

FINDING SUSTAINABLE PACKAGING ALTERNATIVES – THE EXPERIENCE OF ICRC, UNHCR & WFP



BACKGROUND

Polypropylene (PP) woven bags are popular in humanitarian work for their versatility, durability, strength, and low cost. In 2018, the International Committee of the Red Cross (ICRC) shipped 150 metric tons of these bags globally, while the World Food Programme (WFP) used 64 million bags (6,500 metric tons) for food distribution. The United Nations High Commissioner for Refugees (UNHCR) also used nearly 150 metric tons of PP bags for non-food items. Most of these bags are produced in India and Pakistan, primarily for the procurement of grains and pulses, with a significant amount also being procured in the United States.



The production of PP woven bags relies on petroleum-based materials. Since these plastic bags are non-biodegradable, they eventually break down into harmful microplastics. In most humanitarian contexts, adequate landfill or recycling infrastructure for such materials is limited or absent. While beneficiaries often reuse the bags, there are no collection systems, leading to their eventual disposal by burning or open dumping, which harms both the environment and human health.

In 2021, the ICRC, UNHCR, and WFP started a project to find alternative packaging for woven PP bags used for food and non-food items. While no ideal solution has emerged, this case study highlights the complexity of assessing the climate and environmental impacts of packaging materials, indicating that a universal solution for humanitarian contexts is unlikely.



PROCESS & RESULTS

The project, supported by the Norwegian Agency for Development Cooperation (NORAD), aimed to design and develop a sustainable alternative to PP woven bags. This included new options (using more environmentally sustainable materials or technology to produce the bags) as well as incremental improvements or modifications to existing bags and production methods to make them more environmentally sustainable. The project consisted of four phases, detailed below.



1 PREPARATION: Performance criteria for alternatives were developed using a lifecycle approach to assess material impacts. ICRC, UNHCR, and WFP set technical specifications, including optional criteria (e.g. no fumigation needed) and mandatory criteria (e.g. food and non-food grades, durability under weight and force, and a minimum 24-month lifespan). Additionally, the cost of alternatives should not exceed 110% of PP woven bags, or \$6-7 per ton of food (\$0.38 per 50 kg bag).

2 MULTICRITERIA ANALYSIS (MCA): Various materials were analyzed, including bamboo, bioplastics, lyocell, jute, organic cotton, paper-based solutions¹, and both virgin and recycled PP, but many were deemed unfeasible. The top performers were jute and recycled PP, while bioplastics were the least effective. Three materials were shortlisted—jute, recycled PP (non-food application only), and virgin PP—and evaluated using MCA criteria: economy (price), social acceptance (reusability), environment (plastic leakage, carbon and water impact, recyclability), and technology (industrial scalability and time to market).

3 RESEARCH & DEVELOPMENT: Based on the above, four alternatives to PP woven bags were researched and developed:

- *Option 1:* Virgin PP bags with an additional layer for protection
- *Option 2:* PP bags with an addition of a layer for protection and containing a % of recycled plastic
- *Option 3:* Jute-based bags with a coating
- *Option 4:* Jute-based bags treated with layer-by-layer technology.

To develop jute-based solutions, the project partnered with two research companies working on plastics as well as a university in Bangladesh specializing in jute bags.

4 FIELD TESTING: The four options were then compared to conventional PP woven bags and tested in field trials in real-life humanitarian conditions in global and regional supply chain scenarios in the Central African region, the Middle East, and India. A life cycle assessment (LCA) was also conducted based on inputs from the field trials. The results of phase 4, and suggested next steps, can be found in the following sections.

¹ Paper based, paper based with liner, recycled paper based, recycled paper based with liner.

OVERVIEW OF PROPOSED SOLUTIONS, ADVANTAGES AND DISADVANTAGES

Proposed Solution	Description	Advantage	Disadvantages	Recommended Action
Extending the lifespan of current PP bags by adding an extra layer (using a bi-layering technique).	The inner layer provides mechanical strength while the outer layer protects the contents of the bag from moisture leakages. Carbon impact slightly decreased by design (weight is less).	<ul style="list-style-type: none"> Increased lifespan allows for a longer period of reuse than conventional PP bags. Designed to be lighter than conventional PP bags. Lower weight means a lower carbon impact. Readily available technology to develop this bag. 	<ul style="list-style-type: none"> More expensive than the original PP woven bags. The bags would not be recyclable and the data on their ability to prevent plastic leakage was not conclusive. To produce the coating, specific pellets are required using a compounder. These pellets might not be widely available in humanitarian settings. 	ICRC, UNHCR, and WFP decided that the climate and environmental benefits of this solution were not sufficient (and the drawbacks too significant) to explore this option further.
Extending the lifespan of current PP and increasing its recycled content.	Similar methodology to option 1 above but a % of recycled PP is used.	<ul style="list-style-type: none"> Increased lifespan allows for a longer period of reuse than conventional PP bags. Designed to be lighter than conventional PP bags. Lower weight means a lower carbon impact. Use of recycled materials. 	<ul style="list-style-type: none"> Difficult for packaging of food items because recycled PP for food applications is only available at lab scale to date. As demand for recycled food grade PP exceeds supply, this option would be expensive. Specific pellets and a compounder required (see <i>above</i>). 	This option will not be further pursued for field testing.
Jute-based bags with a biopolymer coating	The coating aims to increase the jute's resistance to humidity and pest infestation (as it is less resistant than PP in this respect).	<ul style="list-style-type: none"> Increased lifespan compared to conventional PP bags. Use of natural material. 	<ul style="list-style-type: none"> More expensive than the original PP woven bags. The total weight (jute material plus coating) is 10 times that of a PP bag. This increases its impact in terms of carbon emissions. The level of transfer of chemicals from the coating (made of up to 7% plastic) makes this unsuitable for packaging of food. An additional operation needs to be implemented to coat the jute fabric with the coating solution (bath and drying). 	This option will not be further pursued for field testing.

Proposed Solution	Description	Advantage	Disadvantages	Recommended Action
			<ul style="list-style-type: none"> • These bags tend to biodegrade at a rapid rate, making them unsuitable for field conditions (e.g. storage in humid environments). • The availability of jute could be a problem. It is mostly produced in Bangladesh and India, but the jute industry is facing challenges and production is slowing down. 	
Jute-based bags treated with layer-by-layer technology	Provides jute bags with improved strength and protection from water, bacteria, and mold.	<ul style="list-style-type: none"> • Increased lifespan compared to conventional PP bags. • Use of natural material. 	<ul style="list-style-type: none"> • Significantly higher cost compared to conventional PP bags. • The total weight is 6 times higher than PP bags, increasing its impact in terms of emissions. • The availability of jute (see above). 	This is the most viable alternative to the conventional PP bag at this stage. Further field testing is required.

FIELD TESTING JUTE SOLUTIONS

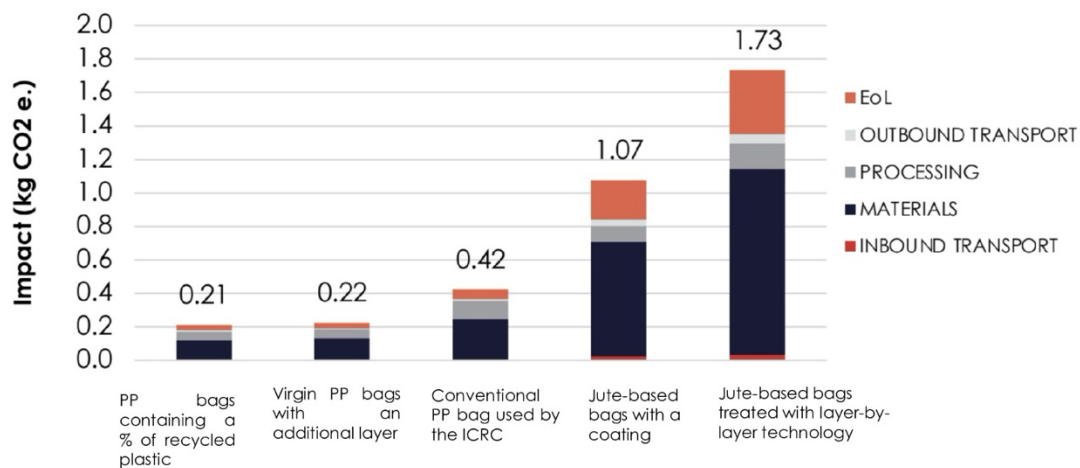
“The weaving tends to loosen when using jute for packaging materials. For instance, when we packed blankets in jute bags, fibers from the jute were found on all the blankets. To fix this issue, a polythene sheet would need to be placed between the blankets and the jute bag. However, inserting the sheet would be time-consuming and require using plastic. Additionally, when we applied stickers to label the bales of blankets packed in jute bags, the adhesive didn’t stick, and the stickers fell off.” – UNCHR field staff



LESSONS LEARNED

- Assessing the environmental sustainability of packaging requires more than just analyzing its components and manufacturing.** Key factors include how often a packaging item can be reused, which is crucial for its environmental impact. Social acceptability is also vital, as beneficiaries will not reuse a bag they find unacceptable.
- Material and technology availability is crucial for scaling solutions industrially.** The project showed that while mixing recycled PP with virgin PP boosts sustainability, recycled PP for food applications is only available at lab-scale to date. Further, adding coatings or layers to PP bags requires specific pellets and machinery that may not be widely available in humanitarian settings.
- Identifying sustainable packaging solutions involves trade-offs.** The project showed that while jute is biodegradable and more environmentally friendly than synthetic PP bags, it is six times heavier, increasing carbon emissions (see *graph below*), transportation costs, and handling challenges. Jute's high absorbency can also lead to mold and mildew in humid conditions unless treated or coated.

CARBON FOOTPRINT OF OPTIONS 1-4 AND CONVENTIONAL PP BAGS USED BY ICRC (ACCORDING TO AN LCA BASED COMPARISON)



- Implementing new packaging solutions can be challenging for supplier selection.** Humanitarian organizations prioritize product quality over packaging, so suppliers are chosen mainly for their product quality. Most suppliers source their packaging materials from other suppliers. New technologies for sustainable packaging, like specific pellets and compounding, may not be widely available.
- Developing and implementing sustainable packaging materials often involves additional costs that many humanitarian organizations cannot afford.** To overcome this, collaboration is essential for sharing research expenses and results, as demonstrated by this project with three major humanitarian actors, to enable informed decision-making.



CONCLUSION

This project highlights that there is no silver bullet solution. Each alternative material investigated had its own strengths and weaknesses, with none outperforming PP woven bags across all categories, meaning the ideal vision described earlier remains unattained. Based on the findings, ICRC, UNHCR, and WFP have begun discussions with a supplier to explore the feasibility of another alternative, aiming to develop a more durable PP bag. This solution will be tested, with results expected by early 2025.

Despite this, the project has generated valuable insights and initiated a process of change within ICRC, UNHCR, and WFP. These leading humanitarian organizations remain committed to improving the relief items they provide to beneficiaries through additional research.



For further information on this ICRC-UNHCR-WFP project, visit the following links:

- [Project Narrative Report \(January 2024\)](#)
- [LCA-based Comparison of Materials Report](#)
- [Detailed report on development of different prototypes](#)