

**FINAL REPORT**

**ON**

**FEEDING STUDIES OF TRANSGENIC Bt COTTON SEED OF  
JKAL EVENT 1 CONTAINING CRY1 Ac GENE IN LACTATING  
CROSS BRED DAIRY COWS**

*Submitted to*

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**Principal Investigator and  
All Collaborators**

**PROJECT: FEEDING STUDIES OF TRANSGENIC Bt COTTON SEED  
OF JKAL EVENT 1 CONTAINING CRY 1 Ac GENE IN LACTATING  
CROSS BRED DAIRY COWS**

**INTRODUCTION**

Cotton is one of the important commercial crop of the dry regions of India. Cotton seeds and cotton seed cake are extensively used in the diets of farm animals particularly for the feeding of dairy cattle and buffaloes. However, damage of cotton crop by insect pest is quite common in India, which causes great economic loss due to low yield and poor fiber quality. Almost 130 species and strains of insects have been identified responsible for the damage of cotton crop and greater damage is caused by Lepidopteron insects. Several types of insecticides and pesticides are used for the control of these insects. These drugs are not only expensive but mostly pose environmental pollution problems and resistance has also been developed against many chemicals, which have become ineffective for controlling insect infestations.

An effective control measure for preventing damage by insects and pests has been evolved by the application of transgenic technology, which is also environmental friendly. An insecticidal gene naturally present in bacterium, *Bacillus thuringiensis*, has been identified, isolated and introduced in the cotton genome. This has developed the ability of production of cry group of protein(s) in the cotton crop, which has preventive effect against lepidopteran insect pests. A genetically modified (GM) cotton variety commonly known as Bt. Cotton is being used by large number of farmers in India and many other countries since its commercial use from 2002. A CryI Ac protein introduced genetically in Bt. Cotton provides significantly effective protection against feeding damage caused by lepidopteran insect pests, and cultivation of Bt. Cotton use much less



quantity of harmful insecticides for controlling these pests. This increases production of better quality cotton providing higher income in comparison to conventional cotton varieties.

A new genetically modified cotton variety named as JKC738 Bt.-a-*Gossypium hirsutum* parental line has been developed by JK Agri Genetics Ltd. for commercial cultivation. The introduced insecticidal gene HD73 CryI AC (1845bp) from *Bacillus thuringiensis* has effective insecticidal effect against important species of Lepidopteran insect pests of cotton, viz. American bollworm (*Helicovspa armigera*), spotted bollworm (*Earias vitella*) and pink bollworm (*Pectinophora gossypiella*). Large quantity of cotton seeds produced from the extensive cultivation of Bt. Cotton has to be used for the feeding of livestock including the dairy bovines the JK Agri. Genetics Ltd. has requested IVRI, Izatnagar for conducting a feeding Trial of 58 days duration using Bt. Cotton seed in the diet of lactating Crossbred Cows. This is mandatory requirement of GOI/DBT for feed safety evaluation before the release of the JKC738 Bt. Cotton seed for the feeding of livestock.

## **OBJECTIVES**

The purpose of this study is to assess the effects of feeding transgenic plants/plant part samples on feed intake, milk production and milk composition in lactating crossbred dairy cows as compared to feeding non-transgenic plants/plant part samples grown under identical conditions and harvested at the same physiological maturity as its transgenic counterpart.



## **MATERIAL AND METHODS**

Adequate quantity of feed to be fed to the experimental animals for testing were supplied by the applicant. The supplied feeds were Bt. Cotton seed and non-Bt. Cotton seed said to be produced under similar cultivation conditions. The feeds were labelled as Bt. Cotton seeds and non-Bt. Cotton seed and were stored properly. Other feed ingredients to be used for the feeding of experimental cows were procured in a lot.

All the feeds were either crushed or ground as per the need individually, sampled for chemical analysis and then used for the formulation presented in **table –1**. The concentrate mixture contained 40 percent of respective cotton seeds. The proportion of cotton seeds from two varieties was quite high to facilitate adequate quantity for showing effects on health and production of the animals.

The intake of diets of crossbred cows of the two groups were made of chaffed green maize fodder and liberal amount of concentrate mixture for fulfilling the nutritional requirements of milk production and also to maintain good health.

## **EXPERIMENTAL ANIMALS**

Twenty multiparous cows in early lactation (70-130 days) were selected from the standard cattle herd of Indian Veterinary Research Institute (IVRI). The cows were distributed into two groups of equal number on the basis of comparable body weight, milk yield and as far as possible genetic composition. All the cows were having permanent identification number.

**TABLE- 1. COMPOSITION OF CONCENTRATE MIXTURES**

<b>Ingredients</b>	<b>Concentrate mixture with Bt. cotton seed</b>	<b>Concentrate mixture with Non Bt cotton seed</b>
<b>Crushed maize grain</b>	20	20
<b>Wheat bran</b>	25	25
<b>Crushed cotton seed (Bt)</b>	40	-
<b>Crushed cotton seed (Non-Bt)</b>	-	40
<b>Mustard cake</b>	12	12
<b>Mineral mixture</b>	2	2
<b>Common salt</b>	1	1

The experimental cows were maintained under strict hygienic condition as per the standard schedule of the livestock farm. All safety arrangements were made for the protection of experimental animals during the study period.

The feeding, watering, milking, examination for health etc. were carried out as per schedule of the farm with intake of the individual cows of the two groups and recording of body weight at weekly interval.

### **EXPERIMENTAL DESIGN**

In a cross over design 10 crossbred lactating cows were used in each group on comparable performance. All the cows were fed standard farm diet of concentrate and fodder in controlled condition for acclimation. This was followed by the feeding of test diet in Bt. Cotton seed group (Bt. CG) and control diet in Non Bt. Cottonseed group (NBt. CG) for a period of 28 days. At the end of 28 days the cows of Bt. CG group were shifted to NBt. CG group and vice versa. After this they were fed their new diets for one week before further recording in changed condition for 28 days.

During the two phases of 28 days each a digestion trial of 6 days collection period was conducted for the estimation of digestibility of nutrients.

### **MILK RECORDING**

Milk yield of each cow was recorded at morning and evening milking. Representative samples of milk were collected periodically for analysis of milk composition. Somatic cell count in milk was done as per the method described by Schalm *et al.* (1971).



## **BLOOD ANALYSIS**

Periodic blood samples were collected from the jugular vein of the cows and processed for the analysis of haematology and some chemical constituents. The samples were collected at weekly intervals. The parameters analysed were:

- i. Total RBC count
- ii. Total WBC count
- iii. Haemoglobin concentration

The examination of the collected blood for Total Leukocyte Count (TLC) and Total Erythrocyte Count (TEC) was done as per the procedure of Jain (1986). Hemoglobin concentration was estimated by cyanmethemoglobin method and expressed in g/dl.

The calcium, magnesium, zinc, copper, cobalt, sodium, potassium and iron in fodder and serum samples were estimated by using atomic absorption spectrophotometer (AAS-4141 ECIL, India) after digestion of the samples.

Phosphorus in fodder was estimated by the method of Talapatra et al. (1940). The serum inorganic phosphorus was estimated by the method of Taussky and Shorr (1953).

## **ANALYSIS OF SAMPLES OF DIGESTION TRIAL**

All the representative samples of feeds, fodder and faeces were analysed for dry matter and other constituents as per the standard procedures described in AOAC (1985) and later on.

## **DISPOSAL OF MILK**

Milk obtained from the cows fed on Bt. Cotton seed containing diet was disposed after sampling in such a manner that it was not available for the consumption of man or animal in any form. For this purpose a committee of responsible personnels was constituted.

## **STATISTICAL ANALYSIS**

Standard methods of data analysis were followed (Snendcor and Cochran, 1968), if differences due to treatments attracted the requirement.

## **RESULTS**

### **Chemical composition of the feeds**

Average chemical composition of feed ingredients, concentrate mixtures, green maize fodder and its residue is presented in **Table- 2** on dry matter (DM) basis. As expected samples of Bt. Cotton seed as well as non-Bt.Cotton seed contained high percentage of lipids (Ether Extract) showing the richness in energy content . The value of Crude Protein (CP) content in the two concentrate mixtures has been decided in a manner to meet the optimum requirement of milk production in crossbred cows.

### **Mineral contents of fodder and concentrate mixtures**

The values of important minerals in fodder and concentrate mixtures are presented in **Table –3**. The content of different dietary essential minerals was adequate for the diets of lactating crossbred cows.

### **Dry Matter Intake (DMI) during feeding trial**

Mean values of DMI per day for first phase of four weeks are presented on weekly basis in **Table-4**. There was no difference in the daily DMI of the cows of two groups. It means there was no significant effect of Bt or Non Bt. Cotton seeds incorporation in concentrate mixture on the acceptability and palatability of the diets. Intake of cotton seed in total daily feed intake was about 2.0 Kg per head per day.

### **Weekly live weight change of cows during the experimental period**

Mean values of body weight just before the start of experimental feeding and then at weekly interval were recorded on a platform balance (**Table-5**). The changes in the body weights of experimental cows of two



**TABLE- 2. CHEMICAL COMPOSITION OF DIFFERENT FEED INGREDIENTS AND CONCENTRATE MIXTURE ON DRY MATTER BASIS (%)**

<b>Feed ingredients/ Concentrate mixture</b>	<b>DM</b>	<b>OM</b>	<b>CP</b>	<b>EE</b>	<b>NDF</b>	<b>ADF</b>	<b>Ash</b>	<b>AIA</b>
<b>Crushed maize</b>	90.85	96.98	12.15	3.38	33.12	4.25	3.02	0.48
<b>Wheat bran</b>	91.68	95.00	15.32	4.12	45.22	10.71	5.00	0.34
<b>Mustard cake</b>	92.35	91.02	35.06	1.22	42.76	11.25	8.98	1.65
<b>Cotton seed (Bt)</b>	91.26	93.55	24.83	23.89	21.45	10.93	6.45	1.50
<b>Cotton seed (Non-Bt)</b>	91.42	93.49	22.68	21.74	23.12	11.72	6.51	1.51
<b>Conc. Mixture (Bt)</b>	92.15	91.57	20.51	11.04	23.56	8.22	8.43	1.02
<b>Conc. Mixture (Non-Bt)</b>	91.94	90.89	19.58	10.73	25.12	9.57	9.11	0.92
<b>Green maize (offered) I</b>	-	90.76	7.96	1.43	78.04	56.88	9.24	-
<b>Green Maize (residue) I</b>	-	88.24	7.57	1.45	75.52	57.24	11.76	-
<b>Green Maize (offered) II</b>	-	90.54	7.87	1.45	76.83	54.56	90.46	-
<b>Green Maize (residue) II</b>	-	89.02	7.23	1.48	73.64	56.19	10.98	-

**TABLE -3. MINERAL STATUS IN FODDER AND CONCENTRATE (MEAN±SE )**

	Ca (%)	P (%)	Mg (%)	Na (%)	K (%)	Fe (%)	Co (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
<b>Fodder</b>	0.64±0.02	0.33±0.01	1.14±0.02	0.07±0.003	1.99±0.03	0.015±0.001	0.14±0.04	8.64±0.3	14.71±0.01
<b>Concentrate</b>									
<b>1. Bt. Cotton</b>	0.59±0.02	0.86±0.03	1.03±0.03	0.09±0.002	1.42±0.04	0.019±0.003	0.19±0.02	10.41±0.2	20.04±0.02
<b>2. Non-Bt. cotton</b>	0.54±0.01	0.85±0.03	0.99±0.02	0.08±0.003	1.36±0.02	0.019±0.002	0.20±0.03	10.52±0.3	19.99±0.01

Values between Bt cotton and non- Bt cotton animals were statistically non-significant (P>0.05)

**TABLE- 4. WEEKLY MEAN VALUES OF DRY MATTER INTAKE DURING FIRST FEEDING TRIAL**

	DM intake (Kg/day) during 4 weeks				
Group	1	2	3	4	Overall
Bt cotton group	13.95	11.72	13.79	12.23	12.92
Non- Bt cotton group	13.68	12.39	13.41	11.84	12.83



**TABLE- 5. AVERAGE WEEKLY LIVE WEIGHT (KG) OF COWS DURING PHASE 1 AND 2**

<b>Group</b>	<b>Phase 1 (weeks)</b>					<b>Phase 2 (weeks)</b>				
	<b>Initial</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Initial</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>Bt cotton group</b>	392.0	396.0	394.5	394.5	402.5	411.0	403.5	404.5	418.5	416.0
<b>Non-Bt cotton group</b>	390.0	400.0	390.5	394.5	404.0	409.0	404.0	408.0	<del>414.0</del>	<del>416.5</del>

groups during the two phases of 28 days each were as per the normal changes in the body weight of lactating cows and there was no specific effect of either variety of cotton seed on the periodic changes in body weight during the experimental feeding period.

### **Weekly record of daily milk yield**

Average values of milk yield per cow per day for the two phases of four weeks each are presented in **Table-6**.

The marginal fluctuation in average daily milk yield of the cows of two treatment groups showed the normal lactation pattern, which was comparable in both the groups. This also showed that lactation pattern and daily milk yield has not been influenced by the sources of cotton seeds incorporated in the concentrate mixtures of the diets of the cows of two groups.

### **Milk Composition**

Mean values of the milk samples collected at weekly intervals at morning and evening milking for each cow were analysed for various milk constituents are presented in **Table -7**.

Higher milk fat content in the after noon milking of cows is normal in the tropical climate and there is no effect of diet for such difference. The concentration of protein, lactose and ash content in the milk of the cows of two groups in either phase was as per normal pattern. There was no effect of dietary constituents on the composition of milk.

**TABLE- 6. AVERAGE DAILY MILK YIELD (KG/DAY) OF COWS DURING PHASE 1 AND 2**

	Phase 1 (weeks)					Phase 2 (weeks)				
Group	Initial	1	2	3	4	Initial	1	2	3	4
Bt cotton group	10.82	10.33	9.90	10.50	10.00	10.40	9.80	9.50	9.80	9.70
Non-Bt cotton group	10.24	9.37	9.37	10.50	10.10	10.80	10.40	9.60	9.90	9.66



**TABLE- 7. MILK COMPOSITION (WEEKLY)**

Group	1	2	3	4	5	6	7	8
<b>Milk Fat</b>								
<b>Bt group M</b>	3.93	4.57	5.40	4.52	4.07	4.41	4.47	4.28
<b>E</b>	5.20	4.85	5.72	5.56	5.70	4.66	5.31	5.37
<b>Avg</b>	4.57	4.71	5.56	5.04	4.89	4.54	4.89	4.83
<b>Non-Bt group M</b>	2.84	4.11	4.54	3.98	4.22	4.02	3.85	4.45
<b>E</b>	5.11	4.50	5.22	4.22	4.30	4.92	5.05	4.73
<b>Avg</b>	3.98	4.31	4.88	4.08	4.26	4.47	4.45	4.59
<b>Milk protein</b>								
<b>Bt group</b>	2.73	2.86	2.90	2.92	2.70	2.72	2.75	2.65
<b>Non- Bt group</b>	2.83	2.82	2.74	2.71	2.92	2.91	2.82	2.85
<b>Lactose</b>								
<b>Bt group</b>	4.93	4.93	4.88	4.96	4.98	4.89	4.96	4.94
<b>Non- Bt group</b>	5.10	4.88	4.91	4.89	4.98	4.91	4.90	4.99
<b>Ash</b>								
<b>Bt group</b>	0.697	0.689	0.694	0.689	0.691	0.696	0.701	0.703
<b>Non- Bt group</b>	0.695	0.690	0.693	0.696	0.698	0.701	0.700	0.708

## **Digestibility coefficients of DM and some important nutrients**

Crude protein (CP) and crude fat or ether extract (EE) are the two most important constituents of cotton seed. Most of the farmers are not aware about the importance of CP but almost all dairy animal owners of the cotton growing regions are fully aware of the importance of lipids of cotton seed in the diets of lactating cows and buffaloes. Due to this reason cotton seed has become a most favourite feed of lactating cows and buffaloes and dairy animal owners of even non-cotton cultivating area also prefer to feed cotton seed in the diets of their lactating cows and buffaloes. In view of the nutritional status of cotton seed digestibility coefficients of DM, CP, EE and OM have been determined and presented in **Table-8**.

The average values of intake and digestibility coefficient of DM, CP, EE and OM are apparently showing the non-significant effect of diets and dietary constituents. The digestibility values are as per the expectations for such diets.

## **HAEMATO-BIOCHEMICAL STUDIES**

Haematological values and biochemical constituents of blood have been presented in **Table-9 and 10** for the duration of feeding phase 1 and 2 of the experimental period, respectively. The values of different constituents have been described as follows:-

### **Haemoglobin (Hb)**

The average values of Hb (g/dl) remained between 11.72 and 12.09 during the 28 days of first phase and 11.86 and 12.01 during the 28

**TABLE -8. MEAN INTAKE AND DIGESTIBILITY OF DM AND NUTRIENTS DURING 1<sup>ST</sup> TRAIL.**

Nutrients	Bt Cotton group		Non- Bt Cotton group	
	Intake (Kg)	Digestibility (%)	Intake (Kg)	Digestibility (%)
DM	13.08	71.59	13.21	71.46
CP	1.55	58.01	1.54	57.24
EE	0.64	80.89	0.62	81.58
OM	11.98	73.62	12.17	72.94



**TABLE- 9. SHOWING HAEMATO-BIOCHEMICAL AND MILK PROFILE IN EXPERIMENT I (MEAN±SE )**

S.No.	Parameter	Group I							
		BT Cotton				Non BT Cotton			
		0 day	7 day	14 day	28 day	0 day	7 day	14 day	28 day
1.	Hb (g/dl)	11.81±0.97	11.96±0.86	12.07±0.82	11.82±0.72	11.72±0.52	12.01±0.94	12.09±0.65	11.89±0.95
2.	RBC( $\times 10^6$ )/cmm	6.17±0.88	6.27±0.61	6.29±0.79	6.36±0.65	6.45±0.93	6.44±0.81	6.39±0.79	6.43±0.67
3.	WBC( $\times 10^3$ )/cmm	8.21±0.18	8.24±0.19	8.30±0.11	8.31±0.13	8.29±0.24	8.23±0.29	8.28±0.22	8.24±0.17
4.	Serum Ca(mg/dl)	11.08±0.99	11.71±1.02	11.31±0.93	11.48±1.11	11.51±1.07	11.33±1.09	11.29±1.02	11.27±0.99
5.	Serum P(mg/dl)	5.56±0.65	5.59±0.73	5.64±0.84	5.67±0.69	5.51±0.77	5.63±0.84	5.61±0.91	5.57±0.94
6.	Serum Mg(mg/dl)	2.10±0.06	2.13±0.07	2.14±0.09	2.16±0.07	2.10±0.08	2.15±0.04	2.14±0.06	2.13±0.06
7.	Serum Na(mmol/lit)	143.18±5.71	146.17±7.63	147.28±6.19	149.63±5.14	149.55±8.04	148.19±7.77	146.23±8.90	145.11±8.54
8.	Serum K(mmol/lit)	5.51±0.98	5.59±1.02	5.63±0.87	5.66±0.96	5.56±0.99	5.59±0.94	5.57±1.04	5.55±1.11
9.	Serum Cu(ppm)	0.71±0.03	0.69±0.01	0.64±0.06	0.71±0.02	0.68±0.03	0.69±0.02	0.68±0.02	0.67±0.03
10.	Serum Fe(ppm)	1.11±0.01	1.21±0.02	1.24±0.03	1.29±0.02	1.24±0.03	1.27±0.04	1.24±0.03	1.21±0.03
11.	Serum Zn(ppm)	1.26±0.03	1.27±0.05	1.29±0.02	1.30±0.03	1.28±0.02	1.27±0.02	1.25±0.03	1.23±0.02
12.	Serum Co(ppm)	0.034±0.001	0.036±0.002	0.038±0.001	0.041±0.002	0.032±0.003	0.039±0.002	0.036±0.001	0.035±0.002
13.	Somatic cell count (milk) $\times 10^4$	7.61±0.87	7.64±0.71	7.64±0.75	7.61±0.83	7.63±0.92	7.61±0.86	7.66±0.70	7.69±0.71

Values between Bt cotton and non- Bt cotton animals were statistically non-significant ( $P>0.05$ )



days of second phase. The values were not influenced by either diet or change of diet due to crossover of the cows from one diet to another diet, i.e. from Bt.-cotton seed group to Non-Bt. Cotton seed group and vice versa.

### **Total RBC**

There was no effect of diets on the total RBC count during the either phase of 28 days experimental feeding of Bt cotton seed and non-Bt. Cotton seed containing diets (**Table-9 and 10**). The values were normal and similar in the two groups.

### **Total White Blood Cells (WBC)**

The total WBC count showed the pattern of total RBC count during the either phase of 28 days experimental feeding of diets containing two varieties of cotton seeds. The change pattern in total WBC count was in the normal range and has not been affected with the composition of diets.

### **Serum Mineral Status**

The mineral status of blood (Serum/plasma) may be differentiated into macro minerals and micro or trace minerals. The average value of various minerals are presented in table 9 and 10 for the two phases.

The average weekly values of Ca, P, Mg, Na and K fluctuated in normal range, and these were not influenced by the dietary composition. This indicated that feeding of Bt. Cotton seed containing diet has no specific effect on the content of various macro minerals present in the serum of experimental cows. The effect was similar during the two phases of crossover feeding.

**TABLE 10. SHOWING HAEMATO-BIOCHEMICAL AND MILK PROFILE IN EXPERIMENT II (MEAN $\pm$ SE )**

S.No.	Parameter	Group I							
		BT Cotton				Non BT Cotton			
		0 day	7 day	14 day	28 day	0 day	7 day	14 day	28 day
1.	Hb (g/dl)	12.01 $\pm$ 0.89	11.99 $\pm$ 0.78	11.86 $\pm$ 0.91	11.82 $\pm$ 0.65	11.87 $\pm$ 0.83	11.89 $\pm$ 0.75	11.91 $\pm$ 0.75	11.95 $\pm$ 0.84
2.	RBC( $\times 10^6$ )/cmm	6.27 $\pm$ 0.71	7.32 $\pm$ 0.69	6.45 $\pm$ 0.62	7.56 $\pm$ 0.54	6.66 $\pm$ 0.84	6.57 $\pm$ 0.76	7.63 $\pm$ 0.82	6.47 $\pm$ 0.54
3.	WBC( $\times 10^3$ )/cmm	8.45 $\pm$ 0.21	7.28 $\pm$ 0.11	8.31 $\pm$ 0.17	8.43 $\pm$ 0.14	7.57 $\pm$ 0.16	8.59 $\pm$ 0.19	7.71 $\pm$ 0.20	8.93 $\pm$ 0.13
4.	Serum Ca(mg/dl)	11.11 $\pm$ 0.87	11.21 $\pm$ 0.96	11.27 $\pm$ 0.88	11.32 $\pm$ 0.96	11.35 $\pm$ 1.01	11.33 $\pm$ 0.97	11.36 $\pm$ 1.04	11.39 $\pm$ 1.04
5.	Serum P(mg/dl)	5.61 $\pm$ 0.57	5.63 $\pm$ 0.62	5.66 $\pm$ 0.71	5.70 $\pm$ 0.56	5.73 $\pm$ 0.69	5.73 $\pm$ 0.74	5.75 $\pm$ 0.87	5.76 $\pm$ 0.89
6.	Serum Mg(mg/dl)	2.31 $\pm$ 0.04	2.28 $\pm$ 0.02	2.24 $\pm$ 0.06	2.30 $\pm$ 0.05	2.32 $\pm$ 0.06	2.32 $\pm$ 0.03	2.35 $\pm$ 0.05	2.37 $\pm$ 0.07
7.	Serum Na(mmol/lit)	141.16 $\pm$ 6.61	142.19 $\pm$ 6.73	144.18 $\pm$ 6.38	143.23 $\pm$ 6.74	144.48 $\pm$ 7.03	142.50 $\pm$ 6.71	143.61 $\pm$ 7.93	144.73 $\pm$ 6.51
8.	Serum K(mmol/lit)	5.61 $\pm$ 0.86	5.63 $\pm$ 0.99	5.65 $\pm$ 0.73	5.68 $\pm$ 0.81	5.70 $\pm$ 0.87	5.70 $\pm$ 0.79	5.72 $\pm$ 0.99	5.77 $\pm$ 1.01
9.	Serum Cu(ppm)	0.66 $\pm$ 0.05	0.71 $\pm$ 0.04	0.67 $\pm$ 0.03	0.72 $\pm$ 0.03	0.69 $\pm$ 0.02	0.73 $\pm$ 0.01	0.75 $\pm$ 0.03	0.77 $\pm$ 0.02
10.	Serum Fe(ppm)	1.16 $\pm$ 0.02	1.19 $\pm$ 0.04	1.21 $\pm$ 0.02	1.23 $\pm$ 0.01	1.24 $\pm$ 0.0	1.25 $\pm$ 0.03	1.29 $\pm$ 0.02	1.30 $\pm$ 0.01
11.	Serum Zn(ppm)	1.16 $\pm$ 0.02	1.17 $\pm$ 0.04	1.18 $\pm$ 0.03	1.21 $\pm$ 0.04	1.24 $\pm$ 0.03	1.25 $\pm$ 0.01	1.27 $\pm$ 0.02	1.29 $\pm$ 0.01
12.	Serum Co(ppm)	0.029 $\pm$ 0.002	0.026 $\pm$ 0.001	0.028 $\pm$ 0.002	0.031 $\pm$ 0.003	0.030 $\pm$ 0.00	0.033 $\pm$ 0.001	0.035 $\pm$ 0.002	0.037 $\pm$ 0.003
13.	Somatic cell count (milk) $\times 10^4$	7.44 $\pm$ 0.66	7.56 $\pm$ 0.89	7.32 $\pm$ 0.69	7.47 $\pm$ 0.75	7.56 $\pm$ 0.86	7.67 $\pm$ 0.77	7.34 $\pm$ 0.64	7.09 $\pm$ 0.66

Values between Bt cotton and non-Bt cotton animals were statistically non-significant (P>0.05)

Among the micro minerals the values of copper (Cu), iron (Fe), zinc (Zn) and Cobalt (Co) were also in the normal range in the cows of both the groups and also during the two phases of cross-over feeding duration of 28 days each. The values of micro minerals clearly show that dietary constituents have no influence on their status.

### **Somatic Cell Count in Milk.**

The udder health of all the cows of two groups remained sound during the entire period of experimental feeding of Bt. Cotton seed containing diet and non Bt. Cotton seed containing diet. This was further supported by the low count of somatic cell in the milk samples of all the cows examined at the start of the feeding experiment and then on day 7, 14 and 28 of the feeding period of each phase. The values of somatic cell count ranged from  $7.61 \pm 0.87$  to  $7.69 \pm 0.71$  (Table-9) during phase 1. The values showed slight decline to range between  $7.09 \pm 0.66$  and  $7.67 \pm 0.77$  (table-10) in the milk samples collected during second phase of experimental feeding. Improvement occurred in both the groups and probably it was the effect of individual care and not the dietary treatment.

The perusal of experimental results presented in different tables clearly showed the non-significant difference in almost all the observations recorded during the 56 (28+28) days experimental feeding. The values further indicated that feeding of Bt. Cotton seed containing diet has no adverse effect on the feed intake, digestibility, health, production and milk composition of the cows.



## **SUMMARY**

A study was conducted to observe the effect of feeding genetically modified cotton seed (Bt. cotton seed) produced by JK Agri Genetics Ltd. on the health and production of lactating crossbred cows. For this purpose producer supplied adequate quantity of genetically modified Bt-cotton seeds and non –Bt cotton seeds produced under same agronomic conditions. A comparative study of 56 days duration divided into two phases of 28 days duration in a cross-over design was conducted to observe the effect of Bt. Cotton seeds feeding in the composite diet of standard ingredients and good quality fodder like chaffed green maize. The cows in 70 to 130 days of lactation period were selected from the standard herd of IVRI. All multiparous cows were selected. The animals were fed a common diet of standard ingredients and kept individually tethered in a byre during the entire experimental period.

Two concentrate mixture containing either 40 percent crushed Bt-cotton seeds (Bt. Cotton seed group) or 40 percent crushed non-Bt. Cotton seed (Non Bt. Cotton seed group) along with equal amount of crushed maize grain, crushed mustard cake, wheat bran, area specific mineral mixture and common salt were compounded. The fodder part of diet in both the groups was good quality chaffed green maize. The cows were fed to supply adequate nutrients for maintenance and milk production.

During the feeding trial body weights of cows were recorded at weekly interval, whereas dry matter intake in feeds was recorded daily and averaged for each week for the individual cows. A digestion trial of 6 days collection period was conducted at the end of each feeding phase. Blood



samples were collected for haemato-biochemical studies on day 0,7,14 and 28 of each phase.

There was practically no difference in the values of mean DMI, weekly live weight changes, daily milk yield, average milk composition, digestibility coefficients of main nutrients, haemato-biochemical values and somatic cell count in the milk. The low somatic cell count indicated the good udder health of lactating cows.

Since the effect of Bt. cotton seed feeding on milk quality was not known the entire milk (Except the small samples collected for analysis at weekly interval) was disposed in the presence of a committee. The disposed milk was not accessible to man or animals for consumption in any form.

On the basis of results of this study for the supplied Bt. cotton seed no adverse effect could be observed on the health and production of lactating crossbred cows. The appearance and composition of milk produced during the feeding period was normal. There appears to be no reason to doubt the utility of Bt. Cotton seeds for the feeding of farm animals including the lactating dairy cows.

**Certificate of acceptance of the final report of the project report**

**FEEDING STUDIES OF TRANSGENIC Bt COTTON SEED OF JKAL EVENT 1  
CONTAINING CRY 1 Ac GENE IN LACTATING CROSS BRED DAIRY COWS**

We, Dr. M. P. Yadav, Director Indian Veterinary Research Institute, Izatnagar- 243122 and *Dr. M. Satya Prasad, Scientist-Biotechnology* JK Agri Genetics Ltd., 1-10-177 , 4<sup>th</sup> floor Varun Towers, Begumpet Hyderabad-500016 hereby certify that the Final report of the project entitled **FEEDING STUDIES OF TRANSGENIC Bt COTTON SEED OF JKAL EVENT 1 CONTAINING CRY 1 Ac GENE IN LACTATING CROSS BRED DAIRY COWS** was undertaken by Indian Veterinary Research Institute, Izatnagar –243122, as sponsored project has been duly approved and accepted by both the organizations. It is agreed by both the parties that they will not accept any comments or suggestions that may arise in future on account and review of the report by either of us or a third party.

Date 10-02-2006

Place: IVRI, Izatnagar (U.P.)

Name: Dr. M.P. Yadav

Designation: Director, IVRI, Izatnagar

ICAR Institute

*डॉ० महेश्वर पाल यादव*

Dr. M. P. Yadav

निदेशक/Director

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Sponsoring Organisation/  
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