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Promoting Non-POPs Alternatives to DDT and Environmental Health Through Engaging Key Local Partners:

Low-cost Local Technology and Neem-based Agroforestry in India

PROJECT FULL NAME	COUNTRY & REGION	IMPACT AREAS	IMPLEMENTING AGENCY
Development and promotion of non-POPs alternatives to DDT	India 	▪ Chemical and Waste ▪ Biodiversity ▪ Poverty Reduction ▪ Local Socio-Economic Benefits ▪ Health	United Nations Industrial Development Organization, United Nations Environment Programme **EXECUTING AGENCIES** Ministry of Environment, Forest and Climate Change; Ministry of Chemicals and Fertilizers; Ministry of Health and Family Welfare
GEF PROJECT ID: **4612**	**FOCAL AREAS** ▪ Chemical and Waste		
PROJECT TYPE: **FSP**	GEF Project Grant **$10,000,000**	Co-financing Total **$43,147,167**	GEF Period **GEF-5**
GEF PERIOD: **GEF-5**			

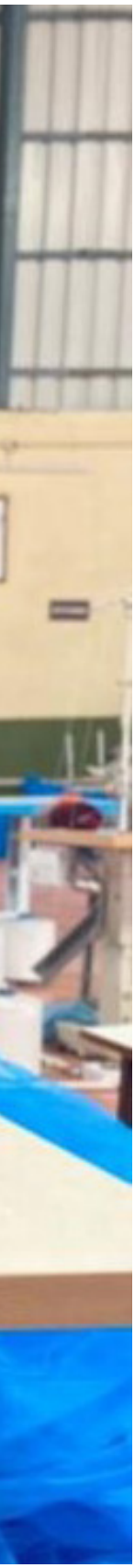
Summary

Through the GEF investment, India has taken the first step to eliminate dependency on DDT by promoting locally appropriate, cost-effective, and sustainable alternatives, including the Long-Lasting Insecticidal Net (LLIN)[1] and Neem[2]-based and bacteria-based biopesticides. HIL (India) Limited (HIL)[3], a public sector enterprise, is the only manufacturer of DDT in the world and committed to phaseout production of DDT by 2024. It now produces 5 million LLINs per year and plans to double production capacity, supplying them across the country through the Ministry of Health and Family Welfare. HIL is also preparing large-scale production of Neem-based and Bti bacteria-based biopesticides for control of vector-borne diseases.

Since Neem trees are available in Africa and large parts of Asia, HIL will also work with partners to transfer Neem-based local technology to other parts of the world.

The project contributes to a global effort to control toxic chemicals and reduce persistent organic pollutants (POPs) following the Stockholm Convention on POPs. Since India is the only country producing DDT, its phase-out of DDT production helps improve the health of millions involved in chemical pesticides. The phase-out also benefits those living in mosquito-endemic areas who are exposed to DDT in their dwellings. Using an agroforestry model, the project supports

Gender participation in Long-Lasting Insecticidal Nets (LLINs) making @UNIDO



large-scale plantation of new cultivars of Neem trees. In addition to providing high quality raw material to make Neem-based pesticides, this model generates additional income for rural populations and farming communities. Engagement of key local partners made the project locally relevant, cost-effective, and sustainable. The project is also strengthening capacity of national stakeholders through training on integrated vector pest management (IVPM). Further, the project will recommend laws and provide guidance on DDT alternatives to the government of India.

Results and global environmental benefits

- Reduced production of DDT and POP pesticides in India and globally.
- Introduced 5 million LLINs per annum into the market to replace indoor residual spraying, including DDT.
- Prepared to register and produce five environmentally sound Neem-based biopesticides for mosquito coils, repellant creams and other uses, and two Bti bacteria-based biopesticides, all of which are highly effective against mosquito larvae.
- Identified four Neem cultivars with high yielding limonoids[4], standardized the protocol for clonal propagation of Neem (through stem cuttings and tissue culture), and started pilot Neem-based agroforestry plantations in five different agroclimatic zones in India.
- Developed four training modules for field workers to adopt DDT alternatives.
- Prepared gap analysis, action plan, and guidance documents for legal framework for DDT alternatives in India.
- Reduced exposure to DDT of millions of production workers of chemical pesticides, handlers, packagers, and applicators, particularly women, as well as populations exposed to DDT year round in their dwellings.

Environmental challenges

About 95% of India's population resides in malaria-endemic areas, exposing them to increased morbidity and mortality from vector-borne diseases such as malaria, kala-azar, and dengue. Such diseases are particularly severe in rural areas where the most vulnerable communities live. The World Health Organization (WHO) recommends seven insecticides for indoor residual spraying, including DDT. India produces DDT exclusively for vector control as per WHO guidelines,[5] and strictly regulates DDT use for public health. As of 2013, India has used 6,183 metric tons of DDT for public health in 27 states. With this continued use of DDT, some Anopheles mosquito species have developed resistance.

The government of India has prioritized replacing DDT with cost-effective, locally relevant, and sustainable alternatives to prevent malaria and other vector-borne diseases. To phase out DDT production, IVPM strategy encourages use of LLINs and biopesticides in high-risk areas. However, there is not enough production of LLINs to meet demand. The farming community has increasingly used Neem-based biopesticides for agriculture, reducing its use of toxic pesticides in consequence. However, Neem-based biopesticides such as mosquito coil, and cream, oil, and spray repellent are produced at small scale for local areas. India needs to scale up production of LLINs and biopesticides and reduce reliance on DDT in public health through IVPM.

The project is a part of a wider effort of the GEF to address use of DDT in vector control. As a supply-side approach, this wider effort aims to replace DDT with alternatives. Meanwhile, several other projects in Africa and Asia aim to reduce DDT use and promote alternatives. Thus, the project aims to phase out production of DDT in India and also ensure that other countries have access to DDT alternatives.

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1 LLIN is a factory-treated mosquito net made with netting material that incorporates insecticide within the fibers. The net must retain its effective biological activity without re-treatment for at least 20 standard washes under laboratory conditions as defined in World Health Organization (WHO) guidelines. The national standard for LLIN is already established in India based on WHO specifications.

2 Neem is a deciduous tree native to India. Besides being tolerant to high temperatures, Neem can also be grown easily on waste and barren land. Different chemical substances are found in the bark, leaves, and seeds. These are collectively known as limonoids. In addition to wood and shade, Neem trees provide many types of health and agricultural benefits due to their biologically active chemicals. They are known as the "village pharmacy" (NBRI 2022).

3 HIL (India) Limited changed its name from Hindustan Insecticide Limited (HIL).

4 Limonoids are phytochemicals of the triterpenoid class. They are abundant in sweet- or sour-scented fruit and alter plants of families Meliaceae, Cucurbitaceae, and Rutaceae. Many limonoids possess biological qualities to fight insect pests.

5 The government banned DDT for agriculture use in 1989: Order No. S.O. 378(E), 26 May 1989. It also restricted DDT use to control disease vectors.

Integrated approach and key features

Environment, health, and socio-economic benefits through low-cost local technology

In collaboration with local institutions, and producers/distributors of DDT and its alternatives, the project began commercial production of LLINs. It also laid the groundwork for commercial production of bio- and botanical pesticides. These are locally relevant, cost-effective, and sustainable alternatives to DDT. During India Chem 2021, LLIN technology was awarded the "Innovator of the Year" Award.[6]

Through developing these low-cost local technologies, the project achieved global environmental benefits. It also generated health and socio-economic benefits for millions of workers involved in the various stages of production, packaging, and application of DDT, especially women. At the same time, it promoted the health of populations in mosquito-endemic areas exposed to DDT in their homes.

Neem has been used in India for agriculture and health benefits since ancient times. However, over the years, use of chemical fertilizers and pesticides in intensive agriculture has increased due to industrialization. Meanwhile, the use of Neem-based fertilizers and pesticides is decreasing because high quality Neem varieties are not available.

Under the project, the Institute of Pesticide Formulation Technology (IPFT)[7] developed five environmentally sound Neem-based biopesticides for mosquito coils, repellant creams, and sprays, and two Bti bacteria-based biopesticides. These are all highly effective against mosquito larvae.

IPFT transferred the technology to HIL for commercial production and is willing to share its technology with others. The market for mosquito repellants is $183 million, half of which is for mosquito coils alone. Large-scale production of biopesticides is planned to cover the entire country and technology transfer is planned to other countries.

In addition, the project engaged with women from states in the rural and tribal belt. This includes Chhattisgarh (Central), West Bengal (East), and Jharkhand (East), which manufacture LLINs. Since women make close to 80% of LLINs, the project empowered them economically; 6,000 women are employed to manufacture LLINs in these three states.

So far, nine pilot testing training sessions for IVPM have been organized, covering over 16 states and benefiting more than 330 participants. The training covered various aspects of vector control, emphasizing alternatives developed under the project and the legal framework. Overall, project components complement each other and help the government of India meet its obligations toward the Stockholm Convention.

South-South cooperation for technology transfer

The project has also promoted technology transfer of biodegradable DDT alternatives such as botanical pesticides and Neem-based biopesticides through synergizing with other projects at country, regional, and global level particularly in Asia Pacific and Southern Africa. HIL, for example, has prepared exporting LLIN to Nepal. The project will also enhance synergies between regional DDT projects managed by WHO and the United Nations Environment Programme.

Lessons learned

Engaging with key local partners to find solutions

The engagement and commitment of relevant local partners were key to ensure the successful development and promotion of locally appropriate, cost-effective, and sustainable alternatives to DDT in India. Collaboration with HIL was critical for commercial production of LLINs and Neem-based and bacteria-base biopesticides. The project also engaged with the Central Institute for Petrochemical Engineering and Technology (CIPET) and IPFT to produce LLINs and formulate Neem-based and bacteria-based biopesticides. The National Botanical Research Institute (NBRI) is playing an important role to identify four Neem cultivars with high yielding limonoids, to standardize the protocol for clonal propagation of Neem (through stem cuttings and tissue culture), and to start pilot Neem plantations in five different agroclimatic zones in India. NBRI also contributed to further development of Neem-based agroforestry based on consultation with local farmers.

6 HIL (India) Limited has also begun to pack and supply LLINs in biodegradable packing to overcome the issue of disposal of packing material, thereby safeguarding the environment.

7 IPFT was established in 1991 under the Department of Chemicals & Petrochemicals, Ministry of Chemicals & Fertilizers as an autonomous institution. It has been working toward development of safer, efficient, and environmentally friendly pesticide.

In the Nepalese mountains, a tree nursery contains seedlings to protect crops from floods, drought, and erosion. @EbA South

Agroforestry model of Neem plantation with different medicinal and aromatic plants @NBRI

The project has also brought together relevant government institutions on a common platform to discuss development and promotion of DDT alternatives. These include Ministry of Environment, Forest and Climate Change (MoEFCC); Ministry of Chemicals and Fertilizers; Ministry of Health and Family Welfare (MoHFW) and state governments in charge of IVPM. Led by MoEFCC, the National Environment Engineering Research Institute (NEERI) developed four training modules to adopt alternatives to replace DDT in the IVPM program. To that end, NEERI consulted with state governments and the National Vector-Borne Disease Control Programme under the MoHFW. Development of low-cost local technology using local resources identified by local research institutions has enabled the country to produce safe and environmentally friendly alternatives to combat mosquitoes. These efforts can save the lives of millions of people in India and across the globe.

Strong co-finance by the industry for sustainability of the project

HIL is committed to phase out DDT by 2024. It arranged co-financing of 160 million Indian rupees (around $2.4 million) to produce DDT alternatives. This co-finance is based on a strong commitment of HIL, which made the commercial production of DDT alternatives sustainable. However, the project has gone through challenges due to the involvement of key stakeholders.

In the early stage of the project, HIL, the sole producer and supplier of DDT for malaria and kala-azar vector control in the country, was unwilling to participate. This led to an amendment in the project document to substitute the Defense Research & Development Organization (DRDO) for HIL in February 2016. DRDO invented the LLIN local technology and could have been a good partner for the commercial production of LLINs. However, it was not ready for the responsibility. In March 2017, after a change in management, HIL announced its interest in establishing the infrastructure and developing capacity to produce LLIN as a viable alternative to DDT. CIPET has transferred technology to HIL to produce 5 million LLINs per annum at commercial level. Subsequently, HIL put up the co-financing for building infrastructure of the LLIN manufacturing facility. It completed construction in 2019, installed machinery, and undertook trial runs and master batch production. HIL also took over commercial production of Neem-based and bacteria-based biopesticides as a part of its facilities. The key lesson: it is critical to engage key local stakeholders of the project regardless of challenges.

Moving toward Neem-based agroforestry with support of local farmers

For large-scale cultivation of Neem-based products, NBRI identified four Neem cultivars with high yielding limonoids. It standardized the protocol for clonal propagation of Neem (through stem cuttings and tissue culture). And it started pilot Neem plantations in five different agroclimatic zones in India.

Through consultation with local farmers on a pilot plantation, the project proposed an approach for Neem-based agroforestry. For the first four to five years of a Neem plantation, farmers cannot harvest Neem seeds and Neem seeds can be harvested only once a year after four to five years. Because of these conditions, farmers caring for a Neem plantation need other sources of income for the first four to five years and non-harvest season of Neem seeds. In response, NBRI proposed Neem-based agroforestry that would make dwarf cultivars of Neem available to cultivate other crops in Neem plantations. Consultation with local farmers and understanding the socio-economic context of large-scale cultivation were critical to make the Neem plantation sustainable.

Under the project, NBRI is studying the cultivation of several types of medicinal (Asparagus) and aromatic plants (Lemongrass, Vetiver, Turmeric, Pipli, and Sarpagandha) in the field of four dwarf cultivars of Neem. As they are dwarf cultivars, a single area can accommodate many plants. There is also enough light on the surface of the field for farmers to cultivate different types of crops.

Based on preliminary data, cultivation of medicinal plants on waste land among Neem plants can provide additional economic benefits and increase soil fertility. NBRI is working for national-level propagation of four high quality cultivars of Neem, setting up plantation at multiple locations, and promoting Neem-based agroforestry. As a unique example of an inclusive and sustainable development model, it integrates the three components of sustainable development: social (employment), economic (higher income) and environmental (increasing soil fertility, supporting biodiversity and reducing use of synthetic chemicals). Thus, the Neem tree holds tremendous potential in sustainable agricultural systems around the world.

References and multimedia

- CEO Endorsement document and Project Implementation Report 2021, https://www.thegef.org/projects-operations/projects/4612
- Video: HIL New Initiative – LLIN, https://www.youtube.com/watch?v=lihz5NCaUq0&t=116s
- Neem – A versatile Tree, https://nbri.res.in/media/English-neem-Folder.pdf

Contact

- Anil Bruce Sookdeo, asookdeo@thegef.org, Chemical and Waste Focal Area Coordinator and Senior Environmental Specialist, GEF
- Yash Pal RAMDEV, Y.RAMDEV@unido.org, National Coordinator of the project, United Nations Industrial Development Organization
- Alessandro AMADIO, A.AMADIO@unido.org, United Nations Industrial Development Organization
- Jitendra Sharma, jitendra.sharma@un.org, Economy Division, Chemicals and Health Branch, GEF Unit, United Nations Environment Programme
- N. Subrahmanyam, n.subrahmanyam@gov.in, Joint Director, Ministry of Environment, Forest and Climate Change
- S. P. Mohanty, cmd@hil.gov.in, Chairman and Managing Director, HIL (India) Limited
- Jitendra Kumar, jitendrakumar7@yahoo.com, Director, Institute of Pesticides Formulation Technology
- SK Barik, director@nbri.res.in, Director, National Botanical Research Institute
- A. Ramesh Kumar, ar_kumar@neeri.res.in, National Environmental Engineering Research Institute

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Author: Ikuko Matsumoto, Knowledge and Policy Officer

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