ENABLING YEAR-ROUND CULTIVATION IN EXTREME CLIMATES WITH COVESTRO POLYCARBONATE GREENHOUSES

What if a sheet of plastic could change the future of farming in one of India's coldest, harshest regions?

Farming during winters was once thought impossible in Ladakh, where temperatures drop to as low as -30°C and snow cuts off access to food for months. But today, Covestro's polycarbonate greenhouses are helping cultivate fresh vegetables and provide nutrition all 12 months.

The Challenge

Natives of Ladakh have always depended directly on their local ecosystem, growing what they could with limited resources. But in recent years, farming has taken a backseat. Harsh weather limited cultivation seasons, and better-paying jobs in tourism have caused a steady shift away from agriculture. Today, only 28% of workers in Leh district identify as full-time farmers.

At the same time, families are relying more on food imported from outside. This drives up costs and creates nutrition gaps, especially in winter, when fresh vegetables are rare. The result? Hidden hunger—micronutrient deficiencies that quietly affect the health of the locals.

Initial Attempts

For years, researchers and the government tried to extend the cultivation period by introducing greenhouses. Most were made of polythene sheets stretched over basic frames. However, these greenhouses often tore under strong winds, collapsed under heavy snowfall, and failed to retain enough heat during Ladakh's freezing winters.

In addition to their limited performance, polythene structures created an environmental burden. The sheets degrade quickly, often needing replacement every 1–2 years, being rarely recyclable. Over time, torn plastic is burned or dumped, adding to air pollution, soil degradation, and microplastic contamination in fragile mountain ecosystems.

A better solution was urgently needed—one that was both climate-resilient and environmentally sustainable.

The Breakthrough

Scientists at **DIHAR (Defence Institute of High-Altitude Research)** designed a greenhouse specifically for Ladakh's climate using UV protected 16mm triple-wall polycarbonate sheets. These sheets are strong, durable, and excellent at trapping sun's heat during the day and maintaining favourable temperature inside through the freezing night.

The Result: a greenhouse that stays 12°C to 18°C warmer than the outside, even in the coldest months. **When it's -7°C outside, it can be over 11°C inside**—warm enough to grow spinach, cabbage, tomatoes, and more. The greenhouse can withstand heavy snowfall and has a life span of at least 10 years.

Polycarbonate: The Material Making It Possible

This breakthrough has been possible only because of the usage of the right material - Polycarbonate sheets, based on the polymer resin and technology of Covestro.

Used as a **16mm triple-layer UV-stabilized sheet, polycarbonate** offers:

- Superior insulation, keeping the greenhouse warmer for longer hours
- Strength to withstand heavy snow loads in winter
- Durability and long lifespan, reducing the need for frequent replacement
- Resistance to discoloration, ensuring consistent sunlight exposure for plant growth
- UV filtering, protecting crops from harmful radiation that can affect growth in high-altitude regions

Compared to polythene sheets used in traditional greenhouses, polycarbonate is longer-lasting, stronger, and more environmentally sustainable.

Smart Design: Harnessing Nature's Advantage

Along with polycarbonate material, specific design optimizations were incorporated to enhance the efficiency of the greenhouse solution.

Ladakh receives an exceptional solar irradiation of 6 kWh/m² with 300 days of sunshine annually. The smart design captures this natural advantage through east-west orientation for maximum solar collection, concrete walls that store daytime heat and release it through cold nights, and a specialized PUF roof that prevents traditional problems like mold growth while providing superior insulation.

This design approach has further helped to transform Ladakh's harsh climate from a farming obstacle into a sustainable energy advantage.

How Much Can Be Grown—and Earned?

The DIHAR greenhouse allows farmers to grow and earn across three distinct seasons—winter, spring, and summer. With the greenhouse's insulation and structural strength, multiple crops and seedling varieties can be grown year-round, ensuring a steady income in a region where farming was once seasonal and uncertain.

Potential yields and income in each season using the greenhouse (90 ft x 27 ft size):

Winter (Mid-October to Early March)

Crop	Yield(kg)	Market Price(₹/kg)	Income(₹)
Cauliflower	546	₹100	₹54,600
Cabbage	664	₹100	₹66,400
Khol-khol	386	₹100	₹38,600

During the harshest months, the greenhouse enables the production of vegetables that contribute to both nutrition and income.

Spring (Late March to Early May)

Crop	Yield	Price	Income(₹)
Watermelon seedlings	33,600 seedlings	₹5/seedling	₹1,68,000
Vegetable seedlings	~2,00,000 seedlings	₹0.50/seedling	₹99,000

In spring, the greenhouse is ideal for nursery raising, which is a high-income activity. Selling seedlings to local farms or markets becomes a profitable venture, maximizing use of the greenhouse space.

Summer (Mid-May to Early October)

Crop	Yield(kg)	Market Price(₹/kg)	Income(₹)
Tomato	1254	₹30	₹37,620
Capsicum	335	₹60	₹20,100
Okra	110	₹60	₹6,600
Brinjal	325	₹50	₹16,250

Even in summer, the controlled environment of the greenhouse supports good yields of vegetables with strong market demand.

Total Seasonal Value: Depending on the crop mix and planting strategy, a single DIHAR greenhouse can generate income of approximately Rs 2 lakhs annually, while ensuring consistent food access for farming families. Fresh, local vegetables are reducing their reliance on expensive, imported produce.

Role of Covestro: Driving Change Through Material Innovation

This innovation reflects the approach of Covestro towards green chemistry to developing and promoting materials that are efficient, safe, long-lasting, and sustainable. Through its Inclusive Business initiative, Covestro focuses on bringing such solutions to underserved communities, ensuring they benefit from high-performance materials that improve their livelihoods while minimizing environmental impact.

The polycarbonate sheets used in these greenhouses support resource efficiency, enable low-emission food production, and reduce the need for frequent replacements—making them a sustainable choice for high-altitude farming.

Covestro's Inclusive Business (IB) initiative has played a key role in promoting the use of polycarbonate greenhouses in Ladakh—not by manufacturing the sheets or building the structures, but by advocating the right material technology for the right environment. Through collaboration with material suppliers, fabricators, local governments, and technical partners, the initiative has helped raise awareness, ensure quality standards, and support the successful rollout of these structures in remote regions.

This fits into the wider mission of Covestro to improve lives through smart material solutions. Through the Inclusive Business initiative, the company aims to positively impact 10 million underserved people by 2025.

With support from government schemes, more than 2,200 greenhouses have been successfully installed since 2020 showing that when purposeful innovation meets local need, meaningful change is possible at scale.

Conclusion: Purposeful Materials, Sustainable Change

Ladakh is just the beginning. The same model can work in other high-altitude and extreme-weather regions, or even hot-arid zones with suitable adaptation.

This simple innovation is doing more than growing vegetables. It's generating better incomes for farmers, improving health of families, and reducing the climate burden of importing food across snowy mountains.

This is a powerful example of what happens when purpose-driven innovation meets local need. As we look ahead, material science, when used thoughtfully, will continue to be a key enabler in making the world more resilient, inclusive, and self-reliant.

Courtesy: Covestro (India) Private Limited.