About 70 per cent cotton cultivation in India is under rainfed conditions. Cotton suffers from various biotic and abiotic stresses right from the germination to maturity. The growth during the seedling establishment phase has a role to play in yield realization. A good plant frame would provide sufficient space for holding and catering the needs of the reproductive parts during the later part of growth. Under Coimbatore condition, the crop experiences initial waterlogging and followed by sucking pests. Both these stresses cause considerable damage to the plant leading to stunted growth. As the cotton plant is photo insensitive they start producing the reproductive parts irrespective of the environmental and physical conditions by 40-45 DAS. Hence sufficient morpho-frame will not be available for the plant to hold the reproductive parts. This leads the plants to either premature death or reduced boll load. Cotton crop failures can be often related to excessive vegetative growth. Lush 2-2.5 mts cotton canopies with fully overlapping middle canopy are havens for insects, and verticillium wilt and boll rot fungi. A luxuriant and dense canopy makes effective insect control essentially impossible and causes lodging, which makes harvesting difficult. More over, squares or small bolls may be shed due to shading effect. The reduced plant growth and modified shape, which result in better light penetration, earlier boll opening and higher harvest, index. Various growth regulators have been applied in cotton in attempts to set more bolls, limit vegetative growth or terminate fruiting. When boll load is limited by carbohydrate supply, exogenous modification of hormonal balance to increase boll set may be futile. More bolls may be set, but will be of smaller size and plant growth is terminated prematurely. Hormonal regulation of plant height is possible, and may be a useful practice where bushy growth of plant is observed and the insect pest infestation is severe. Basically, application of retardant is to remove squares and small bolls, late in the season to deprive pre-diapausing pink bollworm larvae of a food supply. The hormonal termination of growth can be effectively used where cotton is grown in rice fallow tracts and crop rotation systems.

The project entitled "Physiological manipulation of Bt plant morphoframe for enhanced productivity under varied agroclimatic conditions" was initiated during the year 2007-08 with six centres and spread over varied agro-climatic conditions.

OBJECTIVES
1. To study the temporal and spatial distribution of fruiting forms in Bt vs non-Bt (medium and long duration Bt hybrids)
2. To understand the consequences of altered sink activity on physiology and growth of the plant.
3. To formulate product(s) to manipulate morphoframes to minimise yield gap.

SALIENT FINDINGS
Field experiments were conducted at 6 cooperating centers spread across different agro climatic regions of cotton growing zones with the main objective of altering the source sink competition to enhance seed cotton yield through foliar application of ethylene. The experimental locations were CICR (Nagpur), IISS (Bhopal) and GAU (Surat) at Central zone and CICR (Coimbatore), UAS (Dharwad) and ANGRAU (Guntur) at Southern zone. Of these locations cotton is grown under irrigated conditions at Surat & Coimbatore and rest are under rainfed condition.
Experiment I: Manipulation of morphoframe using action specific chemicals—Ethylene in the form of ethrel in cotton

The experiments were laid as per the technical programme at all the centres representing various agro-climatic conditions. The crop was raised during 2009-10 cropping season with five entries viz Bunny Bt, RCH2 Bt, NECH 2R Bt, JKCH 99 Bt and NCS 138 Bt (Mallika Bt) as main treatments and four different manipulation viz., treatments control (T1), 5.7 mM ethylene at 35-40 DAS (square initiation) (T2), 8.56 mM ethylene at 35-40 DAS (square initiation) (T3) and nipping of squares at 35-40 DAS (square initiation) (T4). The treatments were imposed soon after square initiation. Sudden drop of all the young squares was noticed within 48 hours after foliar spray of Ethylene in all the entries under test.

Acharya N G Ranga Agricultural University, Guntur: Significant differences were noticed in all the yield and yield attributing characters due to entries, manipulation treatments and the interaction of entries with the manipulation treatments. In RCH2 Bt, highest seed cotton yield was obtained in T2 (2382 Kg/ha) followed by T3 (2122 Kg/ha) and T4 (2243 Kg/ha) compared to control (1721 Kg/ha). In NECH 2R Bt, treatment T3 produced highest seed cotton yield (2246 Kg/ha) followed by T4 (1997 Kg/ha) and T2 (1900 Kg/ha) while lowest in Control (1446 Kg/ha). In NCS 145 Bt, significant increase in yield was recorded due to T2 (2502 Kg/ha) compared to control.

Seed index, lint index and ginning percentage also showed significant variation due to entries, manipulation treatments and also due to the interaction of entries with the manipulation treatments. All the manipulation treatments increased the seed index and lint index significantly.

University of Agricultural Sciences, Dharwad: There was a significant improvement in yield attributing characters like number of sympodia, leaf area, number of fruiting parts. The seed cotton yield also showed a positive trend with T2 producing the highest followed by T3, T4, in comparison to control. The pooled data showed that application of 8.56 mM (283 Kg/ha) or 5.7 mM ethrel (2951 Kg/ha) record significant high yield than control (2641 Kg/ha). The treatments mechanical removal of squares although recorded more yield (2717 Kg/ha) than control (2641 Kg/ha), it was not significant.

Central Institute for Cotton Research, Coimbatore: Foliar application of ethrel brought about a significant improvement in physiological parameters viz., plant height, leaf area and number of fruiting parts with foliar application of ethylene in the form of ethrel and square removal. These effects synergistically worked and brought about changes in plant ideotype. There was a positive change in the partitioning of photosynthates to the roots initial stage during the early stage and developing bolls in the later stages.

In Bunny Bt genotype, there was a significantly higher seed cotton yield with foliar application of ethrel at 5.7 mM (22.6 q/ha) followed by control (20.0 q/ha) followed by T4 (mechanical removal of squares (17.4 q/ha).
Experiment II : Manipulation of morphoframe through nipping at Grand growth stage and mimic the effect using action specific chemicals- Maleic hydrazide in cotton

Acharya N G Ranga Agricultural University, Guntur:
Significant variation was noticed among the treatments for plant height (cm), number of monopodia per plant, number of sympodia per plant, number of nodes per plant, number of squares per plant, number of flowers per plant and boll weight at harvest. Significantly highest plant height was recorded in XL 708 Bt (137.5 cm) and it was on par with NCS 145 NBt (127.3 cm).

In NCS-145 Bt, the treatment T4 - Maleic hydrazide @ 500 ppm at 85 DAS recorded significantly lower plant height 108.3 cm and it was on par with T3 - Detopping at 95 DAS followed by nipping of the sympodial meristem at 105 DAS (111.3 cm). In Excel 708 Bt and and NCS 145 NBt, lower plant height was recorded in T3 - Detopping at 95 DAS followed by nipping of the sympodial meristem at 105 DAS only.

Yield and yield attributing characters:
The seed cotton yield per hectare was significantly high in NCS 145 Bt (2517 kg/ha) and it was on par with Excel 708 Bt (2462 Kg/ha). Significantly higher seed cotton yield was recorded in T3 treatment followed by T4. Seed cotton yield was significantly high in T3, T4 and T2. In all the manipulation treatments, significant yield improvement was noticed compared to control.

University of Agricultural Sciences, Dharwad
At harvest, the treatment (T2) detopping at 85 DAS and nipping 95 DAS recorded maximum number of bolls per plant (2656 kg/ha) while MH @ 500 ppm (T4) recorded the least (2317 kg/ha). The pooled data showed significant difference between genotype and treatments. The boll weight also followed the same trend of yield.

Suvin. The treatments were initiated as per the technical programme. Among the treatments T3 (Detopping at 95 DAS followed by nipping of monopodia sympodia at 105 DAS) and T4 (T2 - foliar application of maleic hydrazide (1033 kg/ha)) recorded significantly more boll weight than control or MH (T4 - Maleic hydrazide (500 ppm) at 85 DAS). Thus detopping of long duration tall cotton varieties at 95 DAS followed by nipping of sympodial meristem at 105 DAS or foliar application of MH at 85 DAS (500 ppm) had significant effect on biomass, number of bolls, boll weight and seed cotton yield.

Specific Technologies/ Recommendations
From the three years experiments on foliar application of ethrel, it is confirmed that foliar application of ethrel @ 8.56 mM ethylene at square initiation stage brought about changes in the plant morpho-frame leading to synchronous squaring, flowering and boll bursting. There was an enhanced seed cotton yield of 25% across the genotypes and also the agroclimatic zones with no negative effect on fibre quality.

Efforts made to popularize the technology / recommendation
During the year 2009-10, three on-farm trial was conducted in village using RCH 708 Bt cotton, to demonstrate the technology. The results showed that there was enhanced sympodial growth and around 20-30 extra bolls produced per plant, with foliar application of ethrel @ 8.56 mM during square initiation stage. There was also uniform boll bursting with no harmful effect on fibre quality.