatures for saffron flowering only during I^{st} fortnight of November thereby reducing the flowering period to just 10 days. Low night temperatures recorded during flowering period of November lead to production losses due to poor flower development.

Table.1 Premium details of saffron crop insurance under weather based NCIP

Crop Covered	Premium/ha(Rs)
Sum Insured	825000
Total Premium	99000
Farmer's Share of Premium	49500
Central Share of Premium	24750
State Share of Premium	24750

Table.2 Revised weather based crop insurance scheme (2018-19)-Term Sheet

State			**District**	**Crop**	**Reference weather Station**	**Unit**
Jammu and Kashmir			Pulwama, Budgam, Srinagar, Kishtwar	Saffron	Pampore	Hectare
Term Sheet						
S No	**Weather Parameter**		**Phase I**	**Phase II**	**Phase III**	
1	**Deficit Rainfall Volume**	**Period**	**Bud Sprouting (15th August to 2nd September**	**Shoot Elongation and Flower initiation (3rd September to 2oth October)**	**Initial Vegetative Phase (11th November to 4th December)**	
		Index	**Aggregate of rainfall over respective phases**			
		Strike I (<)	69 mm	114 mm	46 mm	
		Strike II (<)	30 mm	70 mm	20 mm	
		Exit	0 mm	0 mm	0 mm	
		Rate I (Rs/ mm)	351	390	200	
		Rate II (Rs /mm)	2878	1612	740	
		Maximum Payout (Rs)	1,00000	1,30,000	20,000	
		Total Payout (Rs)	**2,50,000**			
2	**Excess Rainfall Volume**	**Period**	**Phase I**	**Phase II**	**Phase III**	**Phase IV.**
			Flower initiation and Blooming (15th October to 10th November)	**Vegetative Phase (Ist March to 31st March)**	**Senescence Ist April to 30th May**	**Dormancy Ist May to 31st May**
		Index	**Maximum of 3 consecutive days cumulative rainfall in respective phases**			
		Strike I(>)	25 mm	50 mm	50 mm	50 mm
		Strike II(>)	50 mm	125 mm	125 mm	125 mm
		Exit	100 mm	150 mm	150 mm	150 mm
		Rate I (Rs/mm)	425	240	240	240
		Rate II (Rs/mm)	1488	480	480	480
		Maximum Payout(Rs)	85000	30000	30000	30000
		Total Payout (Rs)	**175000**			
3	**Decrease in Day Temperature**	Period	Phase I	Phase II	Phase III	
			Bud Sprouting (26th August to	Shoot Elongation (10th September to	Flower initiation (Ist October to 10th	

	(DDT)		9th September)	30th September)	November)	
		Index	Highest of Consecutive days having day temperature less than bench mark			
		Bench Mark	22 ^{0}c	22 ^{0}c		18 ^{0}c
		Strike I(>)	5 ^{0}c	5 ^{0}c		5 ^{0}c
		Strike II(>)	10 ^{0}c	10 ^{0}c		10 ^{0}c
		Exit	15 ^{0}c	15 ^{0}c		15 ^{0}c
		Rate I (Rs/^{0}c)	1500	1500		9000
		Rate II (Rs/^{0}c)	3500	3500		21000
		Maximum Payout(Rs)	25000	25000		1500000
		Total Payout (Rs)	**200000**			
4	**Increase in Day Temperature (IDT)**	**Period**	**Phase I**	**Phase II**		**Phase III**
			26th August to 9th September	10th September to 30th September		Ist October to 10th November
		Index	**Highest of Consecutive days having day temperature greater than bench mark**			
		Bench Value	27 ^{0}c	25 ^{0}c		20 ^{0}c
		Strike I(>)	5 ^{0}c	5 ^{0}c		5 ^{0}c
		Strike II(>)	10 ^{0}c	10 ^{0}c		10 ^{0}c
		Exit	15 ^{0}c	15 ^{0}c		15 ^{0}c
		Rate I (Rs/^{0}c)	1500	1500		9000
		Rate II (Rs/^{0}c)	3500	3500		21000
		Maximum Payout (Rs)	25000	25000		150000
		Total Payout (Rs)	**200000**			

Table.3 Dimensions of experimental plot

Crop	Plot Size		Diagonal distance	Area of the plot in terms of Hectare
	Length	Breadth		
Saffron	5 meter	5 meter	7.07meter	1/400th of a hectare

Table.4 Time schedule of CCEs activities

Name of the Crop	Randomly Selection of Village	Date of Submission of Exhaustive list	Randomly selection of Farmers	Cut off date for receiving CCE results
Saffron	15th July	25th July	30th July	20th November

Table.5 CCEs format for submission of yield data

Nam of the district	Name of the Agri Sub-Division	Name of the Block	Name of the Circle	Name of the Village	Name of the saffron Grower	Date of CCE	Dry weight of saffron/25m^2 Experimental Plot

Table.6 Format for reporting Crop Cutting Experiment Results

Sl No.	Particulars	
1	Name of the District	
2	Name of the Agri. Sub-Division	
3	Name of the Block	
4	Name of Agri. Sector	
5	Name of the Circle	
6	Name of the Gram Panchayet	
7	Name of the Cultivator where actual CCE conducted	
8	Operational size of the holding of Farmer	
9	Name of the crop	
10	System of Cultivation	Scientific/Traditional
11	Corm used/Kanal	
12	Whether Manure/ FYM used in the plot	Yes/ No
13	If yes, quantity of manure/FYM used (in per Kani)	
14	Whether Chemical Fertilizer used in the plot	Yes/ No
15	If yes, quantity of Chemical fertilizer used(in per Kanal)	
16	Time of sowing	(Early / Normal/ Late).
17	Date of last flower picking	
18	Total area under crop (kanal) in respect of cultivator for which CCE's is under taken	
19	Age of the filed where CCE's is under taken	Ist year/2nd Year /3rd Year/4th Year/Above 4 years
20	Length of the field (in footsteps)	
21	Breadth of the field (in footsteps)	
22	Pair of random number selected	
23	Fresh Weight of the Produce obtained in CCE's in grams	
24	Moisture Percentage in the produce obtained in CCE's	
25	Date of taking total Dry Weight of the Produce obtained in CCE's	
26	Dry Weight of the Produce obtained in CCE's (in gm)	
27	Normal Average yield in (Kgs / Kanl) where CCE's undertaken (as per farmer experience)	
28	Production obtained through CCE's in respect of Normal average yield is	Normal/Good/Bad
29	Remarks about Production observed	
30	Whether the selected field was irrigated or un-irrigated	
31	If irrigated the source of irrigation	
32	Land type where CCE is undertaken	Upland/ Medium Land/ Low Land
33	Weather condition during Crop season	Normal / Drought/flood
34	Extent of damage by pests or any disease	

Figure.1 Saffron production and productivity trend over years (2009 to 2017)

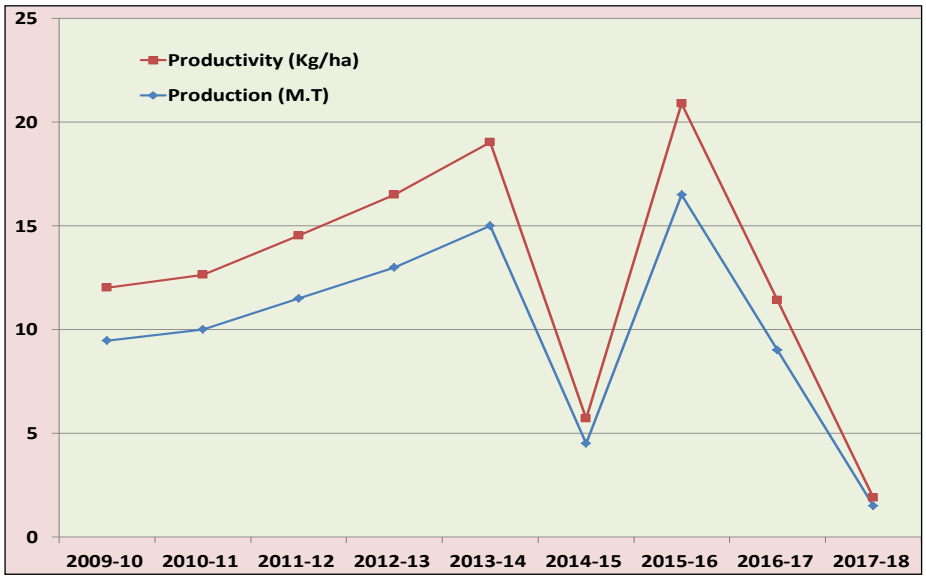


Figure.2 Erratic precipitation pattern during critical stages of saffron crop over growth years (2014-2017)

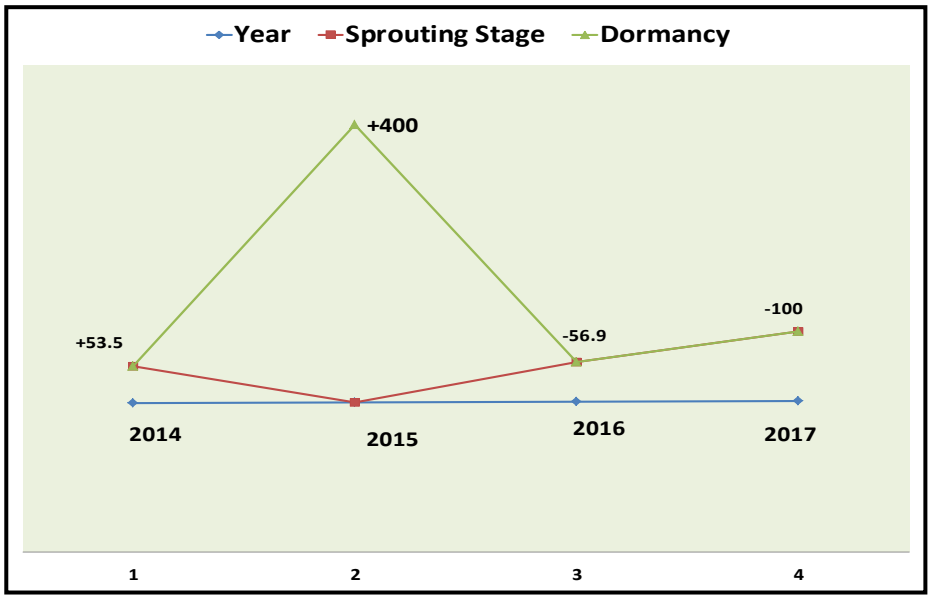


Figure.3 Weather parameters recorded during flowering period-averaged over years

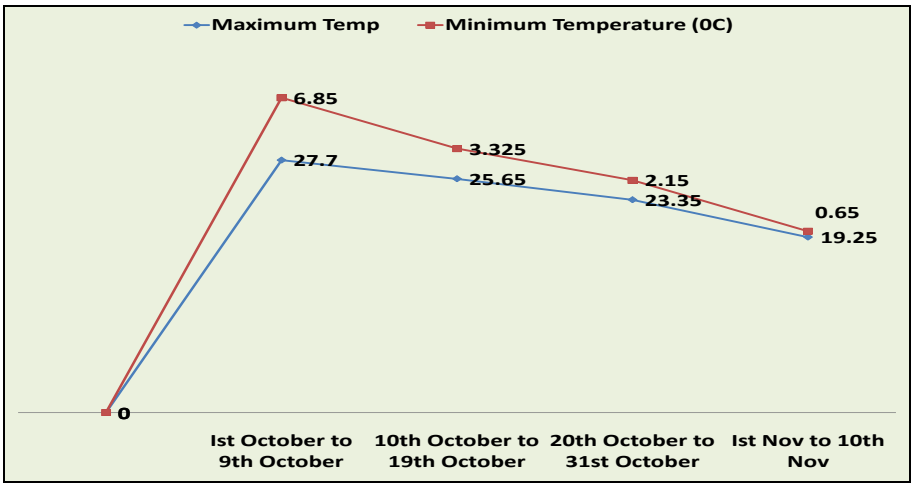


Figure.4 Stratified Random Sampling

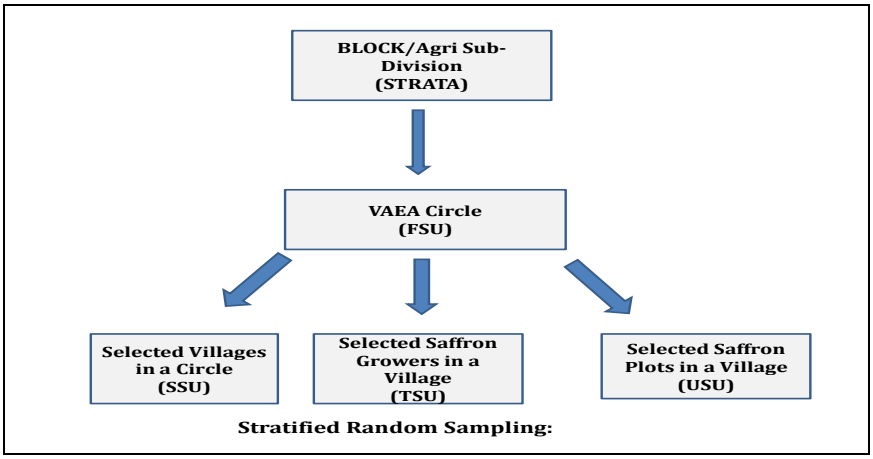


Figure.5 Site selection plan under CCEs in saffron

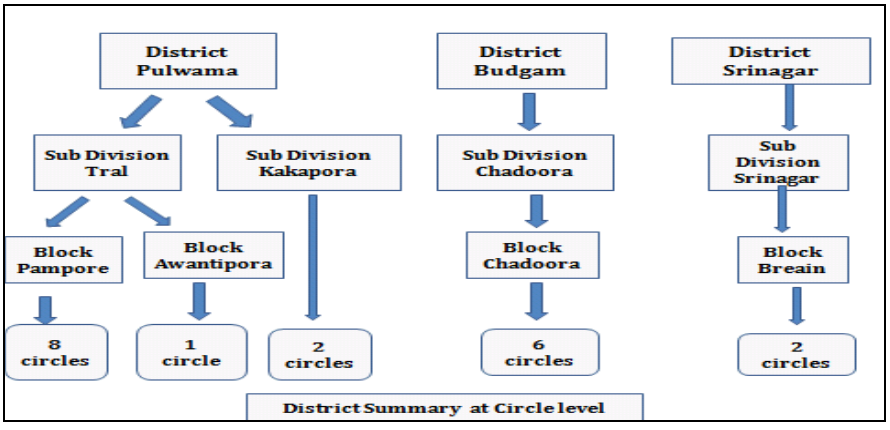
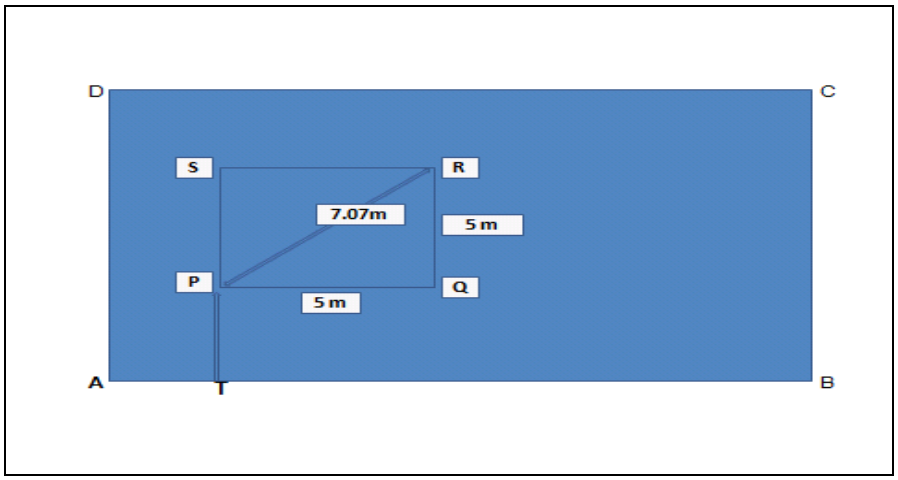


Figure.6 Procedure: for locating an experimental plot for crop cutting experiments (Square plot of Size 5x5m)



Deficit rainfall

Weather data averaged over two years recorded very high day temperature during October ranging from 23.3°C to 27.7°C and was accompanied with low night temperatures ranging from 3.3°C to 6.8°C (Figure 3).

High day temperatures by 3-7°C above normal was observed to be responsible for delaying the process of flowering followed by anthesis. However, Ist fortnight of November recorded normal day temperature (19.2°C) but was accompanied with very low night temperature (0.65°C) (Figure 3).

Deficit moisture availability once covered as trigger weather under crop insurance policy will cover the yield losses based on deviation to the maximum payout value of Rs 250,000. Water availability during sprouting stage ensures 40% yield gain over moisture stress cultivation due to activation of meristematic regions from apicular, axillary and lateral buds. Water deficit over a period of 87 days (15th August to 11th November) is categorized under two different strike rate, viz; strike 1 as < 229 mm and strike 2 as <120 mm. Out of total payout of Rs 250000 during pre and post sprouting stages maximum pay out of Rs 1, 30,000 is earmarked under phase- II(Shoot elongation and flower formation) followed by Rs 1,00000 in Phase I (Bud sprouting) and Rs 20,000 for phase III (Initial vegetative). Table 2. Insurance cover during this period will ensure financial safety against yield losses on account of rainfall deficit.

Excess rainfall

Similarly excess precipitation during Flower initiation and Blooming (15th October to 10th November), Vegetative Phase (Ist March to 31st March), Senescence (Ist April to 30th May) and Dormancy (Ist May to 31st May) leads to crop failure and is thus considered trigger weather. A total Payout of Rs 1, 75,000 is considered for a trigger weather covering excess rainfall to the extent of >175 mm as strike I and > 425 mm as strike II .Maximum payout of Rs 85,000 with a payout rate of Rs 425 /mm as Rate I and Rs 1488/mm as Rate II is considered during phase-1 (Flower initiation and Blooming) as excess rain during this period would lead to saffron flower loss. Whereas for other phases a uniform maximum payout of Rs 30000 is considered with Rs 240/mm as Rate I and Rs 480/mm as Rate-II for strike I and II excess rainfall (Table 2).

Decrease and Increase in Day Temperature (DDT)

On the basis of trigger weather for temperatures, uniform term sheets were framed based on "Adverse Weather Incidence" leading to crop loss, on account of Decrease and Increase in Day Temperature by $>5^0$c as strike I and $>10\ ^0$c as strike II from a bench value for decrease in temperature of 22^0c during sprouting stage and 18^0c during flower initiation stage and bench value for increase in temperature of 27 ^{0}c during Bud Sprouting (26th August to 9th September), 25 ^{0}c during Shoot Elongation (10th September to 30th September) and 20 ^{0}c during Flower initiation (Ist October to 10th November).For yield losses on account of decrease and increase in day temperature maximum pay out of Rs 1,50,0000 is considered for flower initiation (Ist October to 10th November) associated with a pay out of Rs 9000/^{0}c as Rate I and Rs 21000/^{0}c as Rate II. Payout during sprouting phases is uniformly considered at Rs 25000 /phase associated with a payout rate of Rs 1500/^{0}c as Rate I and Rs 3500/^{0}c as Rate II. Yield losses associate with decrease and increase in day temperatures during the trigger points is valued with a total payout of Rs 2, 00000 for each trigger weather (Table 2).

Payout

Payout arises only in case of Adverse Weather Incidence (AWI), Which is equivalent to the deviation between "Trigger Weather" and "Actual Weather" Data recorded at a "Reference Weather Station" during the specified time period. In case of AWI all the insured cultivators growing the Notified Crop in the Reference Unit Area are deemed to have suffered the same level of AWI and the same proportion of crop-loss, and become eligible for the same rate of Payouts.

Pradhan Mantri Fasal Bima Yojna (PMFBY)

Basic principles

Sampling design

The sampling design adopted in the crop cutting surveys of saffron is Multi-stage

Stratified Random Sampling

The traditional Agri. Sub-divisions cultivating the target crop have to be taken as strata, the selected V.A.E.A. circles, within the Block as first stage units (fsu), selected village in a circle as a second stage unit (ssu), selected cultivators in a village as a third stage units and the selected plots are the ultimate stage of sampling (Figure 4).

Size of experimental plot

The size and shape of the experimental plot for saffron crop is square of dimension (5m x 5m) (Table 3).

Time schedule for carrying out different activities for undertaking CCE and submission of CCE result

October and November months are considered critical periods of CCEs (Table 4).

Steps in different activities in crop cut evaluation

Selection of crop cut experimental sites at circle level

Evaluation study need to be carried over 19 saffron growing circles (11 circles in district Pulwama, 6 circles in district Budgam and 2 circles in District Srinagar) with random selection of 2 villages/Circle and 5 experimental sites in each circle village. Thus,

total number crop cut for saffron would be one hundred ninety (19x2x5 = 190) from 4 sub-divisions of saffron growing districts (Pulwama, Budgam, Srinagar) (Figure 5).

Procedure for village selection for taking CCEs of saffron

38 villages from 19 circles need to be selected randomly at circle level. From the exhaustive list of villages in a Circle, a sample of 2 villages would be selected with equal probability. It will be mandatory that the villages to be selected should have some area under the programme crop (Rejuvenated under National Saffron Mission). If however, some of the villages in the sample do not have any area under any of the programme crops, this will be replaced by other villages. For this purpose a list of suitable number of additional villages selected at random will have to be kept ready for use.

Procedure for Selection of saffron growers plot (experimental site) for taking crop cut

For conducting the CCEs, a complete list of the saffron growers for growing programme crops in each of the selected villages will be prepared. From this list required number of saffron grower's plot (5 in each village) would be selected randomly using random number table (Remainder approach).

Experimental materials required

Each member of the staff taking the crop cut is to be supplied with uniform equipment for his experimental work, which is known as Crop Cutting Experiment Kit. This Crop cutting Experiment Kit has to be keept ready in Circle/ Sector Office in a sufficient numbers. The CCE Kit consists of; i). One measuring tape, 30 m length .ii) Sufficient long string / rope, minimum 30 m length, iii) Weighing electronic balance, IV) Electric/Vacuum dryers, v) Moisture analyzer, vi) Pegs/Straight bamboo poles (4 nos.), vii) Random number table, viii) Willow Baskets and ix) Note Book.

Locating an Experimental Plot for Crop Cutting Experiments (Square plot of Size 5x5m)

Procedure

In each selected field one Square size (5 m x 5 m) plot is to be located at random. This is not to be done earlier than the date fixed for harvesting. Before a plot is located, make sure that the field is already selected (Figure 6). The procedure for locating a random plot is as indicated below for a Square plot of size (5 m x 5 m)

Let the four corners of the field in which crop cutting experiment plot is to be located be named as ABCD.

Let the point "A" represents the south-west corner of the field. For locating south-west corner of the field, the Official taking the crop-cut should stand at this point facing the field and keeping the cut area to his right.

The point A, the South -West corner of the field ABCD will be the starting point. For convenience, fix a bamboo pole at the starting point.

From the starting point measure the length and breadth of the field by footsteps.

Deduct 7 footsteps from both length and breadth

Suppose the length and breadth of the fields as shown in Figure below is 40 footsteps and 28 footsteps respectively. Then the length and breadth after deducting 7 footsteps, then length and breadth will be 33 and 21.

Now select a pair of random numbers one for length and the other for the breadth from the random number table. In the above example, the random number for both length and

breadth should be of two digits. Suppose Pair of random numbers for the fields for length is 14 and for breadth is 12.

To get the experimental plot, now start walk 14 steps from the starting point "A" along the length of the field. Call this point as "T". Having arrived at this point "T", enter into the field along a direction at right angle to the length of the field to a distance of 12 footsteps corresponding to the random number selected for the breadth. Call this point as "P".

This point "P" will be the south-west corner of the desired plot "PQRS" to be harvested. Place peg at "P"

From "P" proceed in a direction parallel to AB. With the help of tape measure a distance PQ which is exactly up to 5 meters.

Place another peg at Q. Keep the zero point of the tape at "Q", open a total length of 12.07 meters of the tape and keep the point of the tape showing the length 12.07 meters at "P".

Now keeping the two point's viz. 0 and 12.07 meters on Q and P respectively, stretch the tape and fix the point "R" such that "PR" is of length 7.07 meters and QR is equal to 5 meters. It will be seen that the angle PQR is a right angle.

Place peg at point "R" which is the third corner of the plot to be located.

For obtaining the fourth point keep the two points in the tape marked 0 and 12.07 meters respectively at P and Q respectively and similar process to be adopted as stated in above paragraph to get the fourth point "S".
Place the fourth peg at "S". The pegs PQRS indicate the four corners of the plot to be harvested.

It should be noted that the plot PQRS should be laid out in such a way that the point P is the south -west corner of the plot to be harvested and will be the point nearest to the South – West corner of the whole field.

Flower picking and other operations

Ensure flower picking of all the 2 days old opened saffron flowers falling inside the cut area demarcated by the string on the first picking day and take the fresh weight of the produce. The weight of the produce should be recorded in notebook in Prescribed CCE Format.

Ensure pistil separation within 5 hours of flower picking take the fresh weight of the produce. The weight of the produce should be recorded in notebook in Prescribed CCE Format.

Dry saffron pistils in electric/Vacuum dryers at 60^0c up to a safe moisture level of 10-12 % as per ISO 3632 quality standards.

Repeat same procedure for each subsequent flower picking from the demarcated area and take the total dry weight of saffron and the moisture percentage.

Crop cutting experiment shall be conducted in presence of the officers as desired by the authority

Dry weight and CCEs experimental results to be communicated with in 3 weeks from the date of last picking (Table 5 and 6).

Saffron Insurance policy will ensure financial stability to saffron growers in the J and K state who are despondent about future of saffron due to weather instability. Saffron insurance once implemented shall save saffron growers from annual exchequer loss of about Rs 200 crores as observed in the year 2017.

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