Contingency planning and Crop management interventions for cyclone risk mitigation

Dr. P.S. Brahmanand, Senior Scientist, Dr. S. Roy Chowdhury, Principal Scientist and Dr. K.G. Mandal, Senior Scientist

Directorate of Water Management (ICAR), Bhubaneswar – 751023, Odisha

Introduction

Agriculture sector is the backbone of India as it feeds ever growing population and provides employment to about 58% of the population. Several new advanced techniques have been developed to enhance the crop productivity further. However, it is mainly dependent on monsoon and hence faces severe challenge in the form of natural disasters. This trend is clearly visible if we look in to agricultural production in good and bad monsoon years. The natural disasters like floods, drought and cyclone are primarily responsible for crop loss and low crop productivity resulting in poor socio-economic condition of the farmers. Cyclone is one of the natural disasters which occurs very frequently in India (on an average of six per year) and causes severe crop damage. The frequency of severe cyclonic storms is more in months of October, November and May whereas depressions are more common during south west monsoon period (Fig 1). Its frequency in Eastern Coast of India (Bay of Bengal) is about four times higher than that of western coast (Arabian sea). The higher intensity of cyclones occurred in the last four decades is a major worry for agriculture sector (Table 1).

Fig 1: Trend of cyclonic storms in different months in a year
Table 1. The list of very intense Cyclones in the Bay of Bengal since 1970

<table>
<thead>
<tr>
<th>Place of landfall</th>
<th>Date of landfall</th>
<th>Maximum sustained winds (kmph) - estimated on the basis of satellite imageries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chittagong</td>
<td>13 November, 1970</td>
<td>224</td>
</tr>
<tr>
<td>Chirala, Andhra Pradesh</td>
<td>19 November, 1977</td>
<td>260</td>
</tr>
<tr>
<td>Rameshwaram</td>
<td>24 November 1978</td>
<td>204</td>
</tr>
<tr>
<td>Sriharikota</td>
<td>14 November, 1984</td>
<td>213</td>
</tr>
<tr>
<td>Bangla Desh</td>
<td>30 November, 1988</td>
<td>213</td>
</tr>
<tr>
<td>Kavali, Andhra Pradesh</td>
<td>9 November, 1989</td>
<td>235</td>
</tr>
<tr>
<td>Machlipatnam, AP</td>
<td>9 May, 1990</td>
<td>235</td>
</tr>
<tr>
<td>Chittagong</td>
<td>29 April, 1991</td>
<td>235</td>
</tr>
<tr>
<td>Teknaf (Myanmar)</td>
<td>2 May, 1994</td>
<td>204</td>
</tr>
<tr>
<td>Teknaf</td>
<td>19 May, 1997</td>
<td>235</td>
</tr>
<tr>
<td>Paradip, Orissa</td>
<td>29 October, 1999</td>
<td>260</td>
</tr>
<tr>
<td>89.8°E, Bangladesh</td>
<td>15 November, 2007</td>
<td>220</td>
</tr>
<tr>
<td>16.0°N, Myanmar</td>
<td>02 May, 2008</td>
<td>200</td>
</tr>
</tbody>
</table>
Steps of Cyclone management

The steps for cyclone disaster management includes prevention, mitigation, preparedness, response and rehabilitation (Fig 2). Out of these, preventive measures are important which stress the need for contingency crop planning. Similarly, when the cyclone and its associative flood are already experienced, we need to chalk out the crop management interventions for post cyclone/flood situation.

Fig 2 : Different steps of cyclone disaster management

Concept of Contingency crop plan

The changing climate is a major concern for agricultural productivity in general and food security in particular (Brahmanand et al., 2013). This has also resulted in higher frequency of natural disasters like cyclones. Hence, we must be well prepared for sustaining agricultural productivity and this necessitates the concept of contingency crop planning.

Contingency plan can be defined as a plan aimed and executed for an outcome other than in the usual or expected plan. In other words, it is frequently used for risk management when an exceptional risk in future. In general, the change in sowing or planting time of crops, change in seed rate, change in schedule of fertilizer use, use of short duration varieties, improved crop genotypes form the core component of contingency crop planning. In case of cyclone and its associative flood events, we may recommend use of waterlogging tolerant rice varieties such as
Varshadhan, Hanseswari, Durga for better resilience. However, in case of flash floods, the use of swarna sub-1 should form the core component of contingency plan. Similarly, the use of over aged rice seedlings of 45 days and 60 days old are recommended for cyclone and flood prone areas. The development of community nursery and seed bank is critical in supply of seedlings of rice in case of cyclone damage. Atleast seed bank should be developed for 10% of the area under each block which can be utilized for transplanting in post cyclone period.

**Crop management interventions for post cyclone / flood situation: Case study**

In considerable area in Eastern India, water starts accumulating in the field with onset of monsoon season and water depth rises up to 60 cm or more and continues till maturity of the crop (Jahn et al., 2001 and Biswas et al., 1986). This situation becomes more vulnerable when cyclone and its associated flood occurs. All the engineering and cropping interventions fail in addressing the farming problems during the cyclone/flood season. However, when the flood water recedes gradually, there is an ample scope to implement alternate crop strategies if proper planning is done. Hence, the post cyclone/flood management assumes prime importance for enhancing the crop productivity in India. Eastern India is frequently subjected to cyclone and floods and hence the successful post flood management through contingency crop planning would be of paramount importance in enhancing the crop productivity and thereby ensuring the food security of our nation. Odisha is one of the most important states in Eastern India which is endowed with plenty of natural resources. However, its crop productivity has been found to be quite poor due to waterlogging and cyclone / flood problem. Kendrapada district in Odisha is most susceptible to cyclone associated flood as well as floods due to water inundation from Mahanadi and Paika rivers.

Rice is the major food grain crop grown in Kendrapada district during kharif season and its productivity is very poor due to flood occurrence. The cultivation of flood tolerant long duration rice varieties would certainly boost the crop productivity. However, when flash floods occur, the survival of rice crop becomes difficult leaving the farming community in negative economic situation. After the harvest of rice crop, generally greengram is grown which is harvested in the month of January-February. After the harvest of greengram, the residual moisture left in the soil can be utilized by growing alternate crops that require less amount of water.

Sunflower is an important oilseed crop that is grown under sub tropical climate in wide range of soils. It doesn’t require higher amount of irrigation for its survival and completion of active life cycle. Its water requirement accounts to approximately 500 – 600mm because of which it can be fitted in rice based cropping system in Odisha. The growing demand for the oilseeds in the recent years has brought tremendous scope for the higher profit generation by cultivating sunflower. Sweet potato is an important tuber crop that can be grown well under light texture soils and hence Odisha provides congenial platform for its commercial cultivation. It also requires lesser
amount of moisture for its completion of active life cycle and for production of economic yield i.e. tubers. Its water requirement is approximately 400-500 mm and hence can be adjusted well under rice based cropping systems in Orissa. Sweet potato can also be grown in marginal lands where people are suffering from malnutrition.

Okra is an important vegetable crop that is suitable for cultivation in summer season. It doesn’t require much water and its water requirement is about 600 mm and can also be fitted well under rice-pulse-vegetable cropping system in Odisha. Similarly, bittergourd is a cucurbit crop that can be grown in summer season with less water requirement and its potential for getting adjusted under rice based cropping system is enormous.

All these above mentioned crops have to be tested for their resistance to water shortage under post cyclone/flood situation. At the same time provision of conservation agriculture practices might be helpful in successful establishment of crops. The moisture conservation practices like mulching and zero tillage would be instrumental in saving considerable amount of moisture under such situation.

A field experiment was conducted in the farmer’s field at Raisar village, kendrapada district, Odisha during post rainy season in 2010 to study and evaluate the impact of zero tillage on crop growth performance, yield attributes and yield of sunflower, sweet potato, okra and bittergourd in post flood situation and to critically analyze the suitable crops under post flood situation along with their associating factors. The experiment was laid out in split plot design with type of tillage as main plot treatments i.e. M1: Conventional tillage and M2: Zero tillage and type of crop as sub plot treatments i.e. C1: Sunflower, C2: Okra, C3: Bittergourd and C4: Sweet potato with three replications. The results revealed that zero tillage influenced the growth parameters and fruit yield of okra, bitter gourd and sunflower positively compared to that of conventional tillage.

**Effect on yield attributes**

The zero tillage resulted in superior yield attributes of sunflower, bittergourd and okra compared to conventional tillage. In case of sunflower, the head diameter was found to be highest with zero tillage (15.7 cm) compared to conventional tillage (14.8 cm) (Fig 3). The number of seeds per head of sunflower were also found to be highest with zero tillage (236.2) compared to that of conventional tillage (224.5) (Fig 4). In case of okra, the number of fruits were found to be higher with zero tillage (13.2) relative to conventional tillage (11.4) (Fig 5). Similarly, the number of fruits of buttergourd were found to be superior with zero tillage (7.3) compared to conventional tillage (6.8) (Fig 6). However, in case of sweet potato, the reverse trend was observed. The number of tubers per plant in sweet potato were found to be higher with conventional tillage (3.6) compared to that of zero tillage (3.1) (Fig 7).
Fig 3: Effect of tillage on head diameter (cm) of sunflower

Fig 4: Effect of type of tillage on number of seeds per head in sunflower

Fig 5: Effect of type of tillage on number of fruits per plant in Okra
**Effect on Productivity**

Conventional tillage resulted in lower crop yield compared to zero tillage in sunflower, okra and bitter gourd. Sunflower resulted in seed yield of 0.91 t/ha under zero tillage compared to 0.82 t/ha under conventional tillage (Table 2). This might be attributed to superior number of seeds per head and larger head diameter under zero tillage. However, the superiority noticed was statistically non-significant.
Okra resulted in superior fruit yield of 3.73 t/ha under zero tillage compared to 3.26 t/ha under conventional tillage. Bitter gourd resulted in fruit yield of 4.30 t/ha under zero tillage compared to 4.06 t/ha in conventional tillage. This is due to higher number of fruits per plant and fruit weight under zero tillage. However, the superiority noticed was statistically non-significant. Zero tillage resulted in lower tuber yield in sweet potato (5.90 t/ha) compared to conventional tillage (6.63 t/ha). Though the crop establishment was good under zero tillage, the tuber penetration and tuber development was facilitated by better aeration under conventional tillage in case of sweet potato.

Table 2: Productivity of sunflower, okra, bitter gourd and sweet potato (t/ha) as affected by type of tillage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sunflower (Seed yield)</th>
<th>Okra (Fruit yield)</th>
<th>Bitter gourd (Fruit yield)</th>
<th>Sweet potato (Tuber yield)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional tillage</td>
<td>0.82</td>
<td>3.26</td>
<td>4.06</td>
<td>6.63</td>
<td>3.69</td>
</tr>
<tr>
<td>Zero tillage</td>
<td>0.91</td>
<td>3.73</td>
<td>4.30</td>
<td>5.90</td>
<td>3.71</td>
</tr>
<tr>
<td>Mean</td>
<td>0.86</td>
<td>3.50</td>
<td>4.18</td>
<td>6.26</td>
<td></td>
</tr>
<tr>
<td>CD (Main)</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD (Sub)</td>
<td>0.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD (MxS)</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Case study on impact of phailin

A case study was conducted to assess the impact of phailin on crop situation in Jajpur and Balasore districts of Odisha and farmers were suggested to take up better crop management practices in post cyclone phase. Some farmers responded quickly and implemented the interventions successfully thereby reducing the negative impact on agriculture which is reflected in values of cultivated land utilization index (CLUI).

Impact of crop management interventions on CLUI

The cultivated land utilization index (CLUI) is estimated by summing the products of land area to individual crop component, multiplied by the actual duration of that crop divided by the total cultivated land times 365 days (Chuang, 1973)
\[ \sum_{i=1}^{n} a_i d_i \]

CLUI = \[ \frac{\sum_{i=1}^{n} a_i d_i}{A \times 365} \times 100 \]

Where, \( i = 1, 2, 3 \ldots n \),

\( n = \) total number of crops.

\( a_i = \) area occupied by the \( i \)th crop,

\( d_i = \) days that the \( i \)th crop occupied and

\( A = \) total cultivated land area available for 365 days.

In case of Jajpur district, the CLUI in normal years in the command area studied was found to be 56.5% which has come down to 42.3% in phailin affected year i.e. 2013-14 (Fig 8). However, the CLUI was found to be quite satisfactory (53.9%) even in phailin affected year where the progressive farmers have adopted the advanced crop management interventions. The area under kharif rice was same, however, the jump in area under other crops like groundnut, mustard, vegetables and yam resulted in satisfactory CLUI in progressive village. This is very important finding for formulating the cyclone mitigation and adaptation strategies in the back drop of climate change in future.

![Fig 8: Impact of crop management interventions on cultivated land utilization index (CLUI) due to Phailin in Jajpur district, Odisha.](image-url)
In case of Balasore district, the CLUI in normal years in the command area studied was found to be 54.1% which has come down to 43.2% in Phailin affected year i.e. 2013-14 (Fig 9). However, the negative impact on CLUI was found to be reduced (46.9%) even in Phailin affected year where the progressive farmers have adopted the advanced crop management interventions including crop diversification. The area under kharif rice, banana and other vegetables was found to be same, however, the increase in area under crops like groundnut, mustard, chilli, radish, brinjal, cabbage and other vegetables resulted in satisfactory CLUI in progressive village. There is ample scope to improve CLUI from the present level in this village as plenty of ground water is available. Hence, ground water exploitation in cyclone affected areas would provide a better adaptation strategy in the back drop of climate change in future.

In post cyclone affected period, the intercropping of Groundnut + Mustard would be best practice in terms of utilization of available soil moisture and crop yield and economics. The advancement of sowing time by 10 days from 3rd week of November to 1st week of November in green gram is recommended to enhance the pod yield up to 16% under post Phailin cultivation scenario.

Fig 9: Impact of crop management interventions on cultivated land utilization index (CLUI) due to Phailin in Balasore district, Odisha.

Conclusion

Contingency crop planning would certainly result in reducing the crop loss and productivity in the event of cyclone / flood and it forms the core component of prevention strategy. However, in case of post cyclonic phase, advanced crop management interventions and moisture conservation techniques should form the main component and they should be adopted by the farmers on large scale to sustain the cultivated land utilization index.
References


***