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FAQs on Cotton Research: Tête-À-Tête with an Industry Stakeholder

EXPERT's Column

Dr. Y. G. Prasad
Director, ICAR-Central Institute for Cotton Research (CICR), Nagpur

Dr. Y.G. Prasad did his PhD in Entomology from Pusa Institute, New Delhi and has been Director, Central Institute for Cotton Research (CICR), Nagpur since Oct 2020. He is on the Board of Management of State Agricultural Universities (Dr PDKV, Akola and NAU, Gujarat); Steering group member of Digital India Corporation, Meity, GoI on digital solutions initiative for North East India. As an Entomologist, he has wide experience in IPM, pest forecasting and climate change adaptation and steering country-wide implementation of large-scale demonstrations on HDPS cotton under special project in 8 cotton growing states in PPP mode. He has published research on IPM, microbial pest control, climate smart agriculture and developed crop pest decision support systems.

Shri. Mahesh Sharda
Director, CAI, Mumbai & ICF, Coimbatore and past President, ICAL, Bhatinda

Shri. Mahesh Sharda is Director, DDPL Group Companies and belongs to the fourth generation of a family of cotton farmers and traders. Shri. Sharda is the past President of Indian Cotton Association Ltd (ICAL), Bhatinda; serving as Director in the Cotton Association of India (CAI), Mumbai and Indian Cotton Federation (ICF), Coimbatore.

He has been the key driving force behind conceptualizing several Indian Cotton Conferences to bind together the cotton value chain. He has been instrumental in initiating SANKALP by successfully bringing together Government-Private Enterprise-ICAL-Cotton Farmers on a common platform.

Worldwide, 21 countries produced biotech crops in a commercially significant scale (198.4 million ha area) in 2020. Among them, transgenic cotton for insect resistance (IR) or herbicide tolerance (HT) or both is cultivated in 19 countries. Bollworm resistant Bt cotton is the only genetically modified (GM) crop approved for commercial cultivation in India and has the largest area compared to all other Bt cotton growing countries. Cotton hybrids carrying cry1Ac (MON 531 event) for insect resistance received commercial approval by the Genetic Engineering Appraisal Committee (GEAC), Ministry of Environment, Forest and Climate

Change (MoEF & CC) in 2002 and another pyramided event (BG II, MON 15985) carrying two genes (both cry1Ac and cry2Ab Bt genes) in 2006. Bt cotton BG II hybrids now occupy more than 95% of the 13.0 million ha area under cotton.

The first reports on emergence of resistance in cotton pink bollworm (PBW) to BG II cotton came in 2014 and first outbreak of PBW on Bt Cotton occurred in 2015. Subsequently, serious damage due to PBW was reported in Maharashtra and Southern states during 2017. However, Bt cotton is still holding fort against the major cotton bollworm, Helicoverpa armigera.

Damage due to PBW not only causes yield loss but also damages fibre quality leading to poor marketability and remunerative prices. After the peak of 560 kg lint/ha achieved during 2013- 14, major reasons responsible for stagnant and fluctuating productivity are attributed to rainfall variability, PBW and boll rot outbreaks in the predominantly rainfed tracts of the Central and South zones; high temperature stress, whitefly, cotton leaf curl virus disease and PBW outbreaks in the North zone. Producers, ginners and buyers have voiced concern over the rising inputs costs and unstable output prices for raw cotton due to the disturbed balance between production and consumption. Clamour for novel gene technologies for boosting productivity has become shriller in recent years.

A case in point is the reduced planting area under cotton in the North zone. Current season field reports from Punjab indicate a decline in cotton area falling below one lakh ha. State Department of Agriculture figures from Haryana also indicate a decline in cotton area over the previous season. Significant decline in area is reported in the main cotton growing districts of Sirsa and Bhiwani along with noticeable reduction in Fattehabad and Ch Dadri. Cotton crop reportedly is replaced by paddy, groundnut, green gram and cluster bean in Haryana. The shift in cotton area in the irrigated North zone is a matter of concern especially for the value chain stakeholders like Shri. Mahesh Sharda. Falling cotton production, productivity and area in the North zone is a matter of common concern among stakeholders. Attention immediately shifts to cotton production and supply woes. Mostly voiced concern is technology fatigue as no new GM technology has been released in India for 22 years since the game changing Bt cotton technology was introduced in 2002. Shri. Sharda has summed up such queries related to cotton research in the form of frequently asked questions. This article is an attempt to provide some answers to these FAQs.

What are the main constraints in conducting trials for newer versions of Bt cotton technology in India?

The Genetic Engineering Appraisal Committee (GEAC)is the apex body constituted by the MoEF & CC for biosafety regulation under the Environment Protection Act, 1986. To effectively implement the Rules 1989 six competent authorities have been notified with defined role such as advisory, regulatory/ approval and monitoring i.e., Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Appraisal Committee (GEAC), State Biotechnology Coordination Committee (SBCC) and District Level Committee (DLC). Currently there are no constraints faced by the applicants till the application recommended by the RCGM and the GEAC. The major constraint is the inordinate delay in granting a 'no objection certificate' (NOC) by the concerned state government where the Biosafety Research Trials (BRLs) are intended to be conducted. NOC is a mandatory requirement of GEAC for giving the go ahead for confined field trials. However it appears that this constraint is easing up now, with few states such as Haryana, Punjab, Gujarat, Madhya Pradesh, Andhra Pradesh and Karnataka granting NOCs for conducting BRL trials for evaluation of new Bt cotton transgenic events aimed at PBW management.

Another step initiated by the government is towards the establishment of Notified Field Trial Sites (NFTS). The regulatory requirements for establishing NFTS have been framed by the Working Group constituted by the Department of Biotechnology (DBT) which have now been accepted by the GEAC. ICAR also constituted a committee which identified 42 sites across the various research Institutes and State Agricultural Universities (SAUs) for establishing the National Network on Notified Field Trial Sites (NNNFTS) for Biotechnology Research and Development. The Ministry of Agriculture and Farmers Welfare and MoEF & CC are in communication with the State governments for having one time 'NOC"

for testing new transgenic events at these sites at least for a five-year period. These developments initiated by the government departments for research, development and policy augur well for multi- location field testing and environmental release of new GM technologies in cotton and other crops as well.

What are the stages of conducting research in cotton till new seed is finally released for commercial cultivation, can we fast track the process?

Conventional plant breeding starts with assessment of variability in the germplasm, selection of parents based on traits of interest, hybridisation, pedigree breeding and advancement of generations till stable line having trait of interest is ready for entry into multi-location testing under AICRP on Cotton research network. Based on yield performance compared to zonal and local checks, variety or hybrid is identified, released and notified. The breeding cycle takes about 6-7 years while the overall time taken for the variety to be identified for commercial release requires nearly 8-10 years (Fig. 1). Efforts are underway to adopt speed breeding techniques to reduce the time taken for breeding cycle by 50%. Also, guidelines are in place for fast track release of varieties/ hybrids based on two-year multi-location testing instead of the mandatory three years for selected marker assisted traits and compact plant types suitable for high density planting system.

Transgenic variety or hybrid development involves back cross breeding program between elite parental line and transgenic donor line (Fig. 2) after obtaining due regulatory permissions at IBSC and RCGM levels. - RCGM and GEAC permits conduct of confined field trials and NOC is sought from the state governments. Misandatory for regulatory clearances by GEAC is three years confined field trials (BRL-1 & BRL -11) in two states for environmental safety assessment, laboratory bio-efficacy and food and feed safety assessment data in the form of a dossier. After de-regulation, the elite entry with the transgenic event enters into coordinated multi-location testing and based on yield advantage in comparison to ruling checks, the variety/hybrid is identified for release. In India, the regulatory system is in place for ensuring the biosafety of transgenic events and also for assuring yield performance to benefit farmers adopting the released GM varieties and hybrids.

What is the main reason for Bt cotton technology being only used in hybrids and not in varieties as is the case of other countries cultivating GM Cotton?

Hybrids in any crop exploit heterosis for yield enhancement and this phenomenon is

Fig 1. Steps in Classical Breeding of Cotton Varieties

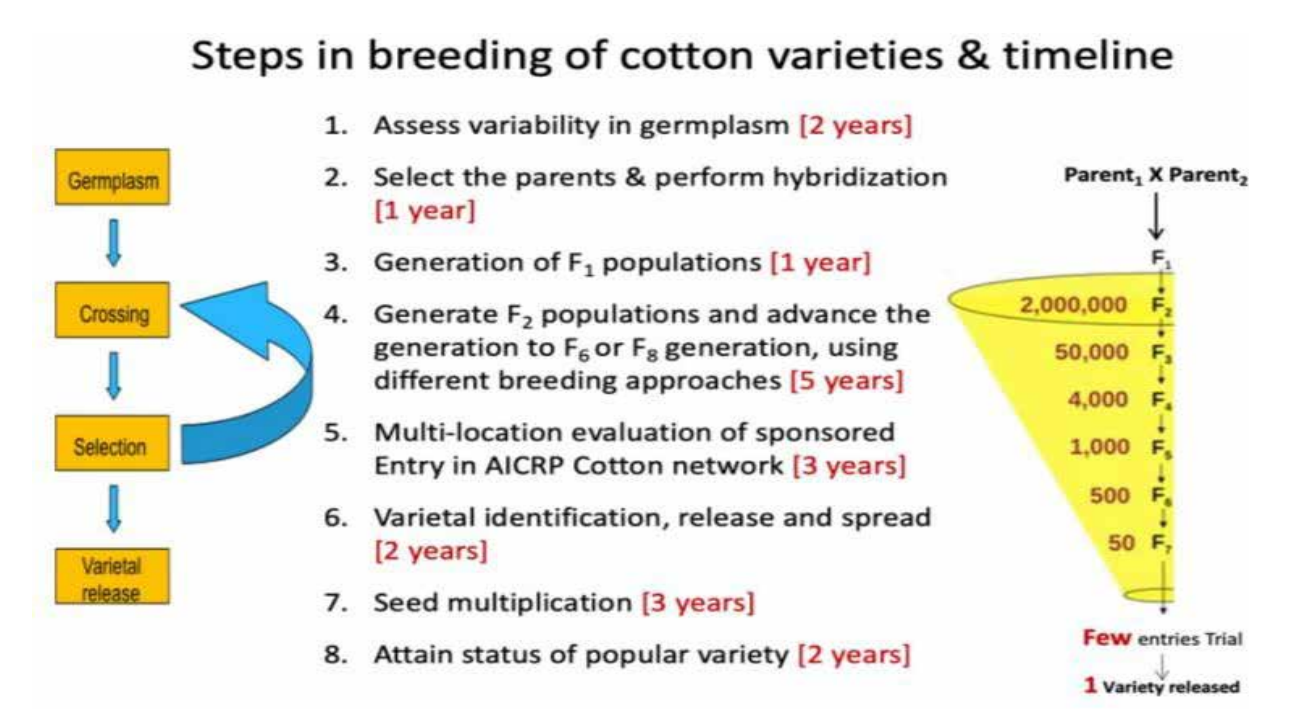
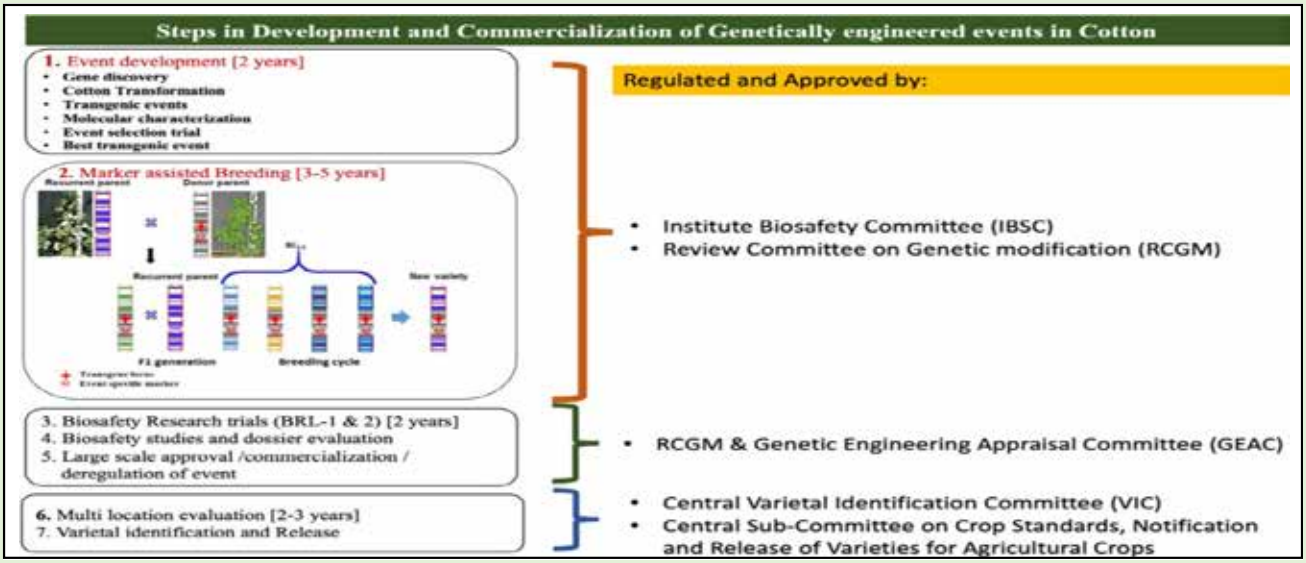


Fig 2. Transgenic Cotton Development, Regulation and Approval for Commercialisation



exploited in several field crops such as maize, millets, rice, vegetables and oilseeds apart from cotton. The first cotton hybrid (H4) was released in 1970 by Gujarat Agricultural University and subsequently several public sector cotton hybrids like H6, H8 and DCH 32 were released and became popular among farmers. About 55% cotton area was captured by the hybrids by 2000. Several research hybrids from the private sector also became popular during the 1990's.

Use of hybrid technology is mostly to exploit heterosis and also increase adaptability by combining diverse parents. It is also a value capture mechanism to investment in research. A return on investments in technology development is essential to promote investments for the development of new products.

In other countries, Bt cotton technology is available only in varieties as mostly high density planting system (HDPS) is widely adopted with plant populations of 1.1 to 2.5 lakh / ha maintained with use of a high seed rate ranging between 13 to 30 kg/ha. In India, the seed rate for hybrids ranges between 2 to 2.5 kg/ha as wider spacing is adopted with populations ranging below 20000 plants/ha. ICAR-CICR is now targeting compact hybrids for HDPS in light soils by increasing seed rate to 6-7 kg/ha. For HDPS to become popular, GM technology in varieties is mostly preferred to reduce cost of seed and facilitate machine sowing with incline plate planter at high density in light soil areas which constitute about 4 million ha in the country. Breeders will develop BG II Bt varieties meeting the standards prescribed under the Seed Act, 1966 if the IP protection is in place to protect the varieties bred by the private sector under the Protection of Plant Varieties and Farmers Rights (PPV & FR) Act, 1968 etc. Seed firms are also facing increasing problems in hybrid seed production challenges and are likely to pursue varietal development in case protection is assured.

Why is cotton seed price regulated in India whereas it is free from price control in the other countries? Does this regulation discourage research?

Cotton seed price is regulated under the Cotton Seed Price (Control) order 2015 under section 3 of the Essential Commodities Act, 1955. The order was issued to fix a uniform price of Bt cotton seed across the cotton growing states in the country for the benefit of farmers. The proportion of Bt seed cost is about 5 % of the total cost of cultivation or 7% of operational cost. Increase in cultivation cost is evident in most crops and cost of cultivation of cotton has increased worldwide. Average global seed cost is estimated at US $ 93/ ha (ICAC, 2020). In India, seed cost for Bt hybrids is estimated at US $ 79/ha which is lower than the varietal seed cost in 17 cotton growing countries such as Australia ($ 142 to 344 /ha), Brazil ($ 203 /ha), China ($ 183 /ha) and USA ($ 166/ha). Fixation of cotton seed price is a consultative process with stakeholders keeping in mind both the interest of seed producer and farmer. Introduction of newer GM traits in cotton may reinstate the discontinued trait value component in seed price.

What is the cost of bringing a good technology in cotton seed variety in India? What would be the cost price of the seed and increase in productivity per acre?

According to a recent study by Crop Life International in 2022, the cost of discovery, development and authorisation of a new plant biotechnology-derived genetic trait commercialised by multi-national companies in the period from 2017 to 2022 has been estimated at $115.0 million. The discovery phase of the process accounted for 6.6% of total costs and 13.3% of the non-consecutive total time. The genetic event construction and testing phase represented 55.8% of total costs and 35.6% of the non-consecutive total time. The regulatory phase, the longest duration of the overall process, accounted for 37.6% of total costs and 51.1% of the non-consecutive total time. The mean duration to bring a genetic trait to the point of commercialisation in 2017–2022 was 16.5 years (Crop Life International study, 2022). In India, there are no cost estimates available for development of transgenic trait. The seed cost will depend on the seed value and trait value. In India, efforts are underway by both public and private sector to develop transgenic events effective against the dreaded pink bollworm. Commercialization of any event effective against cotton pink bollworm is estimated to save Rs. 1299 crores annually (unpublished).

Does India have seed varieties which can sustain drought and rising temperature?

Cotton is a widespread crop cultivated in the arid and semi-arid regions globally, particularly in regions with frequent drought. Abiotic stress significantly impacts cotton plants both morphologically and physiologically. Continuous spell of drought stress not only affects yield but also primarily influences fibre length and micronaire (Abdelraheem et al. 2019). A significant step in the history of breeding research was the release of Bikaneri Narma and its selections 'F414' and 'H 777' which were identified for adaptability and high yields in North India. LRA 5166 was landmark variety released in 1982 which is known for its wider adaptability and drought tolerance. Among hybrids, NHH 44 released in 1983 was highly suitable for rainfed conditions. Most of the Bt hybrids released for the North zone have been released based on high yields in multi-location trials mostly due to better tolerance of the summer sown crop to high temperature stress in the north zone. Some of the hybrids by the private sector released for the central zone and south zone are both drought tolerant and sucking pest (jassid) tolerant. Early maturing compact Bt varieties released by public sector and compact BG II hybrids by the private sector are better suited to avoid terminal moisture stress in rainfed tracts.

How can the private industry associate in cotton research to fast track development of new GM traits?

This is the time for public-private and private-private partnerships in conducting research in cotton to usher in novel traits to break the logjam in productivity. Collaborative research is desired from the inception of research programs, targeted pre-breeding programs, utilisation of genomic resources, consortium development for germplasm exchange, sharing of promising parental lines for hybrid development and marker assisted breeding for insect and disease resistance and tolerance to abiotic stresses. Public sector research collaboration between ICAR and CSIR institutes is in progress. Similarly, early collaboration and joint efforts between private sector would bring down the cost of R & D for development of new transgenic or genome edited lines. Private seed industry depended on public sector research in varietal improvement programs prior to the advent of Bt cotton in India. Revival of such collaborative linkages between public and private sector is the need of the hour so as to rise to the expectations of the farmers and industry stakeholders for a much needed turn-around in cotton sector so vital for a vibrant cotton based textile value chain and economy.

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(The views expressed in this column are of the author and not that of Cotton Association of India)


COTTON ASSOCIATION OF INDIA
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Established 1921
ISO 9001:2015
A CHILD'S CHILDHOOD IS FOR LEARNING
DON'T USE THEIR CHILDHOOD FOR EARNING
SAY NO TO CHILD LABOUR

Glimpses of Varun Yagna at CAI on 31st May 2024

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Gravimetric Trash	Strength /GPT	Spot Rate (Upcountry) 2023-24 Crop June 2024 10th	11th	12th	13th	14th	15th
1	P/H/R	ICS-101	Fine	Below 22mm	5.0 – 7.0	4%	15	12738 (45300)	12738 (45300)	12823 (45600)	12823 (45600)	12766 (45400)	12766 (45400)
2	P/H/R (SG)	ICS-201	Fine	Below 22mm	5.0 – 7.0	4.5%	15	12907 (45900)	12907 (45900)	12991 (46200)	12991 (46200)	12935 (46000)	12935 (46000)
3	GUJ	ICS-102	Fine	22mm	4.0 – 6.0	13%	20	10854 (38600)	10798 (38400)	10798 (38400)	10798 (38400)	10798 (38400)	10770 (38300)
4	KAR	ICS-103	Fine	22mm	4.5 – 6.0	6%	21	12345 (43900)	12317 (43800)	12317 (43800)	12317 (43800)	12317 (43800)	12288 (43700)
5	M/M (P)	ICS-104	Fine	23mm	4.5 – 7.0	4%	22	14341 (51000)	14313 (50900)	14313 (50900)	14313 (50900)	14313 (50900)	14313 (50900)
6	P/H/R (U) (SG)	ICS-202	Fine	27mm	3.5 – 4.9	4.5%	26	14988 (53300)	14960 (53200)	15016 (53400)	14932 (53100)	14904 (53000)	14988 (53300)
7	M/M(P)/ SA/TL	ICS-105	Fine	26mm	3.0 – 3.4	4%	25	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
8	P/H/R(U)	ICS-105	Fine	27mm	3.5 – 4.9	4%	26	15157 (53900)	15129 (53800)	15185 (54000)	15100 (53700)	15072 (53600)	15157 (53900)
9	M/M(P)/ SA/TL/G	ICS-105	Fine	27mm	3.0 – 3.4	4%	25	14454 (51400)	14397 (51200)	14341 (51000)	14341 (51000)	14341 (51000)	14341 (51000)
10	M/M(P)/ SA/TL	ICS-105	Fine	27mm	3.5 – 4.9	3.5%	26	15185 (54000)	15129 (53800)	15129 (53800)	15129 (53800)	15129 (53800)	15129 (53800)
11	P/H/R(U)	ICS-105	Fine	28mm	3.5 – 4.9	4%	27	15410 (54800)	15382 (54700)	15438 (54900)	15353 (54600)	15325 (54500)	15410 (54800)
12	M/M(P)	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	15494 (55100)	15466 (55000)	15466 (55000)	15550 (55300)	15550 (55300)	15550 (55300)
13	SA/TL/K	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	15550 (55300)	15522 (55200)	15522 (55200)	15607 (55500)	15607 (55500)	15607 (55500)
14	GUJ	ICS-105	Fine	28mm	3.7 – 4.5	3%	27	15494 (55100)	15438 (54900)	15466 (55000)	15466 (55000)	15466 (55000)	15466 (55000)
15	R(L)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	15944 (56700)	15916 (56600)	15944 (56700)	15888 (56500)	15888 (56500)	15888 (56500)
16	M/M(P)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	15832 (56300)	15803 (56200)	15803 (56200)	15888 (56500)	15888 (56500)	15888 (56500)
17	SA/TL/K	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	15916 (56600)	15888 (56500)	15888 (56500)	15972 (56800)	15972 (56800)	15972 (56800)
18	GUJ	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	15775 (56100)	15719 (55900)	15747 (56000)	15747 (56000)	15747 (56000)	15747 (56000)
19	M/M(P)	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	16141 (57400)	16085 (57200)	16085 (57200)	16169 (57500)	16169 (57500)	16169 (57500)
20	SA/TL/K/O	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	16169 (57500)	16113 (57300)	16113 (57300)	16197 (57600)	16197 (57600)	16197 (57600)
21	M/M(P)	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	16450 (58500)	16394 (58300)	16394 (58300)	16450 (58500)	16450 (58500)	16450 (58500)
22	SA/TL/ K / TN/O	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	16478 (58600)	16422 (58400)	16422 (58400)	16478 (58600)	16478 (58600)	16478 (58600)
23	SA/TL/K/ TN/O	ICS-106	Fine	32mm	3.5 – 4.2	3%	31	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
24	M/M(P)	ICS-107	Fine	34mm	2.8 - 3.7	4%	33	22777 (81000)	22777 (81000)	22777 (81000)	22777 (81000)	22777 (81000)	22777 (81000)
25	K/TN	ICS-107	Fine	34mm	2.8 - 3.7	3.5%	34	23621 (84000)	23621 (84000)	23621 (84000)	23621 (84000)	23621 (84000)	23621 (84000)
26	M/M(P)	ICS-107	Fine	35mm	2.8 - 3.7	4%	35	23199 (82500)	23199 (82500)	23199 (82500)	23199 (82500)	23199 (82500)	23199 (82500)
27	K/TN	ICS-107	Fine	35mm	2.8 - 3.7	3.5%	35	24183 (86000)	24183 (86000)	24183 (86000)	24183 (86000)	24183 (86000)	24183 (86000)

(Note: Figures in bracket indicate prices in Rs./Candy)