Adhcoc Project: 1

Status of Dr. H. Venkatesh: PI

Adaptation Strategies for Climate Change in North Interior Karnataka

Introduction

Failure of rainfall during the past three years in Northern Karnataka has created more apprehensions in the mind of the people on the climate change, though it could be only a climatological aberration. More queries have been raised on deforestation and global warming influences. Artificial rainmaking, roof water harvesting, artificial ground water recharge and crop contingency measures have become the talk of the day in the Government circles – bringing out Monsoon Management aspects to the fore, as suggested by Swaminathan (2002). This recent experience only points to the vulnerability of the system to climate variability and climate change.

Climate Variability

Rainfall:

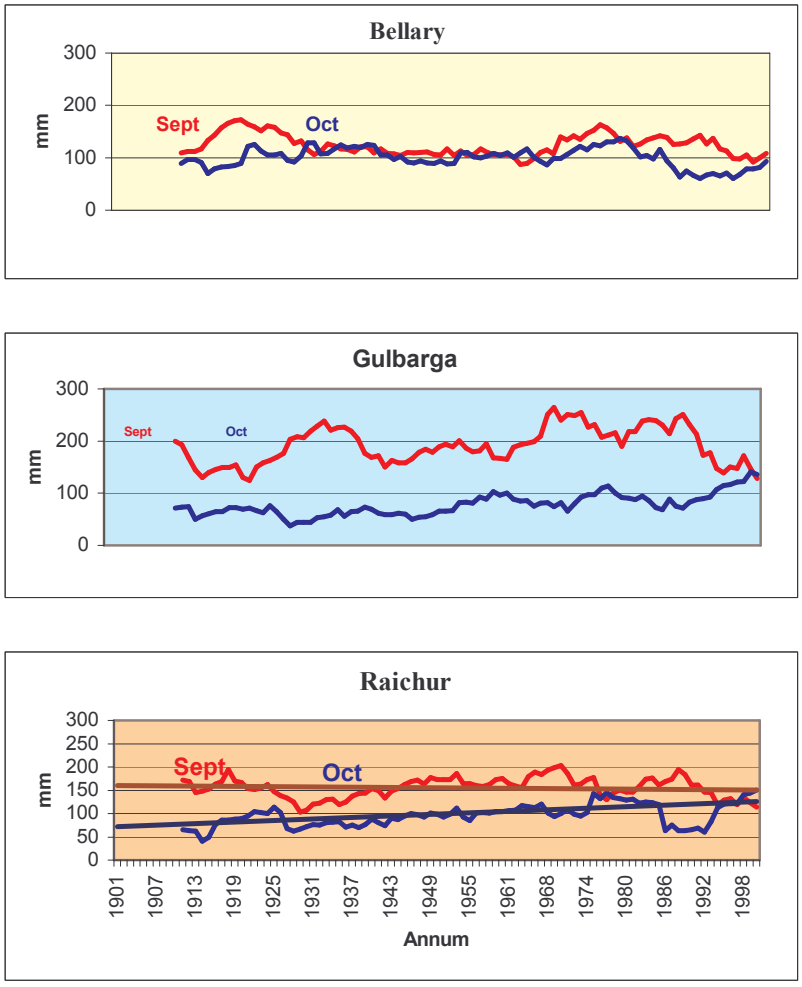


Fig 1. Rainfall variability during 20th Century in North Karnataka

In Bellary district, rainfall of September showed a decreasing trend during the twentieth Century. September rainfall had three distinct periods centering from 1905-1926, 1927-1956 and 1957-1990; the first one was a high rainfall epoch, followed by low rainfall epoch and once again a high rainfall epoch. The differences between rainfall of September-October were larger in the first and third periods, whereas in the intermediate period the differences were very small. Looking to the tendencies, the low rainfall epoch of September is expected to follow next. If sown on time, pest and diseases due to high rainfall in October may affect the crop.

Slightly positive trend of rainfall was noticed in both September and October at Bijapur. Since the 1940s, low rainfall periods of September synchronized with high rainfall periods of October and *vice versa*. The September-October differences were large in high September rainfall epochs, since even in high October rainfall epochs, the October rainfall just neared the September rainfall. In case of Gulbarga the rainfall in October showed a linear trend with increase in 11 year moving means from about 60mm at the beginning of the 20th Century, to 100mm at the end of the Century. A general decrease of rainfall in September and increase in October were observed during the twentieth Century at Raichur. Rainfall profiles were similar for September and October till 1950s. From his time the tendencies became opposite - high rainfall epoch of October synchronizing with low rainfall epoch of September and *vice-versa*, similar to Bijapur pattern.

Climate Change

The net changes in rainfall and temperature in Northern Karnataka during the past Century are given in Table 2.

Table 4: Climate change during the twentieth century in Northern Karnataka

a) Rainfall				
District	September		October	
	1901-10	1991-2000	1901-10	1991-2000
Bellary	111.4	102.7	88.4	102.1
Bijapur	144.1	136.4	46.7	168.3
Gulbarga	206.4	131.0	76.2	131.7
Raichur	180.4	115.8	69.2	158.3

b) Maximum temperature						
District	October		November		December	
	1901-10	1991-2000	1901-10	1991-2000	1901-10	1991-2000
Bellary	33.1	31.4	31.2	30.5	30.2	29.8
Bijapur	33.4	31.3	30.3	30.4	29.1	29.6
Gulbarga	32.7	32.1	30.9	31.7	29.5	30.6
Raichur	32.3	31.6	30.3	31.0	29.0	29.9

c) Minimum temperature						
District	October		November		December	
	1901-10	1991-2000	1901-10	1991-2000	1901-10	1991-2000
Bellary	21.9	19.1	18.9	16.9	15.9	13.9
Bijapur	20.4	21.8	16.2	19.5	14.2	16.1
Gulbarga	20.5	22.2	16.9	18.9	14.8	15.7
Raichur	22.3	22.3	19.4	22.2	17.4	16.9

Rainfall at Bellary in September changed from 111.4 mm in the first decade to 102.7mm in the last decade of the twentieth century, while the October rainfall increased from 88.4 mm to 102.1mm during the period. Maximum temperature decreased by 1.7°C in October, 0.7°C in November and marginally by 0.4 °C from 30.2 °C to 29.8 °C in December. On the other hand, there was a drop in minimum temperature by 2°C in all the three months. Rainfall in September at Bijapur showed a decrease by 7.7mm from the beginning of the century to the end, whereas the October rainfall indicated an increase from 46.7 to 168.3 mm. No change in maximum temperature could be noticed in November, while it increased by 0.5°C (29.1°C to 29.6°C) in December. There was an increase in minimum temperature by 0.6°C in October, 2.7°C in November and 1.9°C in December. The rainfall at Gulbarga decreased by 65.0mm in September and increased from 76.2 mm to131.7 mm in October over the twentieth century. The maximum temperature increased by 0.8°C in November and 1.1°C in December. At Raichur, rainfall decreased by 65.0mm in September, from 180.4mm during 1901-10 to 131.0 mm, during 1991-2000. In October the rainfall increased from 69.2mm to 158.3mm in the corresponding periods. Maximum temperature decreased by 0.7°C in November and 0.9°C in December. On the other hand, minimum temperature increased by 2.8°C in November and decreased by 0.5°C in December. Thus, there was a general decrease of rainfall in September and large increase in October over Northern Karnataka. An increase of temperature in November and December could be observed, indicating greater thermal energy for good vegetative growth (November) and thermal stress in flowering period (December) for the *rabi* sorghum crop.

Choice of *rabi* sorghum genotypes – Farmer's view

Figure 2 represents the percentage of total farmers contacted, who have preferred/used the respective cultivars during the corresponding time. Sometimes the same farmers have used more than one cultivar, and as such, the sum of the percentages could end up beyond 100. In some cases particularly during 1940-1950 and 1950-60 the sum of percentages came out to be less than 100%, since no farmer had taken up to sorghum farming or were not aware of the name or type of variety used.

Earliest *rabi* sorghum varieties were `Gundudeni' meaning round earhead, and `Doddajola' indicating bold seeds. There was no other variety available. Doddajola sustained a little till 1980, while Gundudeni prevailed till 1990 in Bellary district. These two varieties were acceptable only to a maximum of 22.2%. The variety M35-1, which entered the farmers' fields during the 1960s, improved its acceptability to 33% during the 1970s. Since the 1980s it has been accepted or grown by nearly 78% of the surveyed farmers in the district. Meantime, the variety SPV –86 was introduced to the farmers during 1980s (13%), but its acceptability was reduced to 7% during 1990s.

Gundudeni was popular since the 1940s in Bijapur district. From 33% during this period, its popularity increased to 66% during the 1970s, thereafter falling to 20% in the 1980s. On the other hand, M35-1, which was introduced by the farmers during late 1950s (3%), became highly popular in the 1990s (96%). No other variety could sustain against this. In Raichur district, acceptability of Gundudeni was 11 to 13% in 1940s and 1950s. Its rating increased to 60% in 1960s and 89% in 1970s, but decreased sharply to 57% in 1980s and became negligible in 1990s. The released variety of 109-R was acceptable at 2.2% in 1980s, but was discarded immediately. The recently released variety Phule Yashoda showed 2.2% acceptability at the turn of the century. On the other hand M35-1 was acceptable to farmers of Raichur district at 11.1% during the 1970s, and at least to 80% since the 1980s.

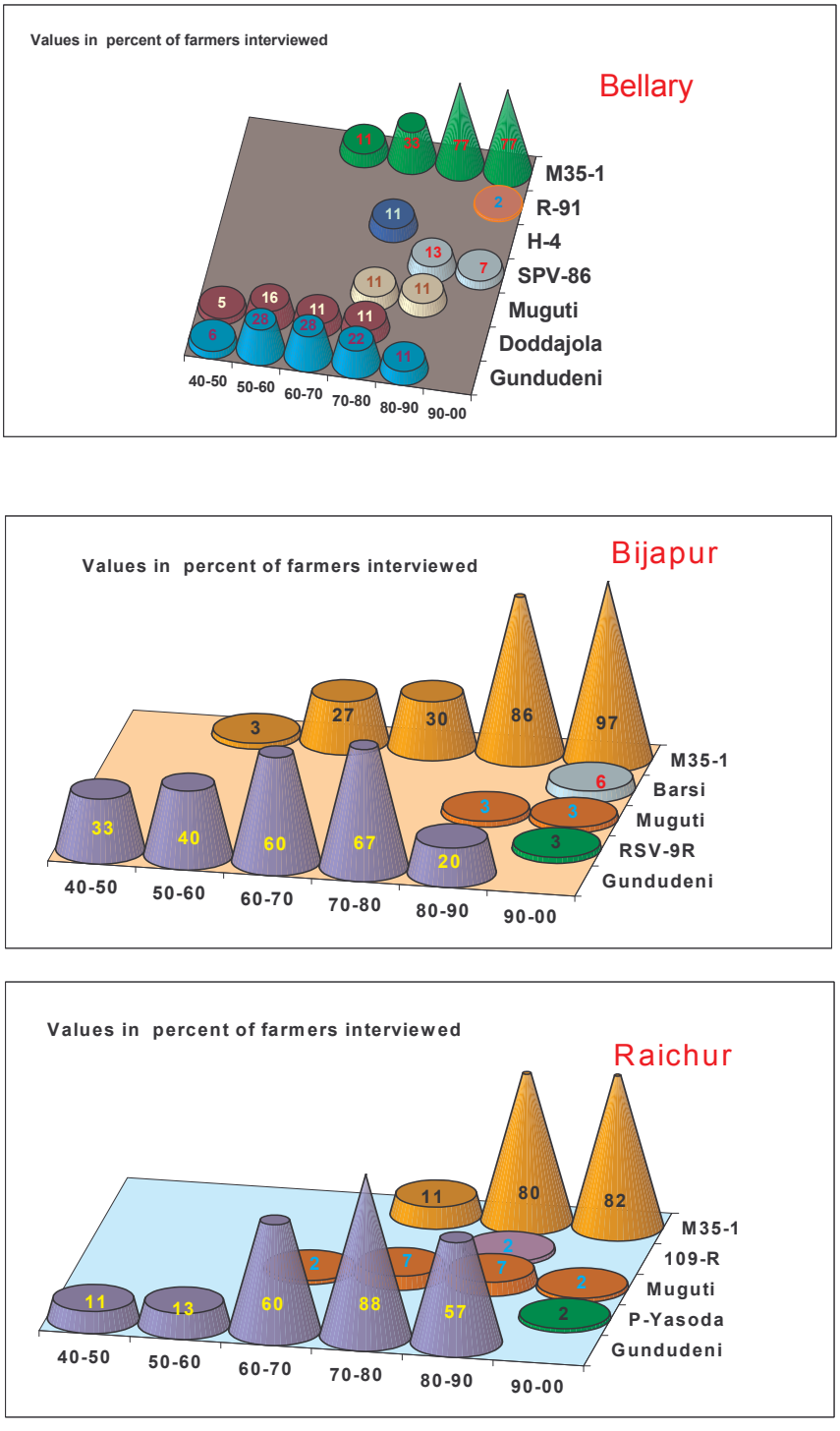


Fig 2. Profiles of relative acceptability by farmers to different *rabi* sorghum genotypes in various decades

Reasons ascribed by farmers for genotype selection

- Farmers used Gundudeni variety during 1940-70 because it was the best available in terms of drought resistance and good quality of fodder and grain. About 40% of the farmers interviewed informed that it was the only variety available at that time. It was replaced by M35-1, particularly because the former was susceptible to insect damage to earhead.
- The released varieties, viz., SPV-86 and 109-R were not continued for longer periods, because of drastic yield reduction after 2 or 3 years. .
- The farmers opted to cultivate M35-1, as they found it to be a high yielder having bold seeds and good fodder quality, in addition to being a drought resistant variety, thereby fetching better market value.

Scientists' Opinion

Fig 3 explains the percentage of scientists who have noticed, during their research/extension tenure, the popularity levels of different genotypes during different periods. This does not provide information on percentage of farmers, *vis-à-vis* genotypes preferred. The popularity levels of various genotypes were reported and the information given indicates that, Muguti variety showed maximum popularity in late 1980s (50%). Otherwise its popularity rating remained at 33% from 1950s till 2000. The popularity score of 16.6% was recorded for local varieties in 1940s and for Barsi variety in the late 1990s. Popularity rating of M35-1 increased from 33.3% in 1940s to 66.6% in 1950s and early sixties, 83% from late 1960s till early 1990s. All the scientists opined that it acquired highest popularity by the turn of the Century.

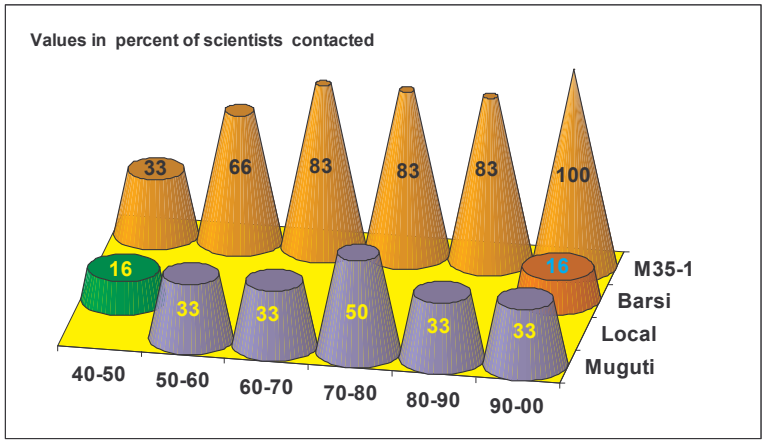


Fig 3. Profiles of relative popularity of different *rabi* sorghum genotypes as reported by scientists consulted

Comparison of information provided by Scientists and Farmers

Profiles of popularity levels of two *rabi* sorghum cultivars, viz. M35-1 (Maldandi) and 5-4-1 (Muguti) are presented in Figure 4, as indicated by the farmers and the scientists. It is noticed that even though 33% of scientists mentioned that M35-1 was popular among the farmers in 1940s itself, it is noticed that among the farmers interviewed, it was put to use by just 1% of them even during the decade 1950-60. Eighty three percent of scientists viewed that the variety was popular among the farmers during 1960-90. It was only during 1980-90 that, the farmers said, they used the variety M35-1 predominantly

(81%). We can attribute these differences to delay in adoption of technology by the farmers. In case of Muguti also, it is noticed that even though 33% of scientists indicated that it was popular among the farmers all through, only 7 to 7.5% farmers adopted the variety (1970-80 and 1980-90).

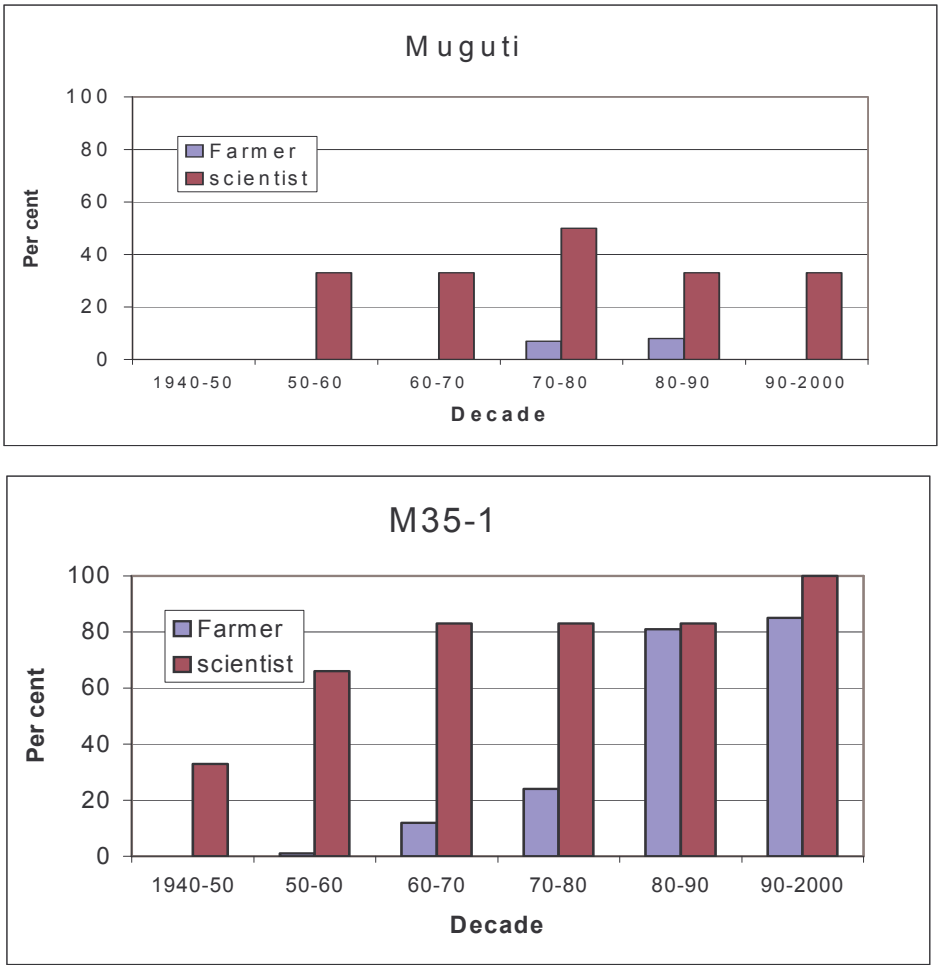


Fig 4. Popularity of *rabi* sorghum genotypes at different periods of time as expressed by scientists and farmers

Thus, we find that the farmers do not opt for new varieties as soon as they are released (i.e., with minimum time gap), and also only a limited number of them adopt it. Because of this time gap mentioned, there is always a possibility that, due to climate variability, the farmers might take up a new variety under relatively adverse climate epochs, thereby making them vulnerable to the changed climate scenario, and reject them straight away in view of their poor performance. This perhaps is the reason why recently developed genotypes have failed in farmers' field, as in case of SPV-86 and 109R. Any new variety developed should have the capability of out-yielding M35-1 variety in times of abiotic and biotic stresses. No variety developed so far has been able to do both. However, sorghum breeders have identified cultivars that are tolerant to these characters individually. These genotypes need to be selectively adopted in different climate epochs.

The characteristics of different *rabi* sorghum genotypes developed are:

⇒ **Rabi sorghum genotypes identified for abiotic stress tolerance:**

• Drought tolerance:	Var. M35-1 (Maldandi) Var. 5-4-1 (Muguti) Var. Selection-3

⇒ **Rabi sorghum genotypes identified for biotic stress tolerance:**

• Charcoal rot disease:	Var. DSV-4 (9-13) Var. DSV-5 (GRS-1)
• Rust disease:	Var. DSV-4 (9-13)
• Shootfly pest:	Var. DSV-5 (GRS-1) Var. 5-4-1 (Muguti) Var. SPV-86 Var. CSV-216R (Phule Yashoda)

⇒ **Rabi sorghum genotypes promising under optimum soil moisture conditions:**

• Favorable soil moisture:	Var. DSV-4 (9-13) Var. DSV-5 (GRS-1) Var. CSV-216R (Phule Yashoda) Var. SPV-86

It is clear that most of the developed genotypes have been towards tolerance to insect pests and diseases. These are also found to be good under favorable moisture conditions during the *rabi* season.

Inferences

The time of withdrawal of genotypes from the farmers' fields, relative magnitudes of rainfall in September and October were collated. From the discussion in previous Sections, it was noticed that in Raichur district the farmers withdrew Gundudeni during 1990s, as it was found to be susceptible to pest incidence. In Bijapur the same variety lost acceptability amongst the farmers during 1970-80 due to insect incidence. The rainfall pattern during the corresponding decades in both the cases, had decreasing tendency in September and increasing tendency in October, resulting in increased humidity during the crop growth period, which may have caused pest buildup. Further, since some of the portions of the Study Area have been brought under irrigation, the humidity levels may have further gone up, resulting in increased pest menace.

Hence, it is inferred that in epochs of low September and high October rainfall, genotypes resistant to pest incidence should be opted. From the discussions in the previous Section, among the genotypes mentioned, the cultivars SPV-86, 9-13, GRS-1, CSV-216R (Phule Yashoda) could be used in high October rainfall epochs. Conversely, Muguti, M35-1 and Selection-3, which are of drought resistant type, could be used during epochs of high September (low October rainfall).

In view of the above it is necessary that:

- Cultivars should be preserved for future climate scenarios similar to the ones in which they were developed.
- Cultivars are developed with objective -Specific cultivars for specific rainfall epochs approach.

This would help in sustaining the *rabi* sorghum yields in the future climate change scenarios by synchronizing favorable cultivars in corresponding epochs.

Rainfall variability – Future projections

Short term projections:

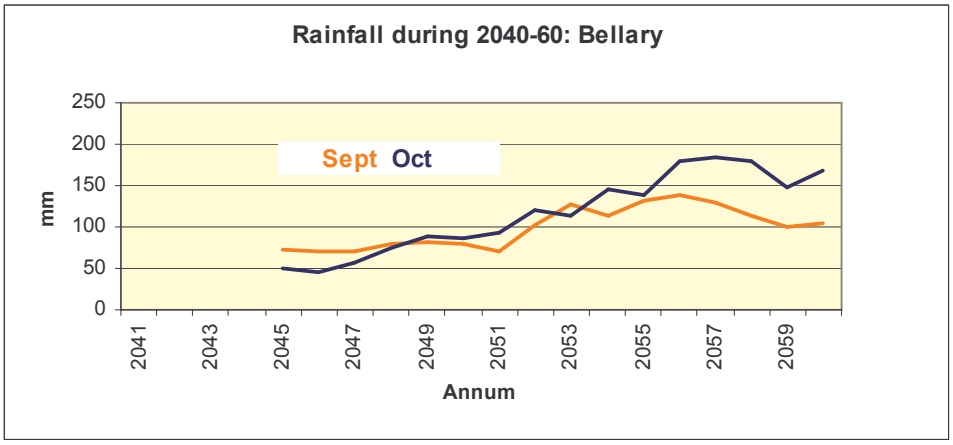
The observed and simulated rainfall variability patterns at Bijapur for September, October and *rabi* season (Anonymous, 2003) are presented in Fig 5. The patterns of observed and simulated series are strikingly similar for September and *rabi* seasonal rainfall.

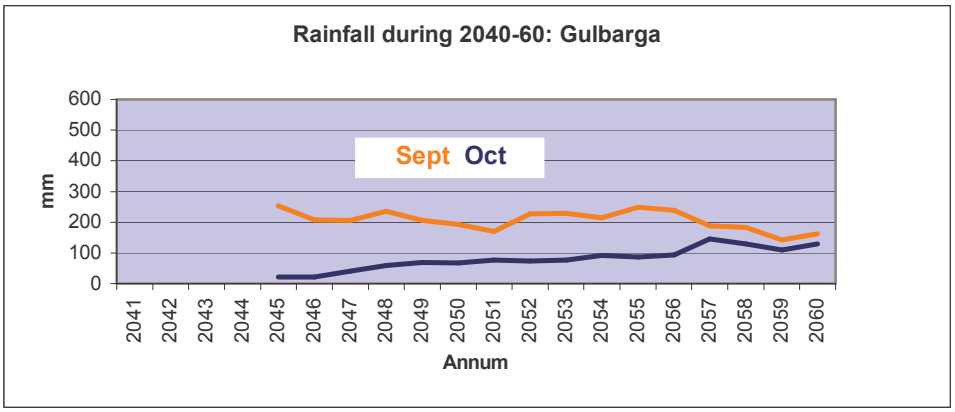
In case of October rainfall the estimations are lower, but the pattern follows the actual. The immediate projections indicate high rainfall epoch in the next 4-5 years followed by low rainfall epoch for September, and reverse variabilities for October. This suggests that in the next 4-5 years, drought resistant genotypes like M35-1 and Muguti should be adopted, whereas the pest resistant genotypes like 9-13, GRS-1 and Phule Yashoda should be opted late on.

Long term projections:

The climate scenarios through HadRM3 model for Bellary, Bijapur, Gulbarga and Raichur are presented in Fig 6. During early 2040s Bellary would experience rainfall of 50- in both September and October, whereas it would be above 100mm in the 2050s in both the months. Hence during early 2040s, varieties which are tolerant to extreme drought situations and are of short duration should be opted. On the other hand during the 2050s, genotypes like 9-13, Phule Yashoda and GRS-1, which thrive in good rainfall situation should be preferred. A rainfall situation of 200mm in September and 50mm in October is projected for Gulbarga for 2040s, while higher rainfall of 100mm in October is projected for 2050s. Hence pest tolerant cultivars would be vulnerable during the 2040s and drought tolerant genotypes would be vulnerable during the 2050s for the corresponding climate scenarios. Appropriate selections need to be made accordingly. Projections for Raichur indicate an increasing trend in both September and October rainfall. However, the October rainfall is expected to be only 50mm even during late 2050s. Hence, the pest tolerant would be susceptible throughout the period, which suggests selection of the improved drought resistant genotypes for Raichur during the mid 21st Century.

Thus it would now be possible to avoid susceptible genotypes during adverse climate epochs and choose the cultivars which are tolerant to the corresponding climate epochs, in case of climate projections of both short term and long term nature.





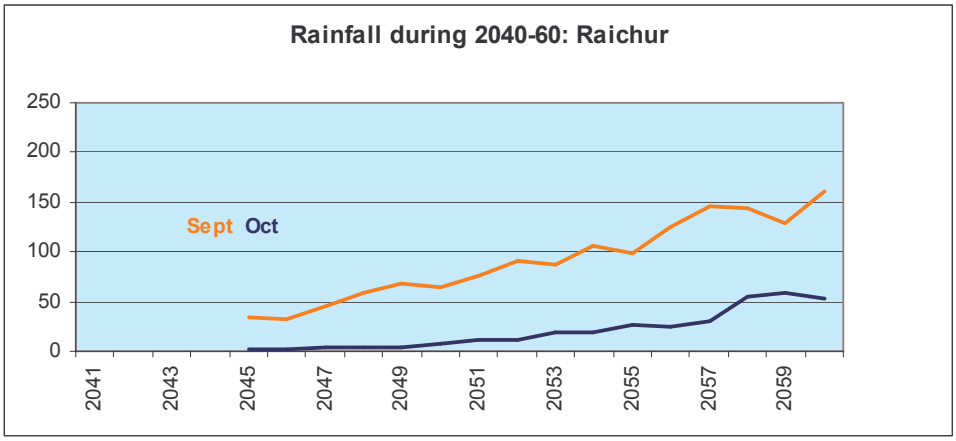


Fig 6. Climate change projections for 2040-2060 in North Karnataka