

## Background

Over the past 2 ½ decades, the pesticide endosulfan has been aerially sprayed on a cashew nut plantation covering several villages in Kasargod District, Kerala State, India. People residing in the villages within the plantation have been afflicted with different kinds of illnesses which, according to the villagers, were not present before the cashew nut plantation started their operations. People also noticed the death of fishes, honeybees, frogs, birds, chicken and even cows. In 1979, a farmer began to suspect that the pesticides being aerially sprayed in the plantation might have caused the deformities and stunted growth, which, he observed in 3 of his calves. A journalist reported the story warning that endosulfan, the pesticide used in the aerial spraying, might have been the cause. The story raised awareness among the people who started voicing out their complaints about health problems and environmental damage. The stories, however, were not given due attention by government authorities and pesticide users and the spraying of endosulfan continued <sup>(1)</sup>.

In 1997, a medical practitioner in one of the affected villages called the attention of the Indian Medical Association about the unusually large number of serious neurological, developmental, reproductive and other diseases, including cancer, that he had been seeing among his patients. His appeal for help and investigation was not given any attention. Meanwhile, more health complaints surfaced and in 1998 concerned people started to organize themselves to address the issue. An appeal to stop the aerial spraying of endosulfan was lodged in the courts by a coalition of public interest groups after their initial investigations confirmed that indeed there was an unusually large number of diseases occurring in the villages within the cashew nut plantation where endosulfan was being aerially sprayed. THANAL, one of the most active environmental organizations involved, conducted a more in-depth investigation on the issue and came up with a report which affirmed the people's suspicion that endosulfan was the cause of their problems. In January, 2000, the School Resource Group, Vaninagar, Government School in Enmakaje, the area where most of the complaints were coming from, also recorded in their internal report that most students coming from the direction of the plantation were observed to be mentally and physically deficient compared to their schoolmates from other areas and that many of them

were suffering from congenital anomalies, physical deformities, mental retardation, and were frequently ill. Later, they attributed the illnesses to be due to endosulfan being used in the plantation. Despite the growing protests, however, the Plantation Corporation of Kerala (PCK), the owner of the cashew nut plantation, continued the aerial spraying of endosulfan, claiming that endosulfan was "safe" and was not causing the reported illnesses. The Center for Science and Environment (CSE) from New Delhi then conducted laboratory analysis of blood, water, and other samples from the affected areas to determine endosulfan contamination. In its study, the CSE found very high levels of endosulfan residues in all the samples collected and published their report on February 28, 2001. By this time, the campaign against the aerial spraying of endosulfan was getting stronger and the Munsif Court of Kasargod in February, 2001, issued a stay order on all endosulfan applications in Kasargod.<sup>(1)</sup>

The CSE report was strongly criticized by some agricultural scientists, including the Director of the National Research Center for Cashew, claiming several deficiencies in the study, which were responded to later by the CSE. A team from the Kerala Agricultural University (KAU) conducted their own study soon after and their results showed no endosulfan residues detected in water, pepper berries, and betel leaf but found high levels of endosulfan in soil and cashew leaf samples from inside the plantation. The PCK also sponsored their own study, conducted two months later, and came up with results showing only small amounts of endosulfan in samples of cashew leaves and soil, and no residues in samples of water, human blood, fish and milk.

Subsequently, the government of Kerala formed a committee, headed by Dr. Achyuthan, to study the problem and suggest remedial measures. The report of the committee was released in November, 2001, with the following significant recommendations, among others:

1. Ban aerial spraying of pesticides in all cashew plantations of PCK in Kasargod District.
2. Use of endosulfan in the PCK plantation of Kasargod District should be frozen for 5 years.
3. "...a detailed investigation involving scientists from all related fields should be conducted to identify the risk factors for the high morbidity in the Pa-

dre village and other areas. ...the health survey should cover the plantation workers also.”

4. The right to information on the use of pesticides should be respected.

The committee, however, concluded that “there is no evidence to implicate or exonerate endosulfan as the causative factor of the health problems”.<sup>(2)</sup>

In August, 2001, the Government of Kerala ordered that “the use of the insecticide endosulfan in crops/plantations in Kerala is suspended until further orders.”

In October, 2001, upon the instance of the National Human Rights Commission, the Indian Council of Medical Research and the National Institute of occupational Health conducted a study on school children and their parents from the affected areas in Kasargod. The report on the study is still being awaited.<sup>(1)</sup>

The public interest groups and the villagers, however, were not satisfied with the way the studies were being done and with the apparent bias of government bodies in favor of the PCK, a government corporation. They observed that the approach of the government designated investigative bodies was not participatory, ignoring the community groups in their decision making and conducting their research without carefully eliciting information from the people themselves.

In November, 2001, the THANAL Conservation Action and Information Network formally requested Dr. Romeo F. Quijano, Professor at the Department of Pharmacology and Toxicology, College of Medicine, University of the Philippines Manila, to visit Kasargod and look into the question of whether or not endosulfan was the cause of health problems observed in the cashew nut plantation areas.

### **Objectives of the Fact –finding Mission**

There were two major objectives of the fact-finding mission:

- A. To determine the veracity of reports that serious health problems and adverse environmental effects have appeared in Kasargod since the time the cashew nut plantation started its operations.
- B. To determine whether the reported illnesses were largely due to endosulfan aerial spraying.

### **Conduct of the Fact-finding Mission**

The fact-finding mission was conducted from January 19-22, 2002, through the following activities:

- A. Ocular inspection of the physical and topographical characteristics of the cashew nut plantation areas in Kasargod.
- B. Ocular inspection of village interiors within the plantation areas covered by the aerial spraying of endosulfan.
- C. Household visits to selected families reported to have been affected by the aerial spraying of endosulfan.
- D. Individual interviews and physical examination of selected persons, and/or their immediate relatives, who had been afflicted with illnesses attributed to endosulfan.
- E. Interviews with key informants, including:
  1. One medical practitioner living in the affected villages.
  2. One medical practitioner in a nearby primary care facility.
  3. One investigative journalist involved in the issue since ten years ago.
  4. Several public interest NGO leaders, and
  5. Some village leaders.
- F. Focus group discussions, and
- G. Review of documents (official reports, scientific articles, internet documents, magazine articles and news reports).

### **Findings**

The cashew nut plantation in Kasargod, estimated to be 4,600 hectares, is located in a slightly elevated hilly area with patches of grassy open spaces punctuated by clusters of small trees and shrubs. The cashew nut trees are mainly in the elevated portions while the villagers’ houses are located in the valleys canopied mostly by areca palm and coconut trees. A government high school is located just at the outskirts of the plantation. Individual houses are interspersed within the lush vegetation in the valleys where the village people reside. Streams vigorously flow with lots of small ponds and tributaries which eventually drain into a nearby river. Households get their water, including drinking water, from open wells or “surangas”, made by excavating a few meters into the rocky side of the hill to draw constant drips of water collecting

into a small pond. Households appear to be generally self-sufficient in food, cultivating modestly sized parcels of land with vegetables, fruit trees, grains and pulses. The main cash crop is the areca nut. Almost every household also has a cow or two and other domesticated animals, including poultry. The houses are modest in size, bungalow type, and usually made of wood and clay material. One or more families live in a single house.

The villagers visited were friendly and were quite open to interview and examination, perhaps due to the fact that the village doctor was with the fact-finding team. The team visited nine households, mostly in Padre village in Enmakaje panchayath which was located within the plantation. A short description of the families afflicted with serious ailments follows:

1. Mr. Narayana Shastri told us that his wife, 35 years old, is a diabetic, asthmatic and is afflicted with skin disease. She was also diagnosed to have endometriosis. She was one of those who provided blood for the CSE study and it was found the endosulfan level in her blood was very high (114 ppm). Mr. Shastri's son also suffers from a skin ailment. He narrated that their cow and buffalo died recently due to some liver problem which he suspected was due to the aerial spraying of endosulfan.
2. Mr. Narayana Bhatt and his family live at the edge of the plantation. His father died of abdominal cancer 6 years ago and his mother died of uterine cancer. His sister, 35 years old, is an epileptic and his nephew, 22 years old, is also an epileptic and suffers from severe mental retardation. Another nephew, Vishnu, 18 years old, is also an epileptic, has breast enlargement and also suffers from severe mental retardation. Vishnu's blood showed 108.9 ppm of endosulfan in the CSE study.
3. Sheena Shetty and his family also live at the edge of the plantation. He narrated that his eldest daughter became epileptic soon after endosulfan spraying started in the area and died 6 years later. His son, Kittanna, whose blood test showed 109.5 ppm endosulfan, suffers from severe cerebral palsy. Another child, Sridhara, 17 years old, is mentally retarded. Mukthaka Shetty, their mother, had 196.47 ppm of endosulfan in the CSE study. Mr. Shetty also revealed that his cow, which was grazing at the time of endosulfan spraying, returned home bleeding and vomiting and eventually died 8 days later.
4. Kumaran, a retired school teacher who is about 60 years old, has been diagnosed with liver cancer and is suffering from severe ascites. He has no history of alcoholism and had no known exposure to hepatitis B virus. He is a non-smoker and claimed that he had been strict on his diet and was very health conscious. He knows of no other possible cause of his disease except endosulfan.
5. Udaya is 10 years old with cerebral palsy. He lives at the edge of the plantation. His mother was exposed to endosulfan spraying during the early months of her pregnancy. There was no history of difficult delivery nor physical trauma and there was also no history of smoking, drinking alcohol, drug intake, or exposure to other chemicals except endosulfan during her pregnancy.
6. Shruthi, 8 years old, has congenitally deformed hands and legs. Each hand is bifid with four fingers. The severely deformed right lower limb was recently amputated to enable the fitting of a prostheses. Her mother was exposed to endosulfan spraying during her pregnancy with Shruthi and there was no history of drug intake or any other exposure to other chemicals or pesticides except endosulfan. Shruthi's mother died of cancer 6 years ago.
7. Balakrishnan, 6 years old, lives also at the edge of the plantation. He was diagnosed to have brain tumour (neuroblastoma). He had undergone one round of chemotherapy but his family could no longer afford the rest of the treatment. His parents confirm that they had been repeatedly exposed to the aerial spraying of endosulfan. There is no history of exposure to any other chemical.
8. Rishana is a 3 year old girl with serious growth retardation and delayed mental and psychomotor development. She could hardly speak and started to walk only a few months ago. Her mother had no history of difficult delivery and was not taking any medication during her pregnancy with Rishana. Her family lives within the plantation the only exposure to potentially toxic chemicals they could recall was exposure to endosulfan aerial spraying.

9. Subramanian was a 19 year old boy with cerebral palsy and lived within the plantation area. He had been an epileptic since birth and had severe physical and mental retardation. He was not able to perform simple tasks and could not respond to questions. His mother had no history of difficult delivery, trauma, nor any intake of medications during pregnancy. He passed away in February, 2001. The source of drinking water for the family is an open well which is left uncovered during the aerial spraying of endosulfan.

The cases described above are just few of the more than a hundred cases that Dr. Mohan Kumar, the medical practitioner in the area, had documented. Since 1990, in fact, he had noted a large number of diseases related to the central nervous system in Padre village where he had his private clinic. He revealed that the 197 cases he had documented came from only 123 households. He added that those he had recorded was not comprehensive and did not include those who might have consulted other doctors. His list also did not include cases of asthma, hormonal disorders, infertility, miscarriages, skin disorders and others. Most of the cases in his list are cancer, cerebral palsy, mental retardation, epilepsy, congenital anomalies and psychiatric cases, including suicides.<sup>(3)</sup>

Dr. Sripathy Kajampady, a medical practitioner and proprietor of a primary health care facility in the nearby Perla village, corroborated the observations of Dr. Kumar. Dr. Sripathy had also seen several patients from the nearby villages within the plantation areas who were suffering from similar diseases. He had also observed the disappearance of small animals in the areas covered by the aerial spraying of endosulfan.<sup>(4)</sup>

Mr. Shree Padre, the farmer-journalist who first wrote the story about cows giving birth to deformed calves after exposure to endosulfan spraying also corroborated the observations of the two medical doctors. He, too, have seen many villagers with various kinds of "strange" diseases.<sup>(5)</sup> The public interest group leaders and other villagers echo the same observations. Reports from both non-governmental and governmental organizations also confirm that an unusually large number of serious illnesses and developmental disorders have occurred in the villages where aerial spraying of endosulfan had been regularly done. The public interest group, THANAL, for example,

has investigated the reports of health problems associated with the aerial spraying of endosulfan and conducted community monitoring in the affected areas. THANAL confirms the observations of the village doctors and the others that indeed there are a large number of illnesses in the villages and stated that the most likely culprit was endosulfan.<sup>(1)</sup>

The official report of the study committee formed by the government of Kerala tacitly admits that there is a high incidence of diseases in the plantation, although other sections of the report cast doubt on the veracity of the health complaints. Recommendation No. 8 of the report, for example, stated that "...a detailed investigation...should be conducted to identify risk factors for the high morbidity in the Padre village and other affected areas."<sup>(2)</sup>

More revealing were the results of the study done by the Kasargod District Committee of the Kerala Shastra Sahitya Parishad.<sup>(6)</sup> A household survey was done to assess the health and environmental situation in 7 villages within the cashew plantation where endosulfan was being aerielly sprayed. A total of 747 households with 4102 inhabitants were included in the study. The respondents were categorized into two main groups. Those from the Enmakaje area, where most of the reports of health problems came from, were designated as Group B and the rest, where such reports were apparently less, was designated as Group A. Health and environmental quality indicators were then compared with those of the entire state of Kerala from the latest available data (1996). The results showed that disability rate was 73 per cent higher in Group B compared to that of Kerala state and that the rate of locomotor disability and mental retardation taken together was higher by 107 per cent. Likewise, chronic morbidity was higher in Group B by 70 per cent. Although the rates of total disability and chronic morbidity in Group A did not seem to be significantly different from the overall rates in the state of Kerala, the rates of locomotor and visual disabilities were significantly higher. In a separate study done in February, 2001, by the Deputy District Medical Officer in Kasargod, in a survey of 400 households in the affected areas, it was also found that the rate of mental retardation in the endosulfan sprayed areas was above the state average.<sup>(2)</sup>

Given the foregoing case descriptions, corroborative testimonies and observations, and governmental and non-governmental studies/reports, there seems to be no doubt that indeed there is an unusually large number of illnesses occurring in the villages within the cashew plantation where endosulfan has been aerially sprayed.

The question now remaining is: are these illnesses mainly due to endosulfan exposure? The answer is YES, for the following reasons:

1. The illnesses observed are to be expected from the known intrinsic toxicologic properties of endosulfan.

The preponderance of neurologic and mental illnesses among the reported health problems is compatible with the fact that endosulfan is a known neurotoxicant, <sup>(7)</sup> belonging to a group of highly toxic organochlorine chemicals. Endosulfan blocks the inhibitory receptors of the central nervous system, disrupts the ionic channels, and destroys the integrity of the nerve cells. Acute toxic effects include dizziness and vomiting, hyperactivity, tremors, lack of coordination, and convulsions. Chronic exposure may result in permanent damage to the nervous system which may manifest in various kinds of neurologic diseases. Apart from its capacity to directly damage the nervous system, endosulfan is also an endocrine disruptor.<sup>(8,9,10)</sup> Even low levels of exposure during pregnancy could result in various forms of endocrine disrupting effects in the offspring, including mental retardation, reproductive organ anomalies, developmental disorders, behavioral disorders later in life, and many others.

There is also evidence that endosulfan can cause cancer, despite contrary claims from the chemical industry produced data often quoted by international technical bodies including the WHO/FAO committees. For example, endosulfan was found to be mutagenic in various assay systems, including the Ames test, micronucleus test, and the yeast conversion test.<sup>(11,12,13)</sup> Endosulfan was also found to cause chromosomal aberrations in hamsters and mice, sex-linked recessive mutations in *Drosophila*, and dominant lethal mutations in mice.<sup>(14,15)</sup> Studies in human cells, both in vitro and in vivo, also showed that endosulfan caused chromosomal damage.<sup>(16,17)</sup> Very recently, a team of researchers found further evidence of endosulfan genotoxicity using sister chromatid

exchanges, micronuclei, and DNA strand breaks as detected by gel electrophoresis as biomarkers.<sup>(18)</sup> Other studies indicate that endosulfan may cause lymphosarcoma and that it is a potential liver-tumour promoter.<sup>(19,20)</sup>

The high incidence of cancer in the endosulfan sprayed areas is therefore compatible with existing independent scientific evidence showing the carcinogenic potential of endosulfan. The fact that endosulfan has not been classified as a human carcinogen by international bodies is no reason to exonerate endosulfan as a probable cause. Most carcinogenic chemicals have not been classified as human carcinogens because of the unrealistic standards of evidence required by corporate dominated "sound science" and the "risk assessment" paradigm.

The genotoxic and chromosome damaging properties of endosulfan not only indicate that endosulfan causes cancer but also explains the high incidence of congenital abnormalities found in the endosulfan sprayed areas, since genotoxic and chromosome damaging chemicals are also usually embryotoxic. In fact, endosulfan has been found to be embryotoxic in animals.<sup>(21)</sup> This embryotoxic property of endosulfan can also explain the high occurrence of abortions, stillbirths, and other related disorders.

There is also scientific evidence that endosulfan is immunotoxic.<sup>(22,23)</sup> This should not be surprising since endosulfan belongs to the organochlorine group of chemicals, many of which have already been demonstrated to destroy the immune system. This immunotoxic property can also explain why many of the affected villagers are very susceptible to practically all kinds of diseases.

2. There is no other probable cause that might reasonably explain the observed health problems except endosulfan.

There is no evidence that other environmental toxicants that might possibly explain the observed health problems are present in the affected areas. There has been no other pesticide, not even household pesticides, that has been used except endosulfan. There are no industrial activities at or near the areas affected which might indicate possible contamination by industrial pollutants, like lead, mercury, cadmium, polyaromatic hydrocarbons, etc.; that might confound

the causation of the health problems in the affected areas. Furthermore, the villages affected were too far away from the nearest city where pollution by other toxicants might possibly occur. Ionizing radiation is also an unlikely cause since there is no identifiable source. Detailed interviews also did not reveal intake of medications or other substances that might have caused some of the observed illnesses like congenital abnormalities. While there is a possibility that areca nut chewing might explain some of the health problems, there was no history of areca nut chewing by the mothers of the affected children before or during pregnancy. Some of the cancers, particularly oral cancer and cancer of the throat, can be caused by areca nut chewing, but the overall incidence of diseases in the affected areas cannot be explained by this possible confounding causative factor. There is also no history of smoking among the affected households, nor any history of habitual alcohol drinking. In addition, the family history of those interviewed did not reveal any confounding factor referable to hereditary causes, infectious agents, or other biological or physical factors. In all cases of congenital abnormalities seen, there was no history of similar cases in either the mother's or the father's relatives. There was also no indication of any infectious episode during pregnancy of the mothers of the affected children, nor was there any history of difficult delivery that might explain some cases of cerebral palsy, epilepsy or severe mental retardation. Malnutrition is also not a causative factor since most households are relatively self-sufficient in food and are, in fact, relatively better off economically compared to other areas. There is also no evidence that other dietary factors such as food additives and other food contaminants might be present. Inter-marriage among close relatives, a possible factor in some developmental disorders, is relatively uncommon and would not explain the observed health problems. The two medical doctors who personally knew the patients and their families also affirm that there are no other likely cause of the observed health problems except endosulfan.

3. There is clear time and geographic association between the occurrence of the health problems and the aerial spraying of endosulfan.

The people's claim that the health problems occurred and gradually accumulated during the period of aerial spraying of endosulfan has not been disputed. Cases of cancer, developmental anomalies, reproductive disorders, neurologic diseases, and the other serious illnesses were practically non-existent before the advent of endosulfan aerial spraying. Drs. Kumar and Sripathy also assert that they noticed the increased incidence of various diseases only after the aerial spraying of pesticide in the plantation was started. The teachers in the school near the plantation also noticed that children from the villages within the cashew plantation were often sick and perform significantly less in school compared to children from other areas outside the plantation. It was also observed that health problems were more numerous and were more serious in the villages inside the plantation compared to those farther away from the plantation.

4. There is corroborating evidence of adverse effects on animals and the environment which are attributable to endosulfan.

The reports on fish kills and dwindling population of honeybees, frogs, birds, and other animals soon after the aerial spraying of endosulfan started have not been disputed. Cows and chicken were also observed to die of mysterious causes. People were also complaining that their domestic animals had suffered miscarriages, bleeding, infertility, stunting of growth and deformities. These effects can be expected as a result of exposure to endosulfan. Endosulfan is highly toxic to fish, honeybees and birds, and can also result in the diminution of the population of various species of animals and wildlife.<sup>(24.25.26.27)</sup> Existing scientific data reveal that the above mentioned adverse effects observed in the endosulfan sprayed villages in Kasargod have also been observed in many areas around the world as a result of endosulfan contamination.

5. There is credible testimonial and clinical record evidence of the various illnesses from competent medical practitioners who had been directly consulted by the affected villagers.

There is no reason to doubt the veracity of the

depositions of Dr. Kumar and Dr. Sripathy pertaining to the occurrence of the health problems reported. These depositions are backed-up by clinical records of patient consultations. Their professional evaluation of the cases seen leads them to conclude that endosulfan is the most likely cause of the diseases they were seeing.

6. Endosulfan has been demonstrated by laboratory analysis to be present in high concentrations in biological and environmental samples taken from the most affected village inside the endosulfan sprayed area.

The CSE study, which published its results and described in detail the standard methodology used, revealed very high levels of endosulfan in all samples, including human blood, milk, water, soil, plants, and several others, taken from Padre village.<sup>(2)</sup> While the study had been criticized, the criticisms had been answered by the CSE scientists. Another study, the KAU study, did not show endosulfan levels in samples of water, pepper and betel leaves but showed low to high levels of endosulfan in soil and cashew leaves. This study, which was not openly published and which has not described its methodology in detail, concluded that there was no conclusive evidence that endosulfan was the cause of the problem. A study was also done two months later by the PCK and the pesticide manufacturers themselves and came up with results showing no endosulfan residues found in samples of fish, water, milk, and blood; while there were low levels in soil and low to moderate levels in cashew leaves. This study was also not openly published and no details of the methodology were provided.

7. People's experiences and testimonies from the affected villages had indicated that endosulfan was causing health and environmental problems.

The people in the affected villages had been seeing the increased incidence of diseases and environmental problems only since the plantation started its operations. Many other villages in Kasargod have also reported such health problems at various times during the years of endosulfan aerial spraying.

People's experiences and testimonies provide important information and evidence on the causation of certain illnesses. Medical practitioners often rely on the oral narrations of patients or their close rela-

tives and friends to determine the nature and causation of diseases. The clinical impression often overrules laboratory analysis since very often, unquantifiable uncertainty factors, including intuition based on clinical experience, prove to be very useful in the total appraisal of the situation. Clinical decisions are often based mainly on patient's personal account of signs and symptoms of ill health and its cause. In the particular case of the health problems in Kasargod, the people's testimonies and experiences implicating endosulfan as the cause of their health problems, carry a lot of weight.

Taken together, the foregoing reasons establish beyond reasonable doubt that endosulfan is primarily the causative factor of the health problems in the villages within the cashew plantation in Kasargod, Kerala, India.

## Conclusions

Based on the foregoing findings and analysis, it is concluded that:

1. There is an unusually large number of illnesses occurring among the people in the villages of Kasargod within the cashew plantation where aerial spraying of endosulfan has been going on since the past 26 years.
2. The occurrence of these illnesses is due mainly to endosulfan.

## Recommendations

1. The use of endosulfan should be permanently banned.
2. A comprehensive health and environmental survey of the villages which were likely exposed to endosulfan should be undertaken to determine the extent of adverse health and environmental damage.
3. Remediation measures should be undertaken immediately on the affected villages. Immediate medical assistance should be provided to the victims and economic compensation paid for by the polluters should be awarded to the affected families. Clean-up of the soil and water at the expense of the polluters should be immediately undertaken in areas where endosulfan levels are determined to be high.

4. Community health and environmental monitoring for at least 10 years should be instituted to determine the occurrence of latent and delayed effects and to determine the effectiveness of remediation measures.
5. Policy reforms should be initiated to ensure adequate protection of health and environment from pesticides.
6. Steps should be taken to include endosulfan among the list of persistent organic pollutants (POPs) targeted for global elimination.

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