Acknowledgements

The authors would like to thank Villgro Innovations Foundation for this opportunity to study social enterprises across diverse sectors such as agriculture, energy, healthcare, livelihoods and technology. We would also like to thank Sam White, Co-founder and Head of business development, and Rajat Gupta, COO, at Promethean Power Systems for being so generous with their time and inputs.

Authors:
Nisha Kumar Kulkarni
Usha Ganesh

About Villgro

Villgro Innovations Foundation works to identify, finance and support early-stage social enterprises that promote innovative products and technologies in the health, energy and agriculture sectors, and have clearly defined potential to positively impact rural and peri-urban India. Villgro has been in operation for over 10 years and has financed and supported over 50 social enterprises. Social enterprises supported by Villgro have collectively gone on to raise over INR 200 million in follow-on funding and have impacted the lives of an estimated 400,000 rural Indians.

Villgro differentiates itself with its high-touch mentoring and support services. Villgro’s advisory services go beyond traditional consulting roles to encompass domain-specific mentoring, strategic and operational planning and access to key industry stakeholders in an enterprise’s sector of operation.

For more information, please visit http://www.villgro.org/.

About Intellecap

Intellecap is a pioneer in providing innovative business solutions that help build and scale profitable and sustainable enterprises dedicated to social and environmental change. We are uniquely positioned at the intersection of social and commercial business to attract and nurture intellectual capital that combines the business training of the commercial world with the passion and commitment of the social world. Our clients include a broad range of enterprises, investors, development finance institutions, foundations, and private sector corporations. We work in over 20 countries around the world, with a special focus on South and South East Asia, and Sub-Saharan Africa.

Knowledge and Information Services leads Intellecap’s research, knowledge management and thought leadership related to social enterprise, with specific emphasis on the sectors we work in and themes we focus on. The practice area undertakes studies on social enterprise, yielding academic and non-academic papers and articles, policy briefs, reports, and online material.

For more information, please visit http://www.intellecap.com/.
In March 2012, five years after launching their social enterprise Promethean Power Systems (PPS), co-founders Sorin Grama and Sam White, and COO Rajat Gupta sat in their office in Pune, India, gearing up for the busy months ahead. It was the calm before the rush: the enterprise’s first orders were due to be shipped soon, and they were ready for their innovation to start modernizing the cold storage supply chains of India’s dairy industry.

Grama and White invented a “rapid milk chiller” (RMC), a device that improves the efficiency of milk supply chains across India by providing milk refrigeration at the point of extraction. PPS recently ran their first field trial at a dairy in an Indian village. It proved to be challenging. Although the RMC was easy to set up in the PPS lab, it was a markedly different experience to do so on-site. Unexpectedly, it took 11 difficult days to set up the RMC: the PPS team worked side-by-side with their client, a rural dairy, and each person was equally invested in the RMC’s success. Once it was installed, the PPS team assisted the dairy in operating the RMC for four days, and thereafter relinquished control to the dairy.

The critical value proposition of the RMC is that it is an affordable, efficient solution for multiple stakeholders involved in dairy production. It has the potential to increase the incomes of thousands of India’s dairy farmers and to reduce milk costs for consumers. The RMC contains a thermal battery, so the product can function throughout the day in rural India, where electrification is often unreliable. The technology behind the RMC is current and practical, a winning combination for a product that has no close competitors in the Indian market.

Recently, the head of collection at the largest private Indian dairy shared this prediction with White: “The technology PPS has developed will be the standard in two years.” Although Grama and White felt deep pride in seeing their innovation finally installed at a dairy, many questions remain in their minds. Would the RMC operate as optimally as they believed it could? Would dairy processors find it easy to use and see it as a strong investment? How could PPS build order volume? What improvements need to be made to the system? Over five years, PPS’s innovation journey taught the team about market dynamics in India and different refrigeration technologies that ultimately lead to creation of the RMC and thermal battery. Now, the PPS team would have to evaluate the performance of the RMC and its thermal battery to ensure that they delivered all that the team promised they would.

India’s Dairy Industry

India is the world’s largest producer of milk and claims 20% of the world’s total milk production.1 The national government has long considered dairy farming a poverty-alleviating activity because it provides rural employment and improves livelihoods. Near 820 million

---

people live and work in rural India, and almost 10% of rural families – 80 million – work in dairy production.²

According to milk production data by the National Dairy Development Board, over the 2000-2011 period, milk production in India has increased by approximately 51% from 80.6 million tons to 121.8 million tons.³ Today, India’s dairy industry is valued at INR 71,372 crore (US$ 14 billion). The Associated Chambers of Commerce and Industry of India (ASSOCHAM) estimates that the Indian dairy industry is growing at 10% per annum, and will be valued at INR 5 lakh crore (US$ 98 billion) by 2015 with production set to cross 190 million tons.⁴

India is also the world’s largest consumer of dairy products, with nearly 100% of its milk production consumed domestically.⁵ Sixty percent of milk is consumed in liquid form, while 40% is consumed as ghee (clarified butter), paneer (white cheese), traditional sweets, curd or yogurt, cheese, ice cream and dairy whiteners.⁶ Milk and milk products are a rich nutrition source for the predominantly vegetarian country.

Despite the dairy industry’s economic and social importance, India’s demand for milk far outweighs its supply, resulting in a high price of milk. Recent food inflation has affected the dairy industry: in the week ending November 5, 2011, for example, overall food inflation was at 10.63%, whereas milk prices were growing at a faster rate of 10.74% for the same period.⁷ An ASSOCHAM study entitled “Indian Dairy Industry: The Way Ahead” notes that one key reason for this upward trend in milk prices is the lack of proper infrastructure, like cold storage, to minimize spoilage and wastage of milk.

Rural Refrigeration

After extraction, refrigeration is the most vital step of milk processing. When milk is extracted from cattle, it is warm and needs to be chilled as soon as possible to prevent bacteria growth. To preserve raw milk quality, given India’s hot – and, in many places, humid - climate, cold storage is a necessity. Today, large dairy aggregators or processors, like Amul and Mother Dairy, source raw milk from their centralized village collectors who get milk from numerous dairy farms that are small and spread out.

Farmers from several villages in relative proximity to each other bring their raw milk to a village collector. A dairy processor (e.g., Amul) picks up the raw milk from the collector twice a day in a

---

⁴ PTI, “Indian dairy industry to touch Rs 5 lakh crore by 2015: ASSOCHAM.”
⁶ PTI, “Indian dairy industry to touch Rs 5 lakh crore by 2015: ASSOCHAM.”
⁷ Ibid.
chilled truck, transporting it to its designated milk-processing center, specifically “chilling center,” where milk is refrigerated until processing. For optimal quality, the milk should ideally be stored at 4°C within four hours of extraction. Dairy processors are involved in two main activities: (1) heat treatment to make milk safe for human consumption and to extend shelf life, and (2) dehydration of products, like butter and yogurt, for storage. It is then delivered to consumers and retail outlets.

Figure 1 below summarizes the milk collection process and the chilling supply chain. As can be seen, a considerable proportion of the entire process involves just the transport of milk (i.e., from the dairy farm to the village collector, from the village collector to the chilling center). This means that milk goes unrefrigerated longer and thereby decreases in quality due to the ever-growing bacteria count. An estimated 30% of milk collected goes bad due to an inefficient and expensive storage and delivery process.8

Figure 1: Milk Collection & Chilling Supply Chain

Overall, India’s perishable food wastage - including milk - is valued at INR 50,980 crore (US$ 10 billion) per year due to unreliable cold storage supply networks.9 Since rural electrification in India is unreliable, chilling the milk at source is often not an option because a diesel generator is required, which makes it economically unviable. However, it is hard to say exactly what the actual financial costs associated with milk spoilage are due to the loosely organized, diverse and spread out nature of the industry. Commercial refrigeration options do exist in the current supply chain, but may prove to be very expensive for farmers and dairy processors with relatively low milk volumes.

According to research by the Netherlands-based Rabobank, a global financial services firm, there are 250,000 milk-producing villages that sell to dairy processors in India. Based on his knowledge and experience, Promethean Power Systems Co-Founder Sam White estimates that around 50% of “organized” milk collection is properly chilled. There are, however, myriad milk-producing villages that have never sold their product to a dairy processor, and approximately 85% of the Indian dairy industry is controlled by this “unorganized” sector.10 If one takes this into account, the number of milk-producing villages in India may be closer to 500,000, and the total percentage of Indian villages that properly chill their milk significantly less.

10 PTI, “Indian dairy industry to touch Rs 5 lakh crore by 2015: ASSOCHAM.”
The Competitive Landscape

Commercial refrigeration for India’s dairy industry is a niche market and, as such, the major suppliers have not been extensively mapped. Although major players are difficult to identify, numerous small manufacturers based in India provide cold storage options for milk and milk products. In a National Bank for Agriculture and Rural Development (NABARD) Bankable Project scheme focused on bulk milk cooling units (BMCUs) \(^{11}\), it is noted that companies like DeLaval, Fabtech and IDMC, among other manufacturers, supply such equipment. The extent of each company’s market share in India is unknown.

The costs involved in current industrial cold storage systems are high and those high costs have defined a very specific consumer market. Most commercial milk refrigeration systems require a dedicated diesel generator, which can double the capital cost and triple the operating cost of such a system. Industrial cold storage solutions offered by suppliers to the dairy industry therefore cater to high-volume dairy processors. It only makes sense to install such systems in large milk-producing villages where volume is 2,000L or more per day. It so happens that processors with volumes in the range of 5,000L-10,000L per day are the primary ones who can afford and will purchase available BMCUs. However, since most Indian dairy farms are small, producing around 300L-500L of milk per day, they find available BMCU options prohibitively expensive.

There are more affordable cold storage options manufactured by companies like Arneg, Blue Star and Khambete Kothari Cans & Allied Products, for example, which are used by dairy processors. But since these products are not specifically built to facilitate milk processing and are more appropriate for retail level storage, they are imperfect substitutes for the BMCUs manufactured by the aforementioned commercial suppliers.

---


---

Key BMCU Manufacturers

Swedish company DeLaval, a subsidiary of the Tetra Laval Group, is a global leader in innovating solutions and services to support dairy farming. It operates in more than 100 markets and serves customers with livestock holdings ranging from one to 50,000 animals. For 125 years, DeLaval has been “driving progress in milk production.” It offers a variety of products and services catering to the entire dairy production supply chain. It has 22 products for milk cooling and storage.

Noida-based Fabtech Industries is a manufacturer and supplier of products for milk processing and storage in the international arena. It manufactures 22 different dairy milk storage tanks. Fabtech also provides a service for the design and installation of dairy plants.

In Gujarat, IDMC Limited is one of India’s largest project engineering and equipment manufacturing companies across many industries, including dairy. IDMC has five modern manufacturing units that supply a complete range of equipment for the dairy industry. It has an array of BMCUs that can be made as per customer specifications.
There are limited commercial refrigeration options at the village level and, as outlined above, the available technology either requires expensive diesel-powered backup generators or is not specifically built to facilitate milk processing (i.e., insufficient volume size, no in-built power supply, unable to maintain the correct cold temperature or keep all bacteria out). This renders dairy farms vulnerable to high costs associated with transportation and spoilage. An opportunity exists to bring at-source refrigeration to dairy producing villages that would ensure better quality product and minimize milk collection trips.

The Story of Promethean Power Systems

With as much as 30% of milk collected going to waste due to an inefficient and expensive storage and delivery process, Grama and White saw a distinct opportunity to address the issue of rural India’s limited cold storage options and the resulting wastage.

Sorin Grama and Sam White launched Promethean Power Systems \(^{12}\) (PPS) in 2007 as a for-profit enterprise to work with large dairy processors sourcing milk from small dairies. Limited rural infrastructure meant that the transportation process could not be improved upon significantly. There needed to be more focus on creating a better quality process to preserve milk. Refrigeration plays a pivotal role in improving the process – by preventing milk spoilage, the supply chain would become more efficient, consumers would see lower prices, and as an added bonus, farmers would potentially see greater returns.

---


Other Cold Storage Manufacturers

Italian company, **Arneg**, is a global leader in commercial refrigeration for the retail sector. It designs, manufactures and installs refrigerated cabinets, refrigeration systems, cold rooms and fixtures. Arneg does not sell refrigeration systems specifically for milk and milk products. Its head office in India is in Mumbai, with approved dealers and distributors in the northern and southern regions of the country.

**Blue Star** is India’s largest central air conditioning company. It manufactures air conditioning units for residential, corporate and commercial consumers, and it has also become a leader in commercial refrigeration equipment. Blue Star has a large portfolio of product offerings, and within its commercial refrigeration line carries milk coolers. The company website states, “Whether you own a grocery store, a kirana store or a dairy depot, your single most important concern is to provide your customers with milk product at the right temperatures.”

Maharashtra-based **Khambete Kothari Cans & Allied Products** (KK Cans) manufactures storage products and accessories for the dairy industry. KK Cans’ product line includes cans (aluminum alloy milk cans, aluminum alloy lockable milk cans and stainless steel milk cans), bulk milk coolers (vertical open tank, cylindrical close tank and horizontal open tank) and accessories (samplers, milk measures, funnels with filter and collection trays).
Figure 2: Benefits of Affordable Refrigeration

**Farmer**
- Less milk spoilage means more quality product to sell in the market
- Possible to refrigerate milk at source and sell directly to the market rather than relying on large dairy processors

**Processor**
- Less milk spoilage means more quality product to sell in the market
- Transportation costs decrease because milk will not need to be collected twice per day
- Energy costs decrease if diesel generators are not needed

**Consumer**
- Less milk spoilage means increased supply of quality product and, as a result, market price decreases

*Promethean Power Systems’ Founding Team*

Sorin Grama is the CEO of PPS, and he also leads its engineering team. Originally from Romania, he emigrated to the U.S. as a child and completed his formal education there. He has a B.S. in Electrical Engineering from Ohio State University and a M.S. in Engineering & Management from MIT. He has previously worked as a sales manager and as the part owner of a systems integration business.

While completing his graduate degree at MIT, Grama met Sam White, who is head of business development at PPS. White has several years of business development knowledge from working in the U.S. and abroad. He also has experience with deploying new business models and technologies with two previous start-ups, GetConnected and Smartleaf. He has a B.A. from Union College and is a graduate of the Global Social Benefit Incubator program at Santa Clara University.

In 2009, Grama and White met Rajat Gupta, then a Harvard MBA candidate working on a project at PPS. He officially joined PPS in 2010 and became COO in 2011. Gupta has international experience as an engineer and as a manager. He leads operations in India, which involves new business development, supply chain management and interaction with Indian investors. Before earning his MBA at Harvard Business School, he completed his B.E. in Mechanical Engineering from the Indian Institute of Technology in Delhi.


**The Innovation Journey**

In 2007, Grama and White entered the MIT 100K Entrepreneurship Competition\(^\text{13}\), where the grand prize is US$ 100,000 (INR 50 lakh) to launch an enterprise that provided rural commercial refrigeration solutions. As the runner-up, their US$ 10,000 (INR 5 lakh) winning validated their business idea and encouraged them to quit their jobs at the time to start the venture known as PPS today. With their prize money, Grama and White traveled to Bangalore, India.

In Bangalore, Grama and White saw a huge void in cold storage supply chain networks that affected the entire agricultural industry, but particularly the lack of chilling technology that made it difficult for milk to go from villages to market. They considered developing a commercial refrigerator for general usage, but those already existed. And besides, the issue with general refrigeration is that it is unable to capture the subtleties of, for instance, chilling vegetables versus milk versus vaccinations. White comments that for PPS to survive and be effective as a small start-up, it had to have “laser focus on one problem.” Grama and White never forgot those first meetings they took in Bangalore during which they learned about the cold storage problem in the dairy industry. The knowledge they gained in such informational meetings, as well as from their own research and growing networks in India, helped them decide that dairy is the first industry that they would focus on.

The founding duo believed they could develop a strong market-based solution to this problem and executed extensive research to understand the market opportunity and to confirm the interest of numerous cooperative and private dairies in India.

However, they did not land upon the idea of the rapid milk chiller (RMC) right away. The PPS mission is to bring *affordable* commercial refrigeration to India’s dairy industry. To meet this end, PPS has tested various technologies and gone through several iterations before settling on the RMC technology they use today. Although these early attempts were not as successful as the PPS team would have hoped, the team made strides with each successive iteration in improving the dual interests of storing energy and chilling milk, all culminating to PPS’s RMC innovation.

The first PPS refrigerator involved a reciprocating steam-powered heat engine made of old car parts. It ran on solar energy. White notes that while a few of these units were set up in Lesotho, Africa, as part of a World Bank-supported project, the PPS team realized that the technology was not efficient, and the end-product was too large and bulky to be transported to villages.

PPS next tested thermo-electric technology, but came to the same conclusion as their first refrigerator: inefficient technology and bulky hardware did not make this second iteration a viable option. At this point, the PPS team realized that they needed a more compact, efficient technology that was as easy to deliver as it would be to use.

---

\(^{13}\) MIT 100K Entrepreneurship Competition: [http://mit100k.org/](http://mit100k.org/)
Thereafter, they moved onto solar technology. In March 2010, PPS changed their approach from refrigeration to ice delivery using established milk delivery networks. In a trial run in Goa, the milkman delivered ice, and solar technology was used to power a rapid milk heat exchanger that would use the ice water to chill the milk. The trial in Goa demonstrated that this methodology was inexpensive, but was very cumbersome. The feedback PPS received was that customers wanted more automated, higher-end equipment. It was from this foray into ice delivery that PPS realized they needed a solar refrigerator.

Over the next six to seven months back in Boston, the PPS team built a solar refrigerator, and subsequently added a software element, operating partly on grid power and partly on solar power, to cool milk. Although this refrigerator was an improvement on earlier test innovations, it was flawed. The milking cycle is not totally in-sync with the solar cycle, which caused complications. Overall, however, the solar refrigerator proved to be bulky, expensive and inefficient.

The PPS team had tested several technologies and still had not found the right product mix. “[We] played a systems approach more than a technology approach,” Gupta remarks. Going forward, they feel there is clearly a lot of scope to revisit solar technology for smaller applications. The PPS team has ideas that may have potential, but a lot is dependent on the state of technology and how it evolves. In fact, several current dairy customers plan to add solar to their existing PPS chillers now that they have resolved the issue of energy storage.

At this juncture, then, the PPS team had to decide which prototype made more sense and met the needs of the dairy market. Was it the original rural refrigerator idea or something altogether different like ice delivery using solar technology? The original PPS idea was to refrigerate milk in minimally electrified or off-grid areas. The PPS team realized that solar technology was a seemingly smart option, but not yet viable because it was too expensive. Also, solar technology might not be necessary because there is not much milk activity in completely off-grid areas; a majority of milk production happens in minimally electrified areas. They concluded that working on alternative cold storage methods that did not rely on solar technology would be more economical. Out of their lessons from experimenting with solar options, they settled on a model with a different energy source: the thermal battery.

In 2011, Grama and White finalized their prototype for their invention, the rapid milk chiller, a refrigeration system that runs on a thermal battery. Like a traditional refrigerator, it provides cool storage, but specifically for milk. The thermal battery runs on stored electricity, so does not need to be continuously connected to a power source, a feature that is quite useful during the frequent power cuts experienced by rural India.
At the time of launching PPS, public cognizance of the size and importance of the dairy industry was growing, but this is not why Grama and White decided to work on commercial refrigeration for milk. “The technology revolved around the application before it took its final shape,” Gupta explains. “[We] started with [the] problem then tailored technology for it. Now, it is very well-suited to dairy.”

The Rapid Milk Chiller and the Thermal Battery

There is a four-hour window between the time of extraction and when raw milk needs to be refrigerated before it risks spoilage. PPS believes that its RMC and the PPS patent-pending thermal energy battery addresses the problem captured below:

![Diagram showing the problem of unreliable electricity in villages leading to low milk quality and high transport cost.](image)

After three years of R&D, PPS developed the RMC, which cools milk from 35°C to 4°C in seconds – as opposed to the average three hours taken by conventional BMCUs. The RMC runs on an innovative thermal storage battery, a combination of phase-change material that stores energy, fluid that transfers energy, mechanical design to increase energy density and electronics that increase the discharge time. A full five-hour charge can cool 500L, which is the most volume of milk that a typical small dairy farm produces in a single day. The battery also functions such that energy availability is separated from energy use so that milk can be chilled even when the power is out. PPS claims that each single battery has a seven-year life cycle.
Start Up Challenges

Like all start-up enterprises, funding was a huge challenge for PPS. White reflects that PPS never had enough resources to “make great strides quickly.” Over its five-year history, PPS has risen due to “lots of small steps” and though any financial setbacks then felt more “severe,” White believes that those fiscal challenges forced the PPS team to make smart decisions.

Their winnings from the MIT 100K Entrepreneurship Competition gave Grama and White the confidence and the money to push ahead with their business idea. Their next big break came in the form of a US$ 500,000 (INR 250 lakh) investment from a clean technology venture capitalist in California. Their funding search was far from over though: the PPS team spent 50% of its time raising funds. At first, they focused on acquiring funds from clean technology investment sources, but later cast a wider net to include socially-minded investors in their funding mix. White notes that 50% of investment came from the latter investment group.

The PPS founding team also faced challenges in sourcing human capital, and struggled to find the right people to work with. Pune, in Maharashtra, became the headquarters for PPS because of its position as an important industrial city, particularly in the area of mechanical engineering. Pune also happens to be the headquarters of several BMCU manufacturers. Being located in Pune meant that PPS could source all its materials locally, as well as gain access to necessary engineering expertise to innovate.

Before 2011, PPS did not have operations based in India. In 2010, there was limited manufacturing happening in Pune, but all product development and engineering was happening in the U.S. Grama and White worked from their base in Boston, Massachusetts, where their networks and resources were already set up. Gupta believes that the RMC would have been difficult to create in India. “Engineering talent in India is very different,” he states. “Design innovation, for example, is very different. The U.S. is innovation-oriented and India is more process-oriented.” Design innovation requires diversity of thought, which is not inherent in engineering training in India. Gupta reflects further that for PPS, it was essential that all members of the team were capable of thinking at the same level, and to be vocal and collaborative. He adds, “It is difficult to find that kind of talent at the start-up phase especially.”
By the time Grama and White shifted product development and engineering functions to India in 2011, Gupta was already on-board and leading operations. Being non-Indians operating in the Indian business environment was less of a challenge than expected for Grama and White. Overall, White realizes that he and Grama were lucky to have a “great support structure” in place in Pune. In the beginning, Grama and White did struggle with issues like which part to source from which vendor, but when Gupta joined the team in 2010, it was easier for him to set up the supply chain. It helped to have someone like Gupta who had a background in India and who was comfortable with operations.

The Business Model
Dairy processors are currently forced to collect milk twice a day from farms – an endeavor that carries high transportation costs, as well as elevated risk of milk spoilage. The RMC allows dairy processors to chill milk at village collection centers – where raw milk goes before being transported to processors – so that milk is cooled instantly and can be collected every other day. On-site refrigeration also empowers dairy farmers who may lack linkages to large dairy processors and, therefore, the organized market; with the RMC, a farmer could potentially sell milk directly to the market. Using the RMC could increase the per-liter price paid to farmers who directly sell to the market from US$ 0.18 (INR 9) to US$ 0.60 (INR 30).

Manufacturing and Distribution
The RMC and its thermal battery are completely manufactured in Pune, PPS’s headquarters, with materials sourced locally. Today, the RMC and thermal battery costs US$ 7,000 (INR 3.5 lakh) per unit, which is on average 30% lower than most conventional BMCUs, with a payback period of two-to-four years.

The RMC is compact and easy to transport. PPS delivers the RMC systems to dairy processors. The processors, then, decide on which localities they want to install the RMCs, and use their established networks to transfer and set-up the RMCs at the designated dairy farms.

Building the Customer Base
PPS has a strong product it believes in. The next step is to build a customer base and ensure client satisfaction. PPS is targeting large dairy processors, and in April 2012, is delivering
demonstration units to Amul (1,000 units), Mother Dairy (1,000 units), Chitale (500 units) and Hatsun Agro (3,000 units).

The PPS team also believes that joint ventures, licensing and partnerships will help PPS to build a stronger base and achieve scale in the future. They are presently in talks with prospective partners for product and distribution. Since they have an innovative storage product that faces no market competition, there are interested stakeholders. However, having said that, PPS is small, and it is difficult to explore and pursue these options all at once. Gupta notes that any collaboration with a large partner – and most stakeholders would be larger than PPS – requires time and thought.

Current plans are to ship one trial RMC per dairy. In his experience, White understands that all start-ups face that big challenge of getting order volume. High order volume, though, does not solely reflect a strong customer base. However, it does represent the reduction of costs resulting from economies of scale production. Now that the product is ready for the field and PPS is shipping it, White predicts “a lull” in the team while waiting for more orders to come in.

Nevertheless, targeting dairy processors does not mean that PPS is ignoring the individual farmer. Ideally, the PPS team wants to give individual farmers the ability to buy their own RMC and experience higher income due to higher quality milk being produced and sold. Reaching the individual dairy farmer would require reforms in basic infrastructure like roads, but PPS sees that because the farmer has been largely overlooked, there is a distinct opportunity to make impact at the individual level. The success of the RMC with dairy processors would allow PPS to explore how to reach the individual farmer, as well as expand its target customer base to include smaller players in the dairy industry.

**India’s Major Dairy Processors**

Gujarat-based **Amul** is India’s largest food brand and world's largest pouched milk brand with an annual turnover of US$ 2.2 billion, according to fiscal year 2010-2011 data. It is a dairy cooperative managed by the Gujarat Co-operative Milk Marketing Federation Ltd, which today is owned by over three million milk producers. Formed in 1946, it was launched to stop the exploitation of dairy producers by middlemen.

As a subsidiary of the Chitale Group, the **Chitale Dairy** in Maharashtra uses state-of-the-art technology to advance the dairy industry. Since 1939, it has been processing dairy and dairy products. It has varied offerings of buffalo milk and buffalo milk products. Research the dairy has conducted lead it to establish innovative, advanced centers to enhance production, such as a modern buffalo R&D farm.

South India’s **Hatsun Agro** is the largest private dairy company in India. Hatsun launched in 1970 with its Arun ice cream, which continues to be the most popular ice cream brand in South India. In 1993, the company started selling fresh cow’s milk in pouches, and since 2003, has been manufacturing other dairy products. Today, Hatsun is a US$ 250 million company, listed on the Mumbai Stock Exchange.

**Pilot and Sales Strategy**

PPS was launched five years ago, but operations did not jumpstart until early 2011, when it installed its first RMC in Tamil Nadu using solar panels instead of the thermal battery. Now,
armed with its thermal battery, PPS is employing a direct sales model to gain foothold in the market. The first RMC system using a thermal battery was set up at a dairy farm in March 2012. The system’s ease-of-use is yet to be seen because the product has just launched. White acknowledges that no matter how easy the PPS team finds the RMC to use, there is a steep learning curve for dairy farmers who are not used to chilling milk at source. In the case of their first system, the PPS team not only ensured that their system was installed correctly, but also educated their customer on the correct way to operate and monitor the equipment.

As far as after-sales services go, for now PPS leaves that to the dairy processors, their customers. It is targeting this customer segment because they have in-house technicians and can manage to service their own RMC systems. In the future, though, as order volume increases, White notes that post-sales services will be incorporated since the PPS team will have a stronger grasp of where the faults are in the system. It will also become a natural extension of their sales process.

**Social & Environmental Impact**

Given that PPS has only recently begun to sell and ship its RMC and thermal battery, there are no statistics about the enterprise’s social and environmental impact. Still, PPS has projected what it believes the impact of its product will be on the dairy industry. PPS estimates that only 2% of milk spoils when village coolers are installed. In the best-case scenario PPS has outlined, if one RMC unit serves 100 farmers and 8,000 units are installed by 2015, as many as 3.2 million rural people would be directly impacted in the first seven years of operation. By using the RMC, farmers could increase the per-liter price (when selling directly to the market) from US$ 0.18 (INR 9) to US$ 0.60 (INR 30).

Environmental impact may be easier to calculate compared to social impact. On average, 88L of diesel fuel is needed to collect 5,000L of milk via trucks twice a day, and 2.7 kg of carbon dioxide is released for every 1L of fuel burned. If village coolers are installed, 33% of diesel fuel can be saved, and carbon dioxide emissions would decrease by 2.9 tons with just one of PPS’s RMCs. If the best-case scenario of 8,000 units installed is achieved, that translates to a reduction of 21,600 tons of carbon dioxide emissions every year.

**Present Challenges and the Road Ahead**

White sees that PPS faces three key challenges today. One is to fine-tune the technology after evaluating its efficacy in the field. As the first trial systems are sold and set up, PPS and its customers will have to see what, if any, challenges arise. In the controlled setting of a lab, the RMC and its thermal battery functioned well, but it will need to be used at dairy farms to understand what requires improvement and what was not accounted for with the current iteration of the RMC.
PPS must also work on product engineering and innovation to further reduce product cost. And it is already happening: in PPS’s Boston lab, they have made progress in reducing the cost of the thermal battery. In mid-2012, PPS plans to apply those findings in a pilot-run of the updated thermal battery in Pune.

The overarching PPS goal is to get some volume orders to reduce costs. This is an ongoing challenge for any enterprise, and PPS is no exception. Economies of scale would help not only drive down the per-unit cost of manufacturing, but also the per-unit selling price to customers. This leads back to the big first step PPS is taking now: to build a strong and satisfied customer base.

**Mapping the Future**

“Scale is not a trivial process,” White says. PPS will move forward as it has in the past: with careful, smart steps towards affordable, efficient innovation. White and Gupta agree that the next steps must involve proving the merit of the RMC in the market, scaling it, and then move into other markets. Firstly, the RMC and the thermal battery must find success in the dairy industry. If large dairy processors are satisfied with the product, this would be a huge achievement for PPS. Their next priority is geographic expansion: making this technology available throughout India, as well as in other developing countries.

In retrospect, Gupta notes that one thing that may have accelerated PPS’s innovation journey was developing the product closer to market, which they finally did in 2011. By furthering product development in India close to the domestic dairy market, the PPS team was able to make a more cost-effective product, as well as have more regular interaction with the industry. Moving to India was key in helping PPS move forward with new, relevant product iterations.

Product expansion is also in the future. There is a need for many applications for commercial refrigeration. There is significant spoilage and wastage of other agricultural products, like fruits and vegetables. A market study on fruits and vegetables was just completed by a group of students from the Institute of Rural Management in Anand, Gujarat, and PPS is now evaluating their entry strategy. Plans are being drawn to meet this different market, and a different team will be set up in Pune with an office in Mumbai as well. A U.S.-based foundation has issued a grant to PPS to take this next phase of product expansion forward.

The PPS team has spent the last five years learning about India’s dairy industry, but also much more than that. Operating in a new business environment and understanding the costs and benefits of various technologies has been key to the successful conception of the RMC and thermal battery. Grama and White had a vision that started with a problem they saw, and they built a solution around that. Though PPS has been around for several years, it is not until recently that they were able to settle on the right solution to the problem they see as a tremendous business and social impact opportunity.
The learning curve will continue for the PPS team as orders for the RMC and thermal battery pick up pace, and they are able to see how their innovation functions in the field. Along this next leg of their journey, the PPS will have to keep innovating and find answers to the critical questions of how to reduce costs and how they can ensure that their product remains innovative and efficient in the field.