added to most cattle-feeds and BSE is the bovine form of scrapie, a prion disease of sheep. (Is it more proper to ask: Is transmission of material, the components of an enzyme machinery rather than "infective prion particles", that causes non-desired conformational changes in normally present proteins, leading to prion diseases?) Transmission to humans, where it can become manifest as the fatal Creutzfeldt–Jakob disease, is thought to occur through ingesting bovine meat products. (Other prion diseases are also known among humans.)'

Addition of a protein supplement to cattle-feed is thought necessary both to increase milk yield and add bulk to beef. Offal from butcheries is just one among many such supplements some of which, like prepared poultry droppings, one cannot normally think of as valuable, except as fertilizer (see other articles in ref. 2). Addition of prepared offal as a cattle-feed supplement is perhaps not as yet widespread in India, where also bovine meat products are not eaten by a large proportion of the population. But contraction of prion diseases through milk, though not clearly proven, remains a possibility.

Leaf fractionation has been said to produce up to 10 times as much protein per hectare as when the land is used to grow food for animals. One reads in a recent comment[3] that it does not require artificially fixed nitrogen, which is made using a large amount of energy. It is already being used on lucerne, or alfalfa, in France, Hungary and the US to make supplementary feed for pigs and poultry. As lucerne is a legume, it adds nitrogen to the soil. The process can be applied to almost any fresh green leaves, including weeds such as water hyacinth and nettles. The leaf protein it produces contains no animal fats, and the fibrous residue is an excellent ruminant feed. (Besides this,) feeding trials in 14 countries have shown that regular leaf concentrate consumption promotes good health and weight gain, increases haemoglobin and vitamin A status, and reduces the frequency and severity of illnesses. A series of trials in which leaf protein was used to supplement the diet of badly nourished children for six months showed that the weight increase was nearly three times as great as that of those whose diet was unaltered.

Anyone interested in researching the history of the 'origins of life' could not but have come upon the ideas advanced by Pirie. The researcher would begin to owe much to Pirie's contributions in taking critical overviews of ideas, both speculative and experiment-based, advanced from time to time in a witty style through the 20th century.

Apart of this and allied interests (e.g. how to recognize alien life), Pirie's leaf-protein work attains immediate relevance in the context of prion disease. Can leaf protein be added as the supplement of choice to cattle-feed, obviating any possibility of transmission of prion disease to cattle and thence to humans? Based on Pirie's work, can India develop and supply to the world, the know-how for producing safe cattle-feed additive on the large scale needed?

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Bt cotton in India

Since the first transgenic plant was obtained, great progress has been achieved in GM crops[1,2]. During the past seven years, the global area of GM crops has increased by more than 35-fold to over 58.7 million hectares (mha) in developed and developing countries[2]. This trend is continuing.

According to Qaim and Zilberman[3], based on one year's trial in India, planting GM crops can dramatically increase crop yield (up to 87%) in developing countries. But, there are several problems with their data and analysis and their results and conclusions are questionable.

Qaim and Zilberman claim that GM crops increase yield due to the inserted gene. Actually, not all GM crops increase yield. Crop yield is controlled by multiple genes. We have not found single or few genes controlling crop yield. Although scientists try to increase yield of some agronomically important crops using transgenic technology, little progress has been made[4]. However, some GM crops do increase yield; the reason is that the modified characteristics in these GM crops reduce yield loss caused by the damage of pests or disease. Many characteristics have been modified by transgenic technology, such as resistance to insects[5-7], diseases[8] or herbicide, modifying plant nutrition[9], delayed-ripening and producing vaccine[10]. Among these factors, only resistance to insects and diseases is the contributing factor for preventing loss in yield. Thus, only insect- and disease-resistant GM crops increase yield; other GM crops, such as resistant-herbicide, enhancing nutritive crops, do not increase yield.

Qaim and Zilberman report that GM crops increase the yield significantly in the developing countries, especially in the tropics and subtropics. Actually increase or decrease in yield depends on the yield loss of the non-transgenic counterparts under the same cropping practice. For *Bt* cotton, in a developed country such as USA, increase in yield is 10–15% (ref. 11); in developing countries such as China, it is the same[5,12,13]. GM crops improve the quality or simplify agronomic practices. We have been planting *Bt* cotton at Hainan, southern China (in the tropics) for many years, and have never found increase in yield of *Bt* cotton compared to northern China[12]. Even in developing countries like Mexico, Australia, Vietnam, Thailand and Egypt (in the tropics) there has not been substantial increase in yield[14,15].

Qaim and Zilberman claim that the potential application of GM crops in developing countries is limited because of lack of knowledge about GM crops. This is not true. According to the report of the International Service for Acquisition of Agri-biotech Applications, in 2002, GM crops were commercially planted in 16 countries. Nine of the 16 are developing countries and more developing countries are joining this list[1,6,16]. Out of the 58.7 mha GM crops, 16 mha was grown in developing countries[1,6]. In 2002, for the first time, more than half the world's population lived in countries where GM crops were approved and grown, most of them being developing countries, especially in regions with more population growth[3,6]. It is obvious that developing countries are quickly adopting to GM crops.

Thus, based only on a single set of small trial data of *Bt* cotton from one season under poor cropping-management, we cannot project high yields for all GM crops in all developing countries.

At the late developmental stage, the resistance of *Bt* cotton to bollworm decreases because *Bt* gene expression decreases[17,18]. Generally, *Bt* cotton needs to be sprayed with pesticides against bollworm 1–2 times in USA[11], and 2–3 times in China[12]. In India, cotton bollworm is more serious than in USA or in China[3]; this means that Indian farmers need to spray more pesticides against bollworm. But Qaim and Zilberman report that in India, *Bt* cotton was sprayed only 0.62 times with pesticides against bollworm (see table 1 in ref. 3).

According to Qaim and Zilberman, *Bt* cotton was sprayed 4.19 (0.62 + 3.57) times and non-*Bt* cotton 7.08 (3.63 + 3.45) times. But for the usage of total and active ingredient of pesticide, *Bt* cotton used 1.74 kg/ha and 0.48 kg/ha, non-*Bt* cotton used 5.43 kg/ha and 1.52 kg/ha, *Bt* cotton saved 68.0 and 68.4% respectively. It is difficult to understand how *Bt* cotton sprayed with less (40.8% times) pesticides than non-*Bt* cotton was able to save about 70% pesticides. If we put these data in figure 2 of ref. 3, we find in this experiment, the bollworm damage to *Bt*-cotton is about 20%, but for non-*Bt* cotton it is about 60%. Why is it so different? Does this mean that all cotton farms suffer 60% yield loss in India? Usually, the criterion against cotton bollworm is to control yield damage to below about 20%. Based on this fact, in the experiment reported by Qaim and Zilberman *Bt* cotton must be given more care than non-*Bt* cotton. So, the result is unbelievable. At the early stage of developing *Bt* cotton in China, timely spraying of pesticides, timely irrigation and other good field managements; for *Bt* cotton gave the same results as those reported by Qaim and Zilberman. Poor crop management plagues *Bt* cotton experiments in India[19].

It is general knowledge that cotton farmers always choose the best and high-yielding cotton varieties. So the current cotton varieties planted by Indian farmers should produce the highest yield with the same cropping practice. But, Qaim and Zilberman reported that the yield of popular cotton varieties is much lower than *Bt* cotton, and non-*Bt* cotton. If it were easy to get high-yielding varieties like the *Bt* cotton in their experiment, most plant breeders would lose their jobs, and the government may not need to spend money on breeding programmes. We started breeding *Bt* cotton ten years ago. In the beginning, the yield of *Bt* cotton was lower than traditional varieties; then it gradually improved[5,12]. Now *Bt* cotton can increase yield by about 10–15% compared with non-*Bt* cotton. Scientists at Monsanto Company, USA and Australia give the same results[11,14,16]. In 2002, the Punjab Agricultural University conducted field trials using three Indian commercial *Bt* cotton hybrids (Mech 12, 162 and 915) of Mahyco Monsanto Biotech Company (MMB) and local non-*Bt* cotton varieties. The highest yield was obtained by the local non-*Bt* varieties, with yield levels of 2400 kg/ha and the *Bt* hybrid produced 2100 kg/ha[20]. The data are more reliable than those reported by Qaim and Zilberman[3].

Qaim and Zilberman mention only about the good performance of *Bt* cotton. *Bt* cotton in India was more susceptible to leaf-curl virus and root-rot disease[19], and suffered greater damage during drought than traditional non-*Bt* cotton varieties[19,20]. This will increase the cost of *Bt* cotton[19]. Also, *Bt* cotton has less fibre length, as a result of which the market is not enthusiastic about it[20]. Although Qaim and Zilberman claim that the pesticide saving was worth about $ 30/ha, they did not mention that Indian farmers need to pay more (four times the price) for *Bt* cotton seeds. According to Sharma[20], 450 g of *Bt* cotton seeds (along with 100 g of non-*Bt* seed for refuge planting) was priced at Rs 1600 (about $32); farmers normally use 2.5 kg/ha of seed. So the actual cost of *Bt* cotton seed is Rs 3500/ha (about $70), about $50/ha more than non-*Bt* cotton. The high seed cost outweighs the advantages.

In March 2002, the Indian Government gave permission for the commercialization of *Bt* cotton[21]. About 50,000 farmers planted more than 40,000 ha of *Bt* cotton in 2002. When Qaim and Zilberman submitted their paper to *Science*, the farmers had harvested the first commercialized GM products. The Indian Council of Agricultural Research (ICAR) had planted *Bt* cotton for the All-India Coordinated Variety Trials[22]. Why did Qaim and Zilberman not present data about the performance of the first GM crop harvest in the country or the data from ICAR? Qaim and Zilberman's data are derived only from some field trial plots of MMB.

The fact is that the application of the first GM crop has put India in a dilemma regarding future application of GM crops; and there are arguments regarding its success[23–25]. After the first year of commercialization of *Bt* cotton, MMB claims that farmers obtained 30% higher yield using 65–70% less pesticide. But, these claims have been questioned by Greenpeace (Bangalore), Gene Campaign (Delhi), and by the Indian parliamentary committee's report that 'farmers who have grown *Bt* cotton have been put to loss in most of the places'[24]. Do GM crops have a future in India? Not only has the entry of additional GM crops into the Indian marketplace been delayed, but the marketing of the MMB-approved *Bt* cotton beyond 2004 is also up in the air[24].

Based on these facts, we believe that the results and conclusion reported by Qaim and Zilberman are questionable. GM crops have many advantages that benefit both human beings and the environment. We believe that economic benefit is the major factor influencing the adoption of GM crops in developing countries; but for developed countries, environmental and ecological factors also influence the adoption of GM crops. This has been approved by both a developed country like USA and a developing country like China[11,12].

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Palaeomagnetic dating of Sankra dyke swarm

There is an inherent contradiction in the palaeomagnetic work on Sankra pluton by Poornachandra Rao *et al.*[1]. According to the NGRI Annual Report[2], Bhalla *et al.* (of which Poornachandra Rao is the second author) state that 'palaeomagnetic data from the surface samples of gray granite and syenite (Sankra pluton) reveal magmatic activity between Late Palaeozoic to Late Cretaceous'. Further 'the pink granite in which the dolerites intrude show downward magnetic inclination whereas, the dolerites exhibit upward magnetic inclinations acquired in normal and reverse fields, with intermediate and shallow southern hemispheric locations respectively. This is in conformity with movement of the subcontinent during the Palaeozoic era'. If the Sankra pluton represents igneous activity during Palaeozoic era (and I am inclined to agree with this interpretation), how do the dykes intruding it give ages between 750 and 50 Ma, as suggested by the authors?

In the absence of (reliable) geochronological data on Sankra and other adjacent plutons, it may not be appropriate to include the plutons in the Malani igneous suite (MIS) and it would be farfetched to propose a tectonic trio. The 700–750 Ma event is very well documented in the form of anorogenic, A-type magmatism, in the Trans-Aravalli block and the South Indian block (north of the Palghat–Cauvery shear zone) of the Indian shield[3]. All the magmatic activity in the Indian shield (except MIS) centred around 700–750 Ma cannot be included in the MIS. The MIS is characterized by epizonal, volcano-plutonic ring structures, 'within plate' A-type magmatism indicating extensional tectonic environment[4]. High quality data generated should be commensurate with strong field base.

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