The endosulfan episode: common sense versus science

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The rejoinder by Mahapatro and Panigrahi[1], in response to our commentary[2] 'A critique of the epidemiological studies on health in allegedly endosulfan-affected areas in Kasaragod, Kerala' is largely based on unverified presumptions and anecdotal evidences rather than hard facts and figures. Their response is built up on the common sense that the endosulfan 'tragedy' in Kasaragod is one of the worst pesticide disasters in the field of community health and toxicology. Common sense, as pointed out by Ernst Mayr, is frequently corrected by science.

The imaginary pesticide treadmill in cashew

Mahapatro and Panigrahi[1] describe the various phases of pest management in cashew such as subsistence, exploitation, crisis and disaster. According to them, the endosulfan tragedy in Kasaragod is a natural fallout of the disaster phase of pest management in cashew. However, the ominous picture painted by them is a far cry from reality. Use of chemical pesticides in cashew plantations raised from seedlings is very low compared to other agroecosystems. In most of the farm fields, cashew is grown in a semi-wild condition. The cashew estates in Kasaragod were established by planting seedlings (not grafts) on newly cleared forest lands in July 1962 by the Department of Agriculture, which was subsequently taken over by the Plantation Corporation of Kerala (PCK) in June 1977. Aerial spraying, on experimental basis, was tried in the Kasaragod estate in 1976–77 by the Central Plantation Crops Research Institute[3]. Continuous aerial spraying 2–3 times a year was undertaken for almost two decades from 1981 and was stopped in 2000 following protests. Mahapatro and Panigrahi[1] estimate the total quantity of endosulfan 35% EC applied in PCK estates over 20 years as not less than 70 tonnes. The actual figures based on information obtained by invoking the Right to Information Act is 31,510 l for 11 years over an area of 2138 ha in Kasaragod (*The Hindu* dated 26 October 2009). This amounts to 1.34 l/ha/year, which is far less than other crop situations such as rice, vegetables, tea or cardamom (Table 1).

Cashew plantations raised from grafts are more susceptible to the ravages of tea mosquito than those raised from seedlings, thus warranting higher use of pesticides. However, cashew grafts as planting material became popular among farmers only in the 1990s. During the same period, rubber became a much more remunerative crop compared to cashew. Spread of the rubber monocrop through aggressive promotion and heavy subsidies curtailed the spread of cashew as well as replanting of existing plantations with grafts. Hence the use of pesticides in cashew was almost limited to the estates of PCK. The crisis phase in cashew as portrayed by Mahapatro[4] is largely an imaginary superimposition of the cotton scenario in Rio Grante Valley of Peru[5] on cashew, and is not based on any empirical evidence. On the other hand, the recommendation for application of three blanket sprays[6] of pesticides a year against the tea mosquito bug, *Helopeltis antonii* (TMB) was later reduced to need-based applications[7]. The tea mosquito bug is one of the well-studied insect pests in India[8], as concerted attempts have already been made to understand its biology and devise management strategies. Development of resistance against insecticides is not a stumbling block in the management of *H. antonii* in cashew, as there is no continuous exposure to pesticides. A maximum of three applications during flushing, flowering and fruiting stages (October–November to January–February) alone is recommended. Eight to nine generations of the insect remain continuously unexposed to pesticides for at least seven months and thus eliminate the chances of build-up of resistance against insecticides. This is further corroborated by the fact that there is no documented evidence of *H. antonii* developing resistance against insecticides. However, in the case of the closely related *H. theivora*, a serious pest of tea, development of resistance against pesticides is well documented[9]. Unlike *H. antonii* on cashew, *H. theivora* on tea is continuously exposed to heavy doses of pesticides applied against insect and mite pests, including *H. theivora*, which is a serious limiting factor in the tea culture. Evidently, lack of continuous exposure and lower rates of application are the key factors which prevent the development of crisis and disaster phases in cashew.

The argument that endosulfan is most effective in field trials due to its dual action as insecticide-cum-fungicide is baseless. There is no empirical evidence to prove that endosulfan is effective against the fungi *Colletotrichum* or *Botryodiplodia*, which damage cashew subsequent to the tea mosquito bug attack. Sulphur-containing insecticides may have some effect on powdery mildew disease only. Also, the argument that as an insecticide is applied, more than 99% of the chemical goes waste, is grossly an unsubstantiated generalization. In a broad-leaved tree crop such as cashew, the thick canopy would act as a sponge that absorbs a significant portion of the spray fluid. Certainly a portion of the insecticide would reach litter and soil. However, in the tropical hot and humid conditions, much of it would be degraded and detoxified in 30 days, as evidenced by many studies[10].

Table 1. Average pesticide use in crops in Kerala

Crop	Pesticide use (proprietary material in litres or kg/ha/year)
One crop of rice	1.5 (to manage one pest and one disease situation)
Two crops of rice	3
One crop of vegetables	1.5
Two crops of rice and one crop of vegetables	4.5
Tea	17.28 (B. Chandramouli, UPASI pers. commun.)
Cardamom	85 (derived from S. Usha[15])
Cashew estates in Kasaragod	1.34
Kerala average	0.6 (ref. 16)

On the Calicut Medical College study

We have pointed out that certain sociological issues might have contorted the results and interpretation of the epidemiological studies carried out by researchers at the Calicut Medical College (CMC)[11]. For example, the reproductive health events in women above 30 years (whose reproductive period coincided with aerial spraying) were compared with those in women aged below 30 years (whose reproductive period started after the cessation of the aerial spraying). As women are literally transplanted into the family of their husbands following marriage, the study population in the sprayed area (Muliyar) might include women who were living outside the sprayed area during the period of aerial spraying (1980–2000). Similarly, the population of married women in the unsprayed Banam may include individuals who spent their pre-nuptial period in the sprayed areas. Mahapatro and Panigrahi[1] state that the above-mentioned argument rather supports the fact that despite this, the natality-related incidents were lower compared to the sprayed areas dataset, thereby making statistical significance robust. If the flow of women was unidirectional from sprayed areas to unsprayed Banam (or at least a higher rate of movement towards the unsprayed area) and still there is significantly higher incidence of reproductive health events in the sprayed area, the statistical significance would have been still robust. In the reverse situation, the result would be entirely misleading. As long as the information regarding the exact nature of exposure of each subject, i.e. whether they spent their life in sprayed areas during 1980–2000 or not, remains unknown, the reliability of the study is at stake.

Many flaws, as serious as misconduct, in the estimation of endosulfan residues in human blood were pointed out by us[2]. Till date, our allegations against the CMC study, in this regard, remains unanswered by the authors as well as their institution. Mahapatro and Panigrahi[1] have come forward to bail them out with the argument that 'the sampling procedure, detection methodologies and protocols might have been different for these two studies' [National Institute of Health (NIOH) study and the CMC study]. We are constrained to state that blaming the methodology for such blatant discrepancies is not only ludicrous but is also unacceptable. The CMC study was aimed at establishing the alleged endocrine-disrupting effects of endosulfan. They have 'succeeded' in this mission through their flawed and biased work which runs on the face of critical enquiry and scientific method. The latest studies rule out the possibility of endocrine disruption by endosulfan at the doses normally used in agricultural situations[12,13]. Mahapatro and Panigrahi raise doubts about the Centre for Water Resources Management and Development (CWRDM) study that reported no detectable endosulfan residues in water, as extremely high levels of residue were observed in the blood serum. This perfectly corroborates our arguments.

According to the 2001 census data, Kasaragod, Kannur and Wyanad districts recorded the lowest disability of 2.4/1000 in Kerala, while Kollam, Idukki and Alappuzha districts recorded a higher rate of disability of 3.2, 3.2 and 3.0 respectively. Eleven out of 39 panchayaths (28%) in Kasaragod were officially declared as affected by the endosulfan tragedy for distribution of financial assistance and rehabilitation. Media reports, even at the international level, portray a grim situation such as 'half the homes in the village of Kattukukke in Kasaragod has a disabled person' (*The Guardian*, 11 January 2012). In such a situation, it is inevitable to bring in the available data to shed light on the reality. Had there been such an unusually high incidence of health problems in Kasaragod, as widely perceived, this would have certainly reflected in the total figures for the district too, as 11 out of 39 panchayaths are allegedly affected.

According to Mahapatra and Panigrahi[1], 'it is quite difficult to exclusively prove all the ill-effects of a pesticide like endosulfan in a country like India'. First of all, the need for establishing the relationship between a health issue and an environmental toxin arises only if the existence of such a health issue is proved. Once the existence of a health problem is proved, absolutely establishing a cause–effect relationship – linking the health effect to endosulfan – may neither be possible nor essential and actions such as phasing out the toxin can be initiated based on circumstantial evidences as no chance can be taken in matters of public health involving a toxin. There are widely adopted tools of epidemiology to quantify the alleged higher incidence or prevalence of health problems in a society. However, instead of properly applying the tools of science with the required rigour to get to the root of the problem, here science is being misused or abused to cater to the biased, unsubstantiated, ill-motivated propaganda and fear-mongering.

Mahapatra and Panigrahi[1] further ask: 'If reflected in scientific perspective, a pertinent question arises as to why adverse health effects similar to those seen in Kasaragod have not been reported from other parts of the nation.' Their question is based on the unsubstantiated yet widely held notion made unequivocal by the reinforcing images of a few mentally and physically challenged persons. We reiterate that there are no valid data to prove this powerful myth of pesticide-induced higher rate of physical and mental disabilities. On the other hand, available information, including the undisclosed data generated by the CMC researchers, suggests that there is no such enhanced incidence of physical or mental disabilities in Kasaragod.

Dumping of toxic chemicals in the Third World

Mahapatra and Panigrahi[1] are concerned that a steadily increasing share of the global chemical production is shifting to the developing and transition countries and a global phase out is essential in order to avoid banned and restricted chemicals from one country being sold or dumped in another. At least in the case of endosulfan, their concern of 'toxic dumping by the MNCs of the developed countries into the developing countries' is misplaced as endosulfan is a generic pesticide and the public sector in India is its largest manufacturer in the world at the time of its enlisting under the category of persistent organic pollutant to be eliminated worldwide. There are unanswered questions about inclusion of endosulfan under the category of persistent organic pollutants, as it does not satisfy all the criteria for inclusion under that category[14]. The scenario of the pesticide market in the post-endosulfan phase underscores the argument that the cheap and effective generic pesticide, largely manufactured by the public sector in India was targeted for elimination to facilitate the smooth entry of costly, patent-protected, new-generation pesti-

cides developed and marketed exclusively by the MNCs of the North. The reported sales of Rynaxipyr, one of the patented, new-generation pesticides, that filled the vacuum created by the ban on endosulfan, developed and marketed by DuPont, a global giant, was Rs 650 crores in 2012 in the Indian market alone (*The Hindu Business Line*, 27 June 2013). The most important lesson that we still refuse to take from the endosulfan episode is that the rigour of good science alone can lead us in the right direction. Unless the tools of science are applied at the right time, other interests creep into the vacuum and create chaos, leading to costly mistakes and irreversible damages.

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