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LESSONS FROM GATHERING OF CROP PRODUCTION STATISTICS IN INDIA: A COMPARISON OF METHODS USED BEFORE AND AFTER THE BENGAL FAMINE OF 1943 – 1944

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ABSTRACT

This paper uses the case of the Bengal famine of 1943 – 1944 in order to compare poor agricultural data collection methods with the ones that are reliable. This study reviewed the methods used to estimate land area under cultivation and yield per unit area prior to the Bengal famine, and the methods used to arrive at these estimates after the tragic event. A comparison of these methods highlighted the deficiencies of the agricultural data estimation methods used prior to the famine. The ambiguity of guidelines, guesswork, and lack of properly trained field personnel played a central role in the faulty estimation of crop production statistics prior to the famine. The Bengal famine became an important motivator for change. A three-stage randomized technique to locate plots where crop-cutting experiments were to take place was developed. Additionally, permanent field personnel were recruited and properly trained to do the job. Any reliable system of collecting crop production statistics must rely on well trained field personnel that are educated in the random sampling process. We conclude that this alone cannot produce reliable agricultural production data unless there is close oversight of the field personnel. A perspective discusses the development of other agricultural trends that appear to set the course for future famines in India, given that these trends are emulating the manmade factors contributing to the previous famines.

Keywords: agricultural data, Bengal famine, stratified sampling, sampling bias

INTRODUCTION

There are no accurate data available about the population of Bengal in 1943. However, census data indicate that the population of Bengal was

60.31 million in 1941 (Ramamurty *et al.* 1984, 203), and had an average annual growth rate of 1 percent (Greenough 1982, 288). Estimates of those who died due to the Bengal famine of 1943 – 1944 have varied from 1.5 to 4 million people. But the low estimate of 1.5 million did not take into account those who died by the roadsides (Sen 1982). Including 'roadside deaths,' Sen put the estimate at a minimum of three million people. Many of the corpses that lay besides the roads or strewn about in the fields were then torn to pieces and eaten away by dogs and vultures (Mansergh *et al.* 1973, 330).

Over the years various causes of the famine have been highlighted and discussed. These include the loss of rice imports from Burma due to the fall of Rangoon to the Japanese on 10th March 1942, the impact of the October 1942 cyclone, a diseased winter rice crop in 1942, the Second World War and the influx of refugees, and impounding of 66,653 boats that brought rice into Bengal from surplus regions of the Indian subcontinent during normal times (Goswami 1990, 449; Mansergh *et al.* 1971, 280).

Meanwhile, in December 1943, the British India Government set up a committee to investigate the causes of the famine. Among its findings, the committee concluded that 'one of the main factors responsible for the famine was the defective statistics of crop production available at the time' (Rao 2006, 5). It is the contribution made to the famine by 'the defective statistics of crop production' that will be the focus of this paper. We will scrutinize the method of collecting crop statistics that was in use in Bengal prior and up to the famine, and then examine the approach used afterwards. Remotely sensed data and computing technologies such as the Geographic Information Systems (GIS) which are in use today but were not available at the time of the famine will not be considered in this paper.

CROP PRODUCTION STATISTICS IN INDIA BEFORE THE 1943 – 1944 BENGAL FAMINE

In Bengal, there are three types of rice crops and each type is sown and harvested at a different time of year (Sen 1982). At the time of the famine, the winter rice crop, or the *aman* crop, comprised 73 per cent of the annual crop, and it was planted sometime between May and July and harvested from November through January. The autumn rice crop, also known as the *aus* crop, was 24 per cent of the total annual crop and it was sown from March to April and harvested from August to September. Finally, comprising only 3 per cent of the annual rice harvest was the spring crop, also known as the *boro* crop, which was sown from November to December and harvested in February and March. Very little wheat, barley, or any other crop was grown in Bengal.

In the years leading up to the famine, the *total supply* of food grain available for consumption was calculated as the sum of the *current supply* and *carry-over* from the previous year. The *current supply* consisted of the annual output of the *aman, aus*, and *boro* crops plus any import into the province minus any export out of it (Greenough 1982, 286).

Current Supply

According to Sastry (1977, 425 – 428), prior to the famine, output for a particular type of crop, which was the basis for computing the *current supply*, was estimated using a simple equation that was the result of the product of the *normal or standard yield* and the *condition factor*. Equation 1 provides the details for the procedure (Islam 1978, 20):

$$O_t = (A_t \times S)\left(\frac{c_t}{100}\right) \tag{1}$$

Where:

O_t = *crop output at time t*

A_t = *area under cultivation (acres)*

S = *standard or normal yield (lbs)*

C_t = *condition factor*

Predictions about crop output based on the equation were not reliable because the infrastructure to collect accurate data on each of the input variables A_t, S, and C_t did not exist. Bengal was a *permanently settled* province, and therefore estimates of acreage under cultivation were 'the guesswork of the chowkidars' and thus 'worthless' (Islam 1978, 20). *Chowkidars* were illiterate, quasi-numerate village policemen whose main task was to provide security for villages. But they had not been trained in collecting agricultural statistics. Moreover, 'Rule 7 of the Chowkidari Manual' stipulated that crop reports must contain *chowkidar's estimate* of the 'actual area' under cultivation and compare this with the 'normal area' that was expected to be under cultivation during a season of ordinary character and expected rainfall; a season of ordinary character was considered to be a season that was 'neither very favorable, nor the reverse.' Table 1 shows a systematic underestimation of 'actual area' under cultivation versus the expected 'normal area' under cultivation (Islam 1978, 22). The information in the table was obtained by averaging the acreage statistics for the period from 1920/21 to 1940/41.

Table 1: Comparison between Chowkidars' estimate of 'actual area' and expected 'normal area' under cultivation (*source: Season and Crop Report of Bengal*)

Crops	*Actual area under cultivation (thousand hectares)*	*Normal area under cultivation (thousand hectares)*
Winter rice (*aman*)	6,189.0	6,858.3
Autumn rice (*aus*)	2,203.9	2,324.1
Spring/Summer rice (*boro*)	164.6	169.3

Ramamurty *et al.* (1984, 202 – 208) made the same comparison on a smaller scale for the 1938 to 1942 period and found even a more significant underestimation of the actual area of the *aman* crop under cultivation. The average crop area for *aman* during the period was underestimated by one-fifth.

On the other hand, in *temporarily settled provinces*, it was common for the British to employ *patwari* who were literate, numerate village accountants and were supplied with cadastral maps to aid them in the collection of acreage statistics. Yet, even *patwari* often falsified data and did not report the actual extent of crop failures in order 'to save themselves trouble' (Tauger 2003, 62). Not to mention that the maps *patwari* used were often old and the information they contained was out of date (Delrome 1982, 4).

The second input variable in the equation, *standard yield* (i.e., *normal yield*), had an ambiguous definition. It was defined as 'the average yield on an average soil in a year of average character' (Sastry 1977). This definition of *normal yield* created confusion because it was similar to that of *normal area*. Additionally, the definition relied on the revenue officials' subjective assessment of what was considered to be 'average yield,' but did not involve 'actual harvests by actual farmers' (Tauger 2003, 60). More importantly, *standard yield* was a major source of bias in the calculation of crop output because sampling of crops was not randomized. It was based on purposive sampling, and the size and the number of plots were not adequate enough to generalize the results over entire districts without regard to fluctuations of crop production within each district (Islam 1978, 28 – 29).

The deeply flawed practice of estimating *standard yield* was acknowledged and criticized long before the Bengal famine. In 1919, the board of agriculture recommended that sampling of crops (i.e., 'crop-cutting experiments') must be randomized within fields and plots in a given district. In addition, a 'moving ten-year average' of crop-cutting experiments was recommended as the measure for *standard yield*. But for various reasons these recommendations were not followed. Table 2 shows the results of subjective assessment of *standard yield* for *aman* and *aus* crops by revenue officials who purposely chose the lots they sampled (Islam 1978, 29). It is clear from the data in the table that estimates of the *standard yield* were not consistent over time.

Table 2: Standard yields (in kg) in the quinquennia (*source: Standard yield figures are available from Estimates and Area of Yields of Principal Crops in India*)

	Standard yield of quinquennium beginning					
Crops	*1916-17*	*1922-23*	*1927-28*	*1932-33*	*1937-38*	*1942-43*
Winter rice (*aman*)	466	463	460	500	464	459
Autumn rice (*aus*)	392	400	401	460	411	389

The third and last input variable in the crop output equation was the condition factor. The condition factor was defined as an index value that quantified the condition of the crop that was being inspected with respect to what was deemed the 'normal condition' for the same type of crop (Sastry 1977, 425 – 428). The condition factor was based on visual inspection and subjective judgment of *chowkidars* who, without training and experience in the work, often guessed at the condition of crops (Islam 1978, 40; Tauger 2003, 61).

With all the three input variables based on ambiguous criteria and unreliable information gathering practices, it was not surprising that the method to calculate *current supply* in Bengal did not produce accurate results. Table 3 shows the percentages by which the yields of the two major rice crops, *aman* and *aus*, were overestimated (Islam 1978, 35).

Table 3: Range of error in the yield of rice (percentage overestimation (+) in the quinquennial yield per hectare)

Crops	*1920-24*	*1925-29*	*1930-34*	*1935-39*	*1940-44*
Winter rice (*aman*)	+11.3	+10.5	+11.3	+12.1	+7.7
Autumn rice (*aus*)	+2.8	+1.2	+6.0	+3.6	+4.0

Better records of import and export quantities of food grains were kept. But there were systemic problems with these, as well, which again lent the information inaccurate and unreliable. Unlike crop area, standard yield, and condition factor, the practice of quantifying import and export tonnage of food grains was not based on subjective assessment and guesses made by *chowkidars*. It was based on receipts produced by Port and Railway authorities and this information was compiled by the Department of

Commercial Intelligence and Statistics (Sen 1982, 59). But the receipts only kept account of 'maunds' and 'lakhs' of imported or exported food grain via 'Rail and river-borne trade,' and did not include movement of grain that crossed provincial frontiers by road or country-boat (Ramamurty *et al.* 1984, 205). The Famine Inquiry Commission later revised up its original estimate of the *current supply* for 1943 from 7.892 million tons to 8.896 million tons. Included in the revised report also was an estimate of quantities of food grain that may have come into Bengal as import via roadways. But no country-boats were kept in operation between March 1942 and April 1943, since the Bengal government was fearful of an invasion by the Japanese (Goswami 1990, 449).

Carry-over

The carry-over was defined as the stock of 'old rice' available on the first day of the new year (Ramamurty *et al.* 1977). Declassified secret letters exchanged between the officials of then the British Government and the officials of the British India Government at the highest level as well as statements of the experts who studied 'the carry-over problem' agree that there was 'no idea' of carry-over stocks from past harvest years (Mansergh *et al.* 1971, 825 – 826; Mansergh *et al.* 1973, 705 – 706; Ramamurty *et al.* 1977, 212).

Hence, it was unavoidable that due to the dubious nature of any quantity claimed as *carry-over*, partial and incomplete records of import and export of food grain, crop inspection methods that were not randomized and underestimated the hectare area under cultivation but overestimated yield, and lack of properly trained personnel to do the fieldwork, very poor estimations of the *total supply* had been the result in the entire subcontinent; and even more noticeably so in Bengal. Even late into the famine, the British India Government had no accurate data to use to help predict production and consumption of food grains within the province. The infrastructure to collect reliable crop production data in Bengal was so desperately in need of repair that a report by the Indian Central Food Advisory Council stated that 'Agricultural statistics particularly in the permanently settled areas are chaotic. Both area and yield figures as recorded at present are unreliable' (Tauger 2003, 62).

Crop Production Statistics in India After the 1943 – 1944 Bengal Famine

The Indian Statistical Institute (ISI) headed by Mahalanobis, and the Indian Council of Agricultural Research (ICAR) headed by Sukhatme, led the way for the revision of crop production statistics in India. The main goal of

Mahalanobis and Sukhatme was to move away from ambiguous methods based on guesswork and adopt methods that made use of random sampling of cultivated areas and crop yield. It took time for the transition to take effect. The National Sample Survey (NSS), established by Mahalanobis in 1950, formed the foundation for a system of collecting quality crop production statistics. Sastry (1977) provides a detailed discussion of the intermediary steps taken and changes put into effect in order to develop the system.

The method developed by ISI and ICAR is based on two fundamental units of agricultural statistics: 1) area under cultivation, and 2) crop yield per unit area. The approach was adopted by the Food and Agriculture Organization of the United Nations (FAO), and it forms the basis for collecting agricultural statistics in India and the rest of the world (Sud *et al.*, 2011, 1). In accordance with the survey design, 'complete enumeration' forms the cornerstone of the methodology for estimating area under cultivation while 'crop-cutting experiments' or CCEs conducted as part of the General Crop Estimation Surveys (GCEs) form the foundation for estimation of the crop yield.

Each year, data are collected from more than 800,000 CCEs in India, which include '68 crops (52 food and 16 non-food)' from 25 states and four Union Territories (Sud *et al.*, 2011, 1). Despite the new sampling design for collecting agricultural statistics, the problem in Bengal was that the province was a 'permanently settled state,' and it did not have a permanent agency to collect land-based data. Therefore, ad hoc methods were used in the beginning to generate the needed estimates for crop production. Moreover, in order to bring a perennial solution to the matter, the government of India took on the project of Establishment of an Agency for Reporting Agricultural Statistics (EARAS). The mission of EARAS was to create a regular agency for gathering, preparing, and reporting of the data in all 'permanently settled states' (Lochan 2006, 137).

Hence, EARAS became responsible for estimating area under cultivation and crop yield in Bengal. Today, annual area and crop yield surveys from 'complete enumeration of 20% sample of villages' are taken while trained staff of the National Sample Survey Organization (NSSO) supervise the operation.

Area Surveys

State officials make the decision about whether or not to include a certain crop in the area surveys. The decision is based on the crop's contribution to the economy and its importance to the state. A stratified three-stage sampling design is used with 'villages, fields, and plots as the first, second, and third stage units, respectively' (Delrome 1982, Annex 2-C). In states where up to date cadastral maps are available, a list of fields where a crop of interest is being cultivated is put together. From the fields on the list, plots where crop-cutting experiments are to take place are then randomly selected and the yield for the entire field is estimated. If cadastral maps are not available, ad hoc sketches prepared by trained staff of the Department of Agriculture are used as substitutes. This was the case in Bengal where no land record system existed for a long time after the famine. Computerization of land records in India, however, eventually made this laborious and time-consuming practice unnecessary (Habibullah & Ahuja 2005).

More specifically, first, a sample of two to eight villages that are known to plant a specific crop of interest that is part of the survey are selected. Then, in each of the selected villages, fields that carry the crop are identified and from each village two plots are located at random. The experimental plots are rectangular in shape, 10 m×5 m in size (the size may vary depending on the type of crop or the location within different states), and they are the only units in the sampling process that are chosen at random. Each of these randomly selected plots is also known as the 'unit of enumeration.' The units of enumeration are harvested at the same time as the rest of the field and with the cooperation of the farmers who cultivate the land. On average, 100 plots are sampled in each district included in the survey (Delrome 1982, Annex 2-C).

Yield Surveys

Delrome (1982, 12) defines crop that has been 'dried, threshed, winnowed, de-husked, shelled, and made ready for consumption' as the most useful concept of yield. To estimate the yield, the production is divided by the net area of the sample fields (Delrome 1982, 68). The method is shown in equation 2.

$$\textit{production in each stratum} = (\textit{yield}) \times (\textit{net area of the sample fields}) \qquad (2)$$

Three sources of bias in the computation of crop yield have been of concern. These are: 1) bias due to plot size, 2) bias due to plot shape, and 3) bias due to 'border effect.'

Bias due to plot size

The problem of the effect of the plot size on the estimated yield has been studied in India more than any other country. ISI and ICAR determined that small circular plots of size 1.13 and 2.55 square-meters overestimate yield by 42.4 per cent and 14.8 per cent, respectively. By the same token, it was observed that equilateral triangle plots of size 2.65 and 10.61 square-meters overestimate yield by 23.4 per cent and 11 per cent, respectively (Delrome 1982, 83). Mahalanobis and Sukhatme recommended a plot size of about 10 square-meters as the standard size for crop-cutting experiments. Nevertheless, this conclusion was not generalized to all crops and all geographical locations due to evidence having been 'too meager.' Sample plots of size 2.97 m 1.48 m (4.4 square-meters) have commonly been used in India.

Bias due to plot shape

Mahalanobis and Sengupta considered the problem of whether different shapes of sample plots of the same size had any impact on the yield from crop-cutting experiments. Table 4 shows the difference in yield from four different sampling configurations (Delrome 1982, 85). The yield from each CCE is expressed in percentages of the crop yield obtained from the circular plot.

Table 4: Difference in the yield obtained by using differently shaped plots of approximately the same size

Shape (each 1.13 sq. m.)	*Average yield expressed in percentages of the average yield of the circular cut*			
	Gouripur (Bangladesh)	*Katwa (West Bengal)*	*Sainthia (West Bengal)*	*Combined*
Circular	100.0	100.0	100.0	100.0
Triangular	115.8	125.0	123.2	123.5
Square	93.0	109.3	107.9	103.5
Fork	91.1	100.4	108.8	103.5

The fork configuration follows a pattern made up of two parallel plantations, and it is often used when the crop is planted in rows. It was determined that a triangular shape is likely to produce the most biased results in the estimation of yield.

Bias due to border effect

A six-step procedure is followed to randomly locate the center of a circular plot or a corner of a rectangular plot within a crop field (Delrome 1982, 72). The procedure stipulates that field enumerators must: 1) measure the perimeter of a field in terms of number of paces; 2) halve the number of paces in order to obtain the semi-perimeter; 3) select two numbers from the table of random numbers both of which must be less than the semi-perimeter; 4) walking in the clockwise direction, begin from any corner of the field and move along the field boundary a number of paces equal to the first random number; 5) walk into the field a number of paces equal to the second random number and in a direction perpendicular to the side of the field in order to establish the reference point for the location of the sample plot; and 6) walk back in the opposite direction the complementary number of paces in case the field is too narrow and step 5 takes the enumerator outside of the field.

Sometimes the sample crop-cutting plot makes an intersection with the boundary margin of the field within which it is located.

If a decision is made to retain the plot as one of the 100 sample plots from the district, then the 'plot's frames are pulled in' so that the entire plot falls within the inner field and away from the field's marginal boundary. In this case, the probability of selecting crop that has been planted near the field boundaries is increased by purposeful adjustment of the plot's frame.

If, on the other hand, the sample plot is 'rejected', then the crop from the particular plot is removed from calculation of the yield on purpose, which violates the criterion that sample plots must be selected at random.

In either case, the decision is bound to lead to biased estimates of yield if the distribution of the crop over the selected field is not uniform. A method was devised in order to determine when to reject a border plot or when the border plot's frames should be pulled in such that bias due to border effect is minimized. The approach hinges upon the computation of two ratios. One ratio depends on the relationship between the distance '*d*' of the corner point of a crop-cutting plot that is closest to the marginal boundary of the field and the distance '*D*' which represents the diagonal of the crop-cutting plot. The ratio d/D is used to establish whether a crop-cutting plot qualifies as a border plot. If it does, then a second ratio is computed which depends on the relationship between the probability of a portion of the field that is both near its border and part of a crop-cutting plot, P_B, and the probability of the inner portion of the field that is also part of a crop-cutting plot, P_I (Delrome 1982, 72 – 76). In other words:

$$\text{if} \qquad x = \frac{d}{D} \leq 1 \qquad \Rightarrow \qquad \frac{P_B}{P_I} \tag{3}$$

Where:

d = the distance of the closest corner point of a crop-cutting plot from the marginal border of the field

D = the length of the diagonal of the crop-cutting plot

P_B = the probability of the portion of a field that is both in the neighborhood of the field's marginal border and part of a randomly selected crop-cutting plot; this probability is proportional to the size of the plot that is to be selected

P_I = the probability of the portion of a field that is both part of the inner field and part of a randomly selected crop-cutting plot; this probability is proportional to the size of the plot that is to be selected

Table 5 shows values for both ratios which may conveniently be used to make decisions in the field (Delrome 1982, 76). If a sample plot is rejected, the procedure to randomly find a new pair of sample plots is repeated.

Table 5: Border bias: value of P_B/P_I

$x = \frac{d}{D}$	P_B/P_I	
	Border plot rejected	*Border plot frame pulled in*
0.1	0.02	0.42
0.2	0.08	0.88
0.3	0.18	1.38
0.4	0.32	1.92
0.5	0.50	2.50
0.6	0.68	2.28
0.7	0.82	2.02
0.8	0.92	1.72
0.9	0.98	1.38
1.0	1.00	1.00

The acceptable range of standard error for the calculation of crop yields is from 0 per cent to 5 per cent (Lochan 2006, 132). However, it has been observed that actual standard errors often exceed this range.

CONCLUSION

The collection of agricultural statistics in India has improved tremendously since the Bengal famine of 1943 – 1944. Nevertheless, even the methods of area and yield enumeration have come under intense criticism. One common complaint has been that the field enumerators do not follow the procedure. In response to this criticism, a program to improve the quality of crop statistics called the Scheme for the Improvement of Crop Statistics (ICS) was initiated in 1973 – 1974. The program provides oversight 'at every stage of work relating to estimation of crop production' (Lochan 2006, 136 – 137). Findings of the ICS confirmed that the field enumerators often do not follow the proper crop-cutting procedure and this has led to 'data which lacks desired quality' (Sud *et al.,* 2011, 1).

Furthermore, another objection has been about the significant time-lag in the availability of reliable statistics which is of considerable importance to anyone from administrators and policy makers to agricultural scientists and forecasters. To remedy this issue, the Directorate of Economics and Statistics (DES) initiated Timely Reporting Scheme (TRS). In addition, in 1987 the Department of Agriculture and Cooperation (DAC) began developing a program for collection of Crop Acreage and Production Estimates (CAPE). The main objective of CAPE is to use remote sensing to improve crop area and production statistics and forecasting (Lochan 2006, 138).

Despite the introduction of new technologies into the sampling process, factual ground data collected by field enumerators remain indispensable to gathering quality agricultural statistics (Craig & Atkinson 2013). For this reason, it is of utmost importance that field enumerators complete the sampling work according to the set procedure.

Perspective for the Future

Famines are caused by severe and prolonged shortage in the food supply. It is inconceivable that famines have occurred in a country with as rich and diverse of an agricultural tradition as India; be it for reasons linked to defective statistics of crop production or not. Specifically, the recent history of India has shown that the country should not have been forced to rely on other nations for its vital food grains, since India could easily meet its own demand for such products. In her exemplary work, Mukerjee (2010) explores how an important contributing factor to the Bengal famine of 1943 was the fact that India's status in production of grains had changed from a self-sufficient "net exporter of grains" during precolonial times to one of an importer of rice, cereal, and salt during the colonial period. Churchill's colonial government in India had forced the country to export its own homegrown rice, only to suffer the consequences and be in need of importing it all back in again (also see Mukherjee, 2013)!

Moreover, this particular contribution to the Bengal famine is especially of note for the future, because less than a century after the end of the colonial rule in India, under the guise of feeding the burgeoning population of the country, the advent of genetically modified (GM) crops is once again threatening to create the conditions which would, over time, lead to cutting off India from having control over its own food crops. GM crops are grown from patented seed products that, by definition, must be imported and cannot be collected and stored locally. Proponents of GM crops rely on data obtained from strictly controlled agricultural experiments in the United States and quote them to the world as facts (U.S. Food & Drug Administration, 2020). But even a cursory search for corroborating facts and testimonials from in situ agricultural settings turns up evidence to the contrary (Cassidy, 2015).

Beginning in the late twentieth century, statistics of cultivating genetically modified (GM) crops that were collected from controlled agricultural experiments in the United States were used by the leading manufacturers of genetically modified crops such as Monsanto, Syngenta, BASF, and other transnational companies to attempt to patent seed and crop production in Europe and India. This assault by giant outside corporations on the Indian farmer is nothing new. In fact, it had been the East India Company that had exacerbated the already disastrous conditions that led to the death of 10 million people in Bengal (a third of the population in the province) in 1770 (Mukerjee, 2010, xv).

In Europe, concerns about food safety and the GM crops being less nutritious, carcinogenic, and/or allergic produced a fierce public backlash that affected the policy makers in the European Union (EU) to take action against and limit the cultivation of GM crops. However, such victory for the people of the European Union was not without its battles and casualties. For example, in a research study conducted by Dr. Arpad Puzstai and his team of researchers in the Rowett Research Institute in Scotland, UK, the researchers placed a group of rats on a diet of GM potatoes for three years. According to Dr. Puzstai, "the liver and heart of rats fed with GM potatoes started getting smaller, and so did the brain. There were also indications that the rats' immune systems were weakening" (Ewen & Pusztai, 1999; Navneet, 2021, 5). Dr. Puzstai was fired from his job and discredited in the scientific community after discussing his findings on a TV show. Yet, eventually, 21 European and American scientists released a memorandum in support of the findings by Dr. Puzstai (Ensernik, 1999).

In India, where subsistence agriculture is the primary source of income for more than 700 million people, "Bt cotton" has been the only GM crop that has been approved for commercial cultivation. At first, disadvantaged farmers were sold the idea that “Bt-cotton” would help them increase their production and income (Navneet, 2021, 1). Not only this promise did not materialize but also as Dr. Vandana Shiva had observed more than a decade earlier, the high cost of GM seeds had led the typical Indian farmer to accumulate enormous amounts of debt. Not to mention the damaging impact of GM crops on the natural biodiversity of farmland habitats, which is so essential for producing quality and nutritious food. Additionally, the farmers who had chosen to grow GM crops became increasingly dependent on private transnational companies to purchase the seeds they needed to grow Bt cotton for the next season, since the seeds of GM crops are sterile and do not germinate. It is for this reason that GM crop seeds cannot be gathered and stored locally, requiring farmers to import patented seeds from outside of the country. This tactic deployed by giant GM seed companies like Monsanto is quite similar to the tactic used by East India Company “forcing peasants to part with the grain they had kept for planting” (Mukerjee, 2010, xv). Shiva et al., (1999) discuss various devastating impacts of growing GM Bt cotton crop in India, including the staggering number of farmers who have been committing suicide.

As stated earlier, during the Bengal famine of 1943, the loss of rice imports from Burma was also considered a contributing factor to the famine. At the present time, as the United States begins to recover from a devastating pandemic, an invaluable lesson that has been learned for the future of the country is to avoid placing the supply chains of vital products outside of the country. The COVID-19 pandemic exposed severe deficiencies in the access to personal protective equipment (PPE). Even the hospital workers who were treating COVID patients did not have sufficient PPEs to make it safe for them to do their work. Not surprisingly, “US is the world’s largest importer of face masks, eye protection, and medical gloves” (Cohen & Rodgers, 2020, 1).

Looking back at these many tragic lessons already learned of the perilous enterprise of importing vital foods and products, while a nation like India can easily avoid to do so, it is clear that a transition to growing GM crops would be detrimental to the future of food production in the country. So far, only the cultivation of Bt cotton has received approval by the government agencies in India (Navneet, 2021, 2). It would be a win for the people of India if not only this approval is cancelled but also no new authorization for growing GM crops is issued. Otherwise, new manmade famines would very much again become a possibility.

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