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# Assessment of Improved Varieties under Different Climate Vulnerabilities

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**ABSTRACT:** A study was conducted for response of varieties to climate vulnerabilities like floods and droughts in selected villages of 13 districts in Andhra Pradesh and Maharashtra. The demonstrations on improved cultivars along with the respective local checks were compared with the participating farmers. The results showed that improved varieties of paddy (PLA-1100), Indra (MTU-1061) and RGL-2537 in Srikakulam while MTU-1121 and MTU-7029 in West Godavari districts were found tolerant to floods and submerged lands in Andhra Pradesh and registered 25-60% higher yield over respective local checks. The improved varieties of groundnut (K-9), pigeonpea (LRG-41) and castor (PCH-111) in Anantapur, chickpea (Digvijay), pigeonpea (PRG-158), blackgram (LBG-645), greengram (MGG-295) and tomato (Nirupam) in Nalgonda while pigeonpea (MRG-1004) in Khammam were found stable in rainfed environment. In Maharashtra, improved varieties of chickpea (Digvijay) in Ahmednagar, Aurangabad and Nandurbar districts and JAKI-9218 in Amaravati and Gondia districts gave 25-35% higher yield and net returns compared to respective local checks. Improved varieties of soybean (JS-9305) in Pune and Amaravati, JayBt-3028 (cotton), CSH-14 (sorghum) in Amravati, NIAW-34 (wheat) in Ahmednagar, SPV-1411 (*rabi* sorghum) in Aurangabad gave higher productivity and profitability under rainfed conditions.

**Key words:** Assessment, improved varieties, floods, drought, dry spell, profitability

Climate change impacts on agriculture are being witnessed all over the world and weather extremes such as floods, droughts, unseasonal rains, hail storms, heat and cold waves are the major manifestations. The agricultural production in India is highly sensitive to vagaries of weather, particularly with variability of rainfall. Eighty per cent of rainfall in India occurs only during three months (June to Sept) from S-W monsoon. Droughts and floods are recurring problems in some or other parts of the country.

Risk is an integral part of the agriculture and in each season farmers are encountering production risks such as weather, pest and diseases and technology, etc. Hence, climate risk management in agriculture is essential to mitigate weather effects on crop productivity. These include selection of crops/ varieties, cropping systems, crop diversification, farming systems approach and other management practices.

Several agricultural practices evolved over the time from the formal research systems or with long term experiences of farmer have potential to enhance the climate change adaptation, if deployed prudently. Management practices that increase agricultural production under adverse conditions also tend to cope with climate change. These practices increase resilience and reduce the yield variability under variable climate and extreme events. Capacity building by extensive participatory demonstration of location specific agriculture practices helps the farmers in gaining access to knowledge and provides confidence to cope with adverse climatic conditions. Among the factors of production, improved cultivars play an important role in enhancing the productivity in rainfed environment.

Keeping climatic variability in view, demonstrations of location specific best practices on climate resilient technologies were organized in 13 districts of Andhra Pradesh and Maharashtra as a part of National Initiative on Climate Resilient Agriculture (NICRA) initiated by Indian Council of agricultural Research (ICAR) in 2011.

## Materials and Methods

Thirteen demonstration sites covering six districts, *viz.,* Anantapur, Kurnool, Khammam, Nalgonda, Srikakulam and West Godavari from Andhra Pradesh and seven from Maharashtra including Ahmednagar, Amaravati, Aurangabad, Pune, Gondia, Nandurbar and Ratnagiri were selected for the purpose of study by multidisciplinary team of Krishi Vigyan Kendras (KVK's) in each district (Table 1). The steps followed in the selection of sites were: analysis of climatic constraints of village based on long term data, assessment of natural resources, identification of major farming situations, constraints of crop production, climatic vulnerabilities, yield gaps and opportunities for climatic change adaptations. Based on the detailed analysis, action plan to demonstrate appropriate cultivars to meet varied climate vulnerabilities was prepared in participatory mode with the help of researchers. The programme was implemented by Programme Coordinators of respective KVKs in each district during 2011-12 and 2012-13. The farmers in each selected village of the district were stratified based on size into: marginal (<1ha), small (1-2 ha), medium (2-4 ha) and large farmers (>4 ha). The farmers for this study were selected based on stratified random sampling representing 10% of population in each category. The training on production skills of different crops were imparted to the participants before conducting demonstrations.

The demonstrations on improved cultivars along with local checks were conducted in participatory mode in each village of all selected districts of Andhra Pradesh and Maharashtra. At the time of harvest, the yields of improved cultivars and local checks were recorded through crop cutting surveys. The input and output relationships were also worked out to quantify the economic benefit of improved varieties for 2011-12 and 2012-13.

## Results and Discussion

### Rainfall pattern during 2011

The rainfall received in the selected village in Nalgonda district was750 mm as against 850 mm of normal rainfall in 2011. The rainfall distribution was erratic and there was no rain after 2nd week of September, 2011. Matsyapuri is flood prone village in West Godavari district, most of the paddy growing fields were submerged (both nurseries and transplanted fields) due to heavy rains particularly in low lying areas.

The Nirmal Pimpri village in Ahmednagar district received 278 mm as against 450 mm of normal rainfall in 2011 resulting in both early as well as terminal drought. Delayed monsoon and terminal drought affected both *kharif* and *rabi* crops production in Takali B.K. of Amaravati district. Shekta Gangapur village in Aurangabad district received 531mm of rainfall as against 644 mm of annual rainfall. The onset of monsoon was delayed by one month in Umarani village of Nandurbar district and received rainfall on 6th July before sowing of crops and another event of intense rainfall (86 mm) on 19th July at seedling stage of crop during 2011. The Jalgoan village of Pune district received an 418 mm rainfall as against normal of 530 mm indicating a deficit of 23%. The onset of monsoon was early with a rainfall of 74 mm in first week of June but later no rains were received till 5th of July. Therefore, sowing of *kharif* crops was delayed. Further, most of the crops were affected due to five dry spells, leading to moisture stress during critical crop growth periods.

### Rainfall pattern during 2012

The total amount of rainfall was excess in selected villages of Khammam (109%) and Nalgonda (38.9%) in Andhra Pradesh, Amaravati (27.8%) and Gondia districts (24.6%) in Maharashtra compared to the normal rainfall of corresponding experimental sites in 2012. The total rainfall was deficient in selected villages of Anantapur (220%), Srikakulam (131%) and Kurnool (226%) in Andhra Pradesh and Ahemadnagar (26.4%), Nandurbar (26.7%), Pune (30.8%) and Aurangabad (65%) compared to their respective normal rainfall years. Groundnut experienced dry spell of 36 days duration at pegging and also severe moisture stress at flowering and pod filling in selected village of Anantapur district. At experimental site of Kurnool district, the rainfall was erratic and yields of cotton, groundnut, sorghum and chickpea were drastically reduced. Non-receipt of rains in November and December in village of Nalgonda district resulted in severe yield reduction of pigeonpea and cotton. There was a continuous rainfall (300 mm) from 7th to 31st July and during first fortnight of August and 4th week of August to 1st week of September in selected village of West Godavari district.

At Ahmednagar, soybean and pearl millet crops experienced severe moisture stress with dry spell of 26 days in the months of August and also from 4th to 30th in October (26 days duration). A dry spell of 37 days duration was experienced during flowering period of pigeonpea in Katangola village of Gondia district. The rainfall in village of Jalgaon was erratic and caused severe yield reduction in cotton and soybean. The rainfall distribution was favourable for many crops grown in Takali BK in Amravati district.

## Tolerance to floods and excess moisture

### Andhra Pradesh

Floods and cyclonic storms are major climatic constraints in Srikakulam and West Godavari districts of Andhra Pradesh. Paddy is the major crop grown in these districts. Most of rice growing areas in these districts experience heavy rains during August to September. The selected village Sirsuwada in Srikakulam experienced submergence during tillering to panicle initiation and also during grain filling stages in 2012. Farmers cultivate varieties like BPT-5204, Swarna, MTU-1001 which are susceptible to submergence. The results indicated that the improved varieties PLA-1100, RGL-2537 (Srikakulam Sannalu) and MTU-1061 were found tolerant to submergence. The improved variety PLA-1100 is fine grain variety with 160 days duration and found suitable for low lying areas but it is prone to sprouting of grains, if rains coincide with harvesting. While RGL-2537 tolerates short period of inundation (4-5 days). MTU-1061, a fine grain variety can tolerate inundation up to 10 days during later stage of crop growth but not during early growth period. MTU-1061 (Indra) was found to have higher tolerance to submergence than local traditional Swarna variety. Heavy lodging of Swarna variety was noticed due to heavy rains from August to September while MTU-1061 escaped. The variety MTU-1061 gave an additional grain yield of 540 kg/ha and net income of ₹ 6750/ha than local Swarna. Varietal demonstrations for submergence of paddy in Matsyapuri village of West Godavari district revealed that the MTU-1121 gave 949 kg/ha higher grain yield than local MTU-1010 (5935 kg/ha) during *rabi* season. The improved variety MTU-1121 was found to be tolerant to lodging and grain shattering (Tables 2 & 4).

Swarna Sub-1 and Gayatri produced about 33.8% and 35.2% higher yield over farmer's variety Swarna in intermediate and semi-deep low lands whereas Varshadhan produced 24% higher yield over farmer's variety Patri Jaganath in deep low lands. The Swarna Sub-1 showed tolerance to submergence for more than ten days and also to multiple periods of submergence in UP, Orissa and Andhra Pradesh (Annual report IRRI, 2013 and CRRI 2012).

## Tolerance to drought

### Yields of crops and varieties

Drought is a common phenomenon in rainfed agriculture. The productivity of crops in rainfed environment depends upon intensity, duration and growth stage of crop which experiences drought. Hence demonstrations on productivity of different crop varieties along with traditional cultivars were conducted in 132 ha involving 355 farmers during 2011-13. The results indicated that improved variety of groundnut K-9 in Chakrayapeta village (Anantapur) recorded significantly higher pod yield of 203 and 207 kg/ha compared to the traditional varieties in 2011 and 2012 respectively. The increased pod yield of K-9 variety of groundnut is attributed to the efficient use of soil moisture after relief of dry spell with prolific root system, good pegging strength and high translocation efficiency during pod formation stage which might have resulted in better development of mature pods (Arunachalam and Kannan, 2013).

Improved varieties of pigeonpea (LRG-41) and castor (PCH-111) recorded significantly additional yields by 29 and 41.2% than their respective locals which gave on an average yields of 671 and 636 kg/ha over two years, respectively. Improved varieties of chickpea Digvijay and JAKI-9218 on an average gave increased seed yields of 330 and 185 kg/ha respectively over respective locals over two years in Yagantipalle village of Kurnool dist. Extensive physiological studies have indicated that the improved varieties of chickpea ICC-498 increased the seed yields due to efficient soil water use by well developed root system under residual moisture condition. High yielding variety of pigeonpea PRG-158 registered significantly higher seed yield of 31.9 and 23.2% compared to the local checks during 2011-12 and 2012-13, respectively. In Sirsuwada village of Srikakulam district improved variety of black gram (LBG-752) performed superior and recorded significantly higher seed yield by 73% than local (465 kg/ha) over two years of demonstration. Improved varieties of *kharif* black gram recorded 15.4% higher mean yield and 14.6% higher net returns over local varieties (Annual report-IPRI, 2013). Similar yield advantage was noticed with respect to improved variety of green gram (TM-962). Improved varieties of *kharif* green gram recorded 13.6% higher mean yield and 12.5% higher net returns over local varieties at Khammam (Annual Report IPRI, 2013). Improved varieties of green gram (MGG-347), pigeonpea (MRG-1004) and tomato (Nirupam) showed significantly higher yield gains of 295, 672.5 and 5250 kg/ha over their respective local checks during 2011 and 2012. In Matsyapuri village of West Godavari district, improved paddy variety RP-bio 226 recorded 12 and 11% higher yield than local checks (4921 and 5100 kg/ha) in 2011-12 and 2012-13 respectively (Tables 2&5).

**Maharashtra**

The results of demonstrations on yields of improved varieties in different experimental sites were documented in Maharashtra. The results indicated that improved variety of chickpea Digvijay in Ahmednagar gave significant increase in yields of 400 and 330 kg/ha compared to the local variety during 2011 and 2012, respectively. On an average, improved cultivar Digvijay gave higher seed yield by 36% compared to the local (1010 kg/ha). Similarly, improved wheat variety NIAW-34 showed higher yield potential by 16.4 and 44.2% than local variety in 2011 and 2012, respectively. The assessment studies on drought tolerance in wheat cultivars revealed that the variety Raj-4125 was found to be drought tolerant due to higher germination percentage, highest relative water content and higher accumulation of solutes (Dutta *et al.,* 2011).

At experimental site of Amravati district, JAKI-9218 of chickpea produced significantly higher seed yields by 400 and 355 kg/ha over local in 2011 and 2012, respectively. Improved cultivar Jay BT-3028 registered an additional yield of 580 and 375 kg/ha than traditional cultivar in 2011 and 2012, respectively. Hybrid CSH-14 of sorghum produced significantly higher grain yield by 56.5% over local (2115 kg/ha) over two years. Similar increment in seed yield was observed with JS-9305 variety of soybean than local in both years.

At Aurangabad, improved variety of chickpea (Digvijay), pigeonpea (BDN-711) and *rabi* sorghum (SPV-1411) gave significantly higher seed yields of 250, 150 and 315 kg/ha over corresponding locals in 2011, respectively. In 2012, improved varieties of these crops proved their superiority with additional seed yields by 11, 37.5 and 39% than their respective locals.

Improved variety JAKI-9218 of chickpea in selected village of Gondia district produced significantly higher seed yield with an additional seed yields of 1100 and 245 kg/ha as compared to the local variety in 2011(2800 kg/ha) and 2012 (1225 kg/ha). In Nandurbar district, improved variety Digvijay of chickpea registered significantly higher seed yield by an average of 290 kg/ha than local in 2011 and 2012 (1088 kg/ha). High yielding variety JS-9305 of soybean in experimental village of Pune district showed higher yield of 330 and 120 kg/ha over locals which gave seed yields of 820 kg/ha in 2011 and 830 kg/ha in 2012 (Tables 3 & 6).

## Economics of improved cultivars

**Andhra Pradesh**

At Anantapur, improved variety LRG-41 of pigeonpea gave higher net returns (₹ 2250) and B:C ratio (3.22) compared to local which gave net returns of ₹ 18850/ha and B:C ratio of 2.84 during 2011-12. Similarly, LRG-41 registered the net income of ₹ 29224/ha as against ₹ 11582/ha in local genotype in 2012-13. In Anantapur, castor hybrid (PCH-111) showed higher tolerance to drought and recorded increased net income by 246 and 300% compared to the local variety (₹ 6400 and ₹ 4845/ha) during 2011-12 and 2012-13, respectively. In Yagantipalle village of Kurnool district, the improved varieties Digvijay and JAKI-9218 recorded higher net income of ₹ 2050/ha and ₹ 5900/ha compared to the respective locals (₹ 14250/ha) in 2011-12, respectively. Similar economic advantages were recorded in 2012-13 on economics of Digvijay and JAKI-9218. Thus, JAKI-9218 showed higher performance in both years. High yielding variety PRG-158 of pigeonpea gave enhanced net income by 40.4 and 87% compared to the local genotype, respectively in 2011-12 and 2012-13. Higher B: C ratios were recorded with PRG-158 variety of pigeonpea in 2011-12 than 2012-13. The increase in seed yield, net income and B: C ratio of improved varieties JAKI-9218 and Digvijay might be due to higher yield components and efficient use of residual moisture (AICRPDA, 2013).

In Sirusuwada village of Srikakulam district, improved varieties of black gram and green gram showed higher tolerance to drought and recorded higher net income of ₹ 20800/ha and ₹ 17200/ha than respective locals which gave the net income ₹ 27000/ha (black gram) and ₹ 15500/ha (green gram) in 2011-12. Similar economic gains were observed with improved cultivars of black gram and green gram in 2012-13. Among the various varieties evaluated, improved variety Uttara recorded higher gross returns and B:C ratio compared to other varieties including local due to higher number of pods, pod weight and higher harvest index (AICRPDA, 2013).

**Table 1 : The details of major climatic vulnerability in selected villages**

| State | Selected district | Name of selected village | Major climatic variability | Mean annual rainfall (mm) | Soil type |
|---|---|---|---|---|---|
| Andhra Pradesh | West Godavari | VeeraVarsam, Matsyapuri | Cyclone/floods | 1185 | Alluvial |
| | Srikakulam | Srisuwada, Annampeta, Thimadam and Adduripeta | Floods | 1162 | Red sandy, red sandy loam with clay base |
| | Anantapur | Chamaluru, Chakrayapeta | Drought | 522 | Red soils (25%), Black soils (75%) |
| | Nalgonda | Nandyalagudem and Boring Thanda, Atmakur (S) | Drought, Sodicity | 750 | Sandy loams, loamy sand, light black to medium black soils |
| | Kurnool | Yagantipalli | Drought | 567 | Sandy clay loam to clay loam |
| | Khamam | Nacharam | Drought, Heat stress | 1039 | Black cotton soil and red soils |
| Maharashtra | Nandurbar | Umarani | Heat stress, Drought | 813 | Red and black soils |
| | Pune | Jalgoan KP Jalgaon KadePathar | Drought | 530 | Black soils |
| | Aurangabad | Shekta | Drought | 644 | Shallow to light |
| | Amaravathi (Durgapur) | Takali B.K. | Drought, Floods | 650 | Medium black cotton soil |
| | Ratnagiri | KP Haral | Floods | 3594 | Red lateritic soils |
| | Ahemednagar | Nirmalpimpri | Drought | 450 | Sandy loam |
| | Gondia | Katangtola and Chandinitola | Drought | 1400 | Sandy, loamy sandy and sandy loam |

**Table 2 : Area and number of farmers covered under different varieties in Andhra Pradesh**

| District where project center located | Crop | Variety | Number of farmers and area | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2011-12 | | 2012-13 | | TOTAL | |
| | | | No. of farmers | Area (ha) | No. of farmers | Area (ha) | No. of farmers | Area (ha) |
| Anantapur | Castor | PCH-111 | 15 | 6.0 | 5 | 2.0 | 20 | 8.0 |
| Anantapur | Groundnut | K-6, K-9 | 5 | 8.0 | 3 | 1.5 | 8 | 9.5 |
| Anantapur | Pigeonpea | LRG-41 | 105 | 40.0 | 15 | 3.5 | 120 | 43.5 |
| Khammam | Green gram | MGG-347 | 3 | 1.2 | 5 | 2.0 | 8 | 3.2 |
| Khammam | Pigeonpea | MRG-1004 | 5 | 2.0 | 5 | 2.0 | 10 | 4.0 |
| Kurnool | Chick pea | Digvijay | 10 | 4.0 | 16 | 6.4 | 26 | 10.4 |
| Kurnool | Chick pea | JAKI-9218 | 15 | 5.0 | 17 | 8.5 | 32 | 13.5 |
| Kurnool | Pigeonpea | PRG-158 | 25 | 10.0 | 16 | 6.4 | 41 | 16.4 |
| Nalgonda | Tomato | Nirupam | 18 | 1.6 | 7 | 2.0 | 25 | 3.6 |
| Srikakulam | Black gram | LBG-752 | 16 | 4.4 | 15 | 5.4 | 31 | 9.8 |
| Srikakulam | Green gram | TM 962 | 10 | 2.6 | 4 | 1.2 | 14 | 3.8 |
| West godavari | Paddy | RP bio-226 | 8 | 2.0 | 12 | 4.6 | 20 | 6.6 |
| Total | | | 235 | 86.8 | 120 | 45.5 | 355 | 132.3 |

**Table 3 : Area and number of farmers covered under different varieties in Maharashtra**

| District where project center located | Crop | Variety | Number of farmers and area | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2011-12 | | 2012-13 | | Total | |
| | | | No. of farmers | Area (ha) | No. of farmers | Area (ha) | No. of farmers | Area (ha) |
| Ahmednagar | Chick pea | Digvijay | 50 | 10.0 | 8 | 3.2 | 58 | 13.2 |
| Ahmednagar | Wheat | NIAW-34 | 20 | 8.0 | 10 | 4.0 | 30 | 12.0 |
| Amravati | Chick pea | JAKI-9218 | 25 | 10.0 | 10 | 4.0 | 35 | 14.0 |
| Amravati | Cotton | Jay BT-3028 | 25 | 10.0 | 10 | 4.0 | 35 | 14.0 |
| Amravati | Sorghum (K) | CSH-14 | 25 | 10.0 | 10 | 4.0 | 35 | 14.0 |
| Amravati | Soybean | JS-9305 | 50 | 20.0 | 25 | 10 | 75 | 30.0 |
| Aurangabad | Chick pea | Digvijay | 36 | 11.1 | 20 | 8.0 | 56 | 19.1 |
| Aurangabad | Pigeonpea | BDN-711 | 18 | 6.0 | 10 | 4.0 | 28 | 10.0 |
| Aurangabad | Sorghum (R) | SPV-1411 | 10 | 4.0 | 10 | 4.0 | 20 | 8.0 |
| Gondia | Chick pea | JAKI 9218 | 36 | 4.0 | 20 | 8.0 | 56 | 12.0 |
| Nandurbar | Chick pea | Digvijay | 5 | 2.0 | 10 | 4.0 | 15 | 6.0 |
| Pune | Soyabean | JS-9305 | 5 | 2.0 | 5 | 2.0 | 10 | 4.0 |
| | | Total | 300 | 97.1 | 148 | 59.2 | 453 | 156.3 |

**Table 4 : Performance of paddy varieties under submergence in Sirsuwada and Matsyapuri villages in Andhra Pradesh (2012)**

| Location of experimental site | Variety | Yield (kg/ha) | Cost of cultivation (₹/ha) | Gross income (₹/ha) | Net income (₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|
| Sirsuwada Srikakulam Dist | PLA-1100 | 5840 | 40000 | 73000 | 33000 | 1.82 |
| | Indra (MTU-1061) | 5460 | 40000 | 68000 | 28250 | 1.70 |
| | RGL-2537 | 5650 | 40000 | 70625 | 30625 | 1.76 |
| | Swarna | 4920 | 40000 | 73000 | 21500 | 1.53 |
| | BPT-5204 | 4700 | 40000 | 70625 | 20750 | 1.59 |
| | C.D | 157.78 | - | - | - | - |
| Matsyapuri West Godavari dist. | MTU-7029 | 5156 | 37500 | 64625 | 27125 | 1.72 |
| | RPbio-226 | 4353 | 37500 | 75461 | 37960 | 2.01 |
| | BPT-5204 | 4101 | 37500 | 71093 | 35593 | 1.89 |
| | MTU-1121 | 6875 | 53138 | 91667 | 38529 | 1.72 |
| | MTU-1010 | 5935 | 53138 | 79133 | 25995 | 1.49 |
| | C.D | 215.74 | - | - | - | - |

**Table 5 : Performance of improved varieties in different districts of Andhra Pradesh**

| District where project center located | Crop | Variety | Yield (kg/ha) | | | | | | | Percent increase in yields over control |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2011-12 | | 2012-13 | | Mean | | CD (P=0.05) | |
| | | | Demo | Control | Demo | Control | Demo | Control | | |
| Anantapur | Castor | PCH-111 | 880 | 550 | 915 | 722 | 897.5 | 636.0 | 40.1 | 41.2 |
| Anantapur | Groundnut | K-9 | 843 | 640 | 1175 | 968 | 1009.0 | 804.0 | 41.7 | 25.5 |
| Anantapur | Pigeonpea | LRG-41 | 680 | 630 | 1050 | 712 | 865.0 | 671.0 | 21.9 | 28.9 |
| Khammam | Green gram | MGG-347 | 790 | 700 | 800 | 300 | 795.0 | 500.0 | 65.3 | 59.0 |
| Khammam | Pigeonpea | MRG-1004 | 1060 | 950 | 1800 | 565 | 1430.0 | 757.5 | 44.4 | 88.7 |
| Kurnool | Chick pea | Digvijay | 1180 | 1040 | 1205 | 685 | 1192.5 | 862.5 | 73.7 | 38.3 |
| Kurnool | Chickpea | JAKI-9218 | 1290 | 1040 | 1205 | 1086 | 1247.5 | 1063.0 | 33.2 | 17.5 |
| Kurnool | Pigeonpea | PRG-158 | 910 | 690 | 1153 | 936 | 1031.5 | 813.0 | 91.2 | 26.9 |
| Nalgonda | Tomato | Nirupam | 24500 | 18400 | 22,200 | 17,800 | 23350.0 | 18100.0 | 881.3 | 29.0 |
| Srikakulam | Black gram | LBG-752 | 880 | 550 | 727 | 380 | 803.5 | 465.0 | 27.0 | 72.9 |
| Srikakulam | Green gram | TM-962 | 800 | 490 | 789 | 400 | 794.5 | 445.0 | 33.1 | 78.7 |
| West Godavari | Paddy | RP bio-226 | 5488 | 4921 | 5650 | 5100 | 5569.0 | 5010.5 | 135.3 | 11.1 |

**Table 6 : Performance of improved varieties in selected districts of Maharashtra**

| District where project center located | Crop | Variety | Yield (kg/ha) | | | | | | CD ((P=0.05) | Percent increase in yields |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2011-12 | | 2012-13 | | Mean | | | |
| | | | Demo | Control | Demo | Control | Demo | Control | | |
| Ahmednagar | Chick pea | Digvijay | 1300 | 900 | 1450 | 1120 | 1375 | 1010 | 64.3 | 36.1 |
| Ahmednagar | Wheat | NIAW-34 | 2840 | 2440 | 6780 | 4703 | 4610 | 3772 | 77.6 | 22.2 |
| Amravati | Chick pea | JAKI0-9218 | 2000 | 1600 | 2155 | 1800 | 2078 | 1700 | 53.9 | 22.2 |
| Amravati | Cotton | Jay BT-3028 | 1360 | 780 | 3250 | 2875 | 2305 | 1828 | 50.5 | 26.1 |
| Amravati | Sorghum (K) | CSH-14 | 3640 | 2280 | 2981 | 1950 | 3311 | 2115 | 46.3 | 56.6 |
| Amravati | Soybean | JS-9305 | 2110 | 1260 | 2400 | 2050 | 2255 | 1655 | 58.9 | 36.3 |
| Aurangabad | Chick pea | Digvijay | 1300 | 1050 | 2000 | 1800 | 1650 | 1425 | 81.9 | 15.8 |
| Aurangabad | Pigeonpea | BDN-711 | 1200 | 1050 | 1100 | 800 | 1150 | 925 | 55.8 | 24.3 |
| Aurangabad | Sorghum (R) | SPV-1411 | 1250 | 935 | 1100 | 820 | 1175 | 878 | 55.3 | 33.8 |
| Gondia | Chick pea | JAKI 9218 | 3900 | 2800 | 1540 | 1295 | 2720 | 2048 | 87.1 | 32.8 |
| Nandurbar | Chick pea | Digvijay | 1240 | 950 | 1440 | 1225 | 1340 | 1088 | 70.9 | 23.2 |
| Pune | Soybean | JS-9305 | 1150 | 820 | 950 | 830 | 1050 | 825 | 47.0 | 27.3 |

**Table 7 : Economics (₹/ha) of different improved varieties in NICRA centers of Andhra Pradesh**

| District where project center located | Crop | Variety | 2011-12 | | | | 2012-13 | | | | Mean for two years | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cost of cultivation | Gross income | Net income | B:C ratio | Cost of cultivation | Gross income | Net income | B:C ratio | Cost of cultivation | Gross income | Net income | B:C ratio |
| Anantapur | Castor | PCH-111 | 6800 | 13200 | 6400 | 1.94 | 13100 | 35920 | 22820 | 2.74 | 9950 | 24560 | 14610 | 2.47 |
| | | Local Variety | 6400 | 8250 | 1850 | 1.29 | 10455 | 25440 | 14985 | 2.43 | 8428 | 16845 | 8417 | 1.99 |
| Anantapur | Groundnut | K-9 | 13690 | 21075 | 7385 | 1.54 | 31000 | 55952 | 24952 | 1.80 | 22345 | 38514 | 16169 | 1.72 |
| | | K-6 (Local) | 12130 | 16640 | 4510 | 1.37 | 29000 | 46095 | 17095 | 1.58 | 20565 | 31368 | 10803 | 1.53 |
| Anantapur | Pigeonpea | LRG-41 | 9500 | 30600 | 21100 | 3.22 | 38015 | 67239 | 29224 | 1.8 | 23758 | 48920 | 25162 | 2.06 |
| | | local | 9500 | 28350 | 18850 | 2.84 | 20900 | 52482 | 11582 | 1.3 | 15200 | 40416 | 15216 | 2.66 |
| Khammam | Green gram | MGG-347 | 8900 | 37920 | 26920 | 3.44 | 25000 | 120000 | 95000 | 4.8 | 16958 | 78968 | 60960 | 8.89 |
| | | local | 8900 | 33600 | 24700 | 3.78 | 20000 | 80000 | 60000 | 4.0 | 14450 | 56800 | 42350 | 3.93 |
| Khammam | Pigeonpea | MRG-1004 | 20000 | 53000 | 33000 | 2.65 | 37500 | 74250 | 36750 | 2.0 | 13713 | 44875 | 34875 | 3.27 |
| | | local | 18500 | 47500 | 29000 | 2.57 | 19000 | 59,400 | 40400 | 3.1 | 18750 | 53450 | 34700 | 2.85 |
| Kurnool | Chick pea | Digvijay | 25000 | 41300 | 16300 | 1.65 | 25116 | 43450 | 18334 | 1.7 | 25058 | 42375 | 17317 | 1.69 |
| | | local | 22150 | 36400 | 14250 | 1.64 | 26218 | 46810 | 20592 | 1.8 | 24184 | 41605 | 17421 | 1.72 |
| Kurnool | Chick pea | JAKI-9218 | 25000 | 45150 | 20150 | 1.81 | 25036 | 56080 | 31044 | 2.2 | 25018 | 50615 | 25597 | 2.02 |
| | | local | 22150 | 36400 | 14250 | 1.64 | 25256 | 43440 | 18184 | 1.7 | 23703 | 39920 | 16217 | 1.68 |
| Kurnool | Pigeonpea | PRG-158 | 10000 | 27380 | 17380 | 2.7 | 26194 | 46120 | 19926 | 1.76 | 18097 | 23653 | 18653 | 1.3 |
| | | local | 9000 | 25200 | 16200 | 2.8 | 29395 | 35568 | 6173 | 1.2 | 19198 | 30384 | 11187 | 1.58 |
| Nalgonda | Tomato | Nirupam | 62230 | 196000 | 133770 | 3.15 | 56500 | 182000 | 125500 | 3.22 | 59365 | 189000 | 129635 | 3.18 |
| | | Arka megahali (Local) | 55936 | 128800 | 72864 | 2.30 | 54200 | 125750 | 71550 | 2.32 | 55068 | 127275 | 72207 | 2.31 |
| Srikakulam | Black gram | LBG-752 | 8600 | 47520 | 38920 | 5.53 | 8900 | 39850 | 30950 | 4.5 | 8750 | 43685 | 34935 | 4.99 |
| | | local | 8600 | 27500 | 18900 | 3.20 | 8900 | 19000 | 10100 | 2.1 | 8750 | 23250 | 14500 | 2.65 |
| Srikakulam | Green gram | TM 962, | 8300 | 40000 | 32700 | 4.82 | 9750 | 39375 | 29625 | 4.0 | 9025 | 39688 | 31163 | 4.39 |
| | | local | 8000 | 24500 | 15500 | 3.06 | 9750 | 43450 | 33700 | 4.5 | 8875 | 33978 | 24600 | 3.83 |
| West Godavari | Paddy | RPbi-226 | 32928 | 71344 | 38416 | 2.17 | 37500 | 75461 | 37960 | 2.01 | 35214 | 73403 | 38189 | 2.08 |
| | | BPT-5204 (Local) | 34449 | 68894 | 34445 | 2.0 | 37500 | 71093 | 33593 | 1.89 | 35975 | 69994 | 34019 | 1.95 |

**Table 8 : Economics (₹/ha) of different improved varieties in selected districts of Maharashtra**

| District | Crop | Variety | 2011 | | | | 2012 | | | | Mean | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cost of cultivation | Gross cost | Net returns | B:C ratio | Cost of cultivation | Gross returns | Net returns | B:C ratio | Cost of cultivation | Gross returns | Net returns | B:C ratio |
| Ahmednagar | Chick pea | Digvijay | 20350 | 46800 | 26450 | 2.30 | 21400 | 52200 | 30800 | 2.44 | 20875 | 49400 | 28625 | 2.37 |
| | | Local | 12568 | 32400 | 19832 | 2.58 | 13820 | 42560 | 28740 | 3.08 | 13194 | 37480 | 24286 | 1.53 |
| Ahmednagar | Wheat | NIAW-34 | 16155 | 39760 | 23605 | 2.46 | 15750 | 94920 | 79170 | 6.02 | 15953 | 59263 | 43300 | 4.24 |
| | | Local | 12890 | 34160 | 21270 | 2.65 | 12340 | 65842 | 53502 | 5.34 | 12615 | 50001 | 37386 | 3.99 |
| Amravati | Chick pea | JAKI 9218 | 19200 | 66079 | 46879 | 3.44 | 20500 | 71200 | 46200 | 2.85 | 19850 | 68640 | 48790 | 3.15 |
| | | Digvijay | 15734 | 52863 | 37129 | 3.36 | 20460 | 65880 | 41280 | 2.67 | 18097 | 39205 | 21108 | 2.17 |
| Amravati | Cotton | Jay BT-3028 | 51468 | 57120 | 5652 | 1.11 | 65000 | 136500 | 71500 | 2.10 | 58234 | 96810 | 38576 | 1.66 |
| | | Local | 32760 | 48672 | 15912 | 1.49 | 57500 | 117875 | 60375 | 2.05 | 45130 | 83274 | 38144 | 1.85 |
| Amravati | Sorghum (K) | CSH-14 | 9400 | 52135 | 42735 | 5.55 | 8500 | 42696 | 34196 | 5.02 | 8950 | 47416 | 38465 | 5.30 |
| | | Local | 7800 | 32656 | 24856 | 4.19 | 6100 | 23400 | 17300 | 3.84 | 6950 | 28028 | 21078 | 4.03 |
| Amravati | Soybean | JS-9305 | 31992 | 69630 | 37638 | 2.18 | 35000 | 79200 | 44200 | 2.26 | 33496 | 74415 | 49919 | 2.22 |
| | | JS-335 | 29955 | 41580 | 11625 | 1.39 | 32500 | 67650 | 35150 | 2.08 | 31228 | 54615 | 23387 | 1.75 |
| Aurangabad | Chickpea pea | Digvijay | 11815 | 31200 | 19385 | 2.64 | 12500 | 48000 | 35500 | 3.84 | 12158 | 39600 | 27442 | 3.26 |
| | | Local | 9377 | 25200 | 15823 | 2.69 | 8900 | 39600 | 30700 | 4.44 | 9138 | 32400 | 23262 | 3.55 |
| Aurangabad | Pigeonpea | BDN- | 17150 | 48000 | 30850 | 2.80 | 16600 | 44000 | 27400 | 2.65 | 16875 | 46000 | 29125 | 2.73 |
| | | Local | 14882 | 42000 | 27118 | 2.82 | 15200 | 32000 | 16800 | 2.1 | 15041 | 37000 | 15041 | 2.45 |
| Aurangabad | Sorghum (R) | SPV-1411 | 5155 | 23864 | 18709 | 4.63 | 3790 | 21000 | 17210 | 5.54 | 4472 | 22432 | 17960 | 5.02 |
| | | Local | 17850 | 29865 | 12015 | 1.67 | 15400 | 33600 | 18200 | 2.18 | 16625 | 31733 | 15105 | 1.91 |
| Gondia | Chick pea | JAKI 9218 | 15630 | 218805 | 203175 | 14.00 | 18000 | 86400 | 68400 | 4.8 | 16815 | 152602 | 135787 | 9.07 |
| | | Local | 15699 | 157091 | 141392 | 10.01 | 16850 | 49210 | 32360 | 2.92 | 16275 | 103150 | 101525 | 6.33 |
| Nandurbar | Chick pea | Digvijay | 9380 | 28470 | 19090 | 3.04 | 11715 | 33062 | 21347 | 2.82 | 10548 | 30901 | 20352 | 2.93 |
| | | Local | 6931 | 21812 | 14881 | 3.15 | 7450 | 17580 | 10130 | 2.35 | 7190 | 31500 | 2431 | 4.38 |
| Pune | Soybean | JS9305 | 20893 | 34500 | 13607 | 1.65 | 21247 | 28500 | 7253 | 1.34 | 21070 | 31500 | 10430 | 1.50 |
| | | JS335 (Local) | 20856 | 24600 | 3744 | 1.18 | 21350 | 21900 | 3550 | 1.16 | 21103 | 23250 | 2147 | 1.10 |

The demonstration results in Nacharam village of Khammam district indicated that improved cultivars of green gram (MGG-341) and pigeonpea (MRG-1004) recorded 9 and 13.8% higher net income than respective locals in 2011-12. But, improved cultivars of green gram contributed for higher net income by 58.3% compared to the local check in 2012-13 (₹ 60000/ha). The improved cultivar of pigeonpea (MRG-1004) registered 5.3% higher net income than local (₹ 34900/ha) in 2012-13 (Table 7). Thus, these demonstrations with improved cultivars of different crops at varied soil types and climatic vulnerabilities revealed that improved cultivars showed higher yield potentials in drought and favourable environments.

**Maharashtra**

In selected village of Ahmednagar district, improved variety Digvijay (chickpea) gave higher net income by ₹ 6618/ha and ₹ 2060/ha than respective locals in 2011 and 2012, respectively. Improved variety of NIWA-34 (wheat) showed higher net returns by ₹ 2335/ha and ₹ 25668/ha in 2011 and 2012, respectively.

At experimental site of Amravati, improved cultivars of chickpea (JAKI-9218), *kharif* sorghum (CSH-14) and soybean (JS-9305) recorded higher net income by 26.3, 71.9 and 223.8%, respectively over respective locals in 2011. Similar highest mean yield, B:C ratio and rain water use efficiency were recorded by sorghum hybrid CSH-14 at Akola (AICRPDA, 2013). Improved cultivars of chickpea, *kharif* sorghum and soybean enhanced the mean net returns by 131, 82 and 113% over respective locals but not in case of cotton. Among improved varieties in different crops, hybrid sorghum recorded highest B:C ratio followed by soybean in 2012. In selected site of Aurangabad district, improved varieties Digvijay (chickpea), BDN-711(pigeonpea) and SPV-1411(sorghum) gave higher net returns of ₹ 3562/ha, ₹ 3732/ha and 6694/ha than respective locals in 2011. Similar trend of economic gains were observed with improved cultivars in 2012 also. Among improved varieties in different crops, SPV-1411of *rabi* sorghum recorded the highest B:C ratio followed by chickpea (Table 8).

In Gondia district, JAKI-9218 (chickpea) showed higher net income of ₹ 61783 and ₹ 36040/ha compared to the locals in 2011 and 2012, respectively. In Nandurbar district, improved variety of chickpea, Digvijay gave higher net income by ₹ 4209 and ₹ 11217 compared to their respective locals in 2011 and 2012, respectively. At experimental site of Pune district, improved variety of soybean (JS-9305) gave higher net gains of ₹ 9863/ha and ₹ 3703/ha in 2011 and 2012, respectively.

## Conclusion

Assessment of improved varieties of paddy to climate vulnerabilities like flood and water logging due to heavy rains in Andhra Pradesh indicated differential behavior and few of them were found to be tolerant like PLA-1100, RGL-2537 and MTU-1061 compared to local checks. Similarly under rainfed condition, groundnut (K-9), pigeonpea (LRG-41), castor (PCH-111) and blackgram (LBG-645 and LBG-752) were found to be drought tolerant in Andhra Pradesh while chickpea (Digvijay, JAKI-9218), pigeonpea (BDN-711), sorghum (SPV-1411) and soybean (JS-9305) varieties in Maharashtra were found to be promising. Thus, there is a need for assessment of varieties to varied climatic conditions and supply of seeds of tolerant ones to the farming.

## References

AICRPDA. 2013. Technology Demonstration Component, Annual Progress Report, National Initiative on Climate Resilient Agriculture (NICRA), Hyderabad.

Anonymous. 2013. Demonstrations of Stress Tolerant Rice Varieties in Stress Prone Parts of India, Annual Report, International Rice Research Institute, New Delhi.

Anonymous. 2012. Strategies to Enhance Adaptive Capacity to Climate Change in Vulnerable Regions, Annual Report, Central Rice Research Institute, Cuttack, Odisha.

Anonymous. 2013. Front line demonstrations, Annual Report, Indian Institute of Pulses Research. Kanpur.

Arunachalam P and Kannan P. 2013. Screening for Drought Tolerant Groundnut (Arachis hypogea) Lines Suitable for Rainfed Alfisol. Asian J. Agricultural Research 7(1): 35-42.

Dutta JK, Mondal T, Benerjee A and Mondal NK. 2011. Assessment of drought tolerance of wheat cultivars under laboratory condition. Journal of Agricultural Technology 7(2): 383-393.

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