Leveraged Innovation Management: Key Themes from the Journey of Dewrain Harvest Systems

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Abstract

Systems for harvesting dew for human consumption are new to India. This paper provides insights from the tracking of the innovation journey of dewrain harvest systems from incidental observation to commercialization. It traces the key phases in the innovation journey and documents the activities and outcomes in each phase. Based on the analysis it identifies a class of innovations called 'leveraged innovations'. These innovations leverage on the early innovating experience of the innovator, the knowledge base of the stakeholders and the available infrastructure.

Data for the paper was collected from the narrative of the innovator and the documents prepared by the innovator and his team. The paper has been divided into three sections. The phases in the innovation journey are presented in the first section. Key themes in leveraged innovation are identified based on the insights from phases, and their link with the literature on innovations management are discussed in the second section. The third section provides concluding remarks and suggests ways forward for mapping the innovation journeys of individual innovators and developing the themes further.

The overall view is that the development of the dewrain harvest system was facilitated by the background of the innovator, the observation of spin offs, the larger externally linked definition of the problem, linkage with the local community that shared the need for solving similar problems, association with local laboratory and network of scientists, and independent learning to augment the received knowledge facilitated the leveraging process for a successful journey.

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Introduction

In the summer of 2001, while working in an arid coastal region in the north-west of India (Kutch, Gujarat) on a project related to greenhouses, Girja Sharan (Innovator) observed incidentally that appreciable quantity of dew condensed on the roof of the cottage where he was staying. The occurrence of dew in summer appeared unusual to him. In his field work in Kutch, he had also noticed that the villages around the project area were chronically and severely short of drinking water. He recollected that in ancient Indian texts (some can be seen in Nature Social and water – website) dew drops were thought of as good water and wondered whether it was possible to build a device to harvest dew for ameliorating water shortage in these regions. The incidental observation and its linkage with drinking water shortage became the trigger points for the 'innovation journey' (Cheng and Van de Ven, 1996) of a new product, dewrain harvest system.

The innovator is an academician with graduate and doctoral degrees in agricultural engineering. He had been engaged in resolving field based technology issues in rural development. Between 2001 and 2005, the innovator, along with his team at Kutch, engineered dew condensers and built dew harvest systems for use of families and communities of Kutch region. Active commercialization began in 2006. The devices are actually termed 'dewrain' harvest systems because while these are specially engineered to harvest dew, rain is routinely harvested as well. The innovation has caught on. There are requests to build and install dewrain systems from NGOs, industries operating in coastal zone and individual farm owners. Dewrain harvest systems have potential in arid areas near coast - Saurashtra and Kutch coast, parts of Karnataka coast, parts of Orissa coast. A Church in Chennai coast has informed us that substantial amount of due occurred in the vicinity. The priest is interested in harvesting it for ameliorating the shortage of water. In the immediate neighborhood of Kothara, there are 152 villages that do not have local source of drinking water and have to be supplied water by tankers on a regular basis. The supply is paid for by the public authorities. The system is unsatisfactory. Dew water will be a supplement and has the advantage - good quality, available right at the roof top of the individual. East and west coasts of Africa, Australia also are known to have the problem of drinking water and potential for dew harvest. (Clarke 1991).

This paper tracks the innovation journey of the dewrain harvest system from incidental observation to commercialization and identifies a class of innovations called ‘leveraged innovations’. These innovations leverage on the early innovating experience of the innovator, his credibility and network, the knowledge of those who can provide support, and the existing infrastructure. While they make a significant impact their demand for additional resources is limited. As opposed to ‘zero base or break away innovations’ leveraged innovations are speedier and predictable. They ‘exploit’ more and their ‘exploration’ is limited and focused. The key to success are the ‘leveraging processes’ and ‘axes for leveraging’, where the innovator brings to bear his/her orientation to problem solving and credibility, to mobilize resources for the success of the idea and gains acceptance. In the process he/she minimizes the element of chance in the innovation game and maximizes the opportunities for success. The innovator moves quickly from the ‘chaotic’ or even ‘random’ phase to order. Based on its analysis the paper identifies key themes in leveraged innovation management.

Data for the paper is collected from the narrative of the innovator and the documents of the journey prepared by the innovator and his team. The narrative has been in response to a series of structured and unstructured questioning by the other author. This paper has been divided into three sections. In the first section, we present the phases in the innovation journey of Dewrain Harvest Systems. In the second section we present our insights and key themes for leveraged innovation management. The third section provides concluding remarks and suggests ways forward for mapping the innovation journeys of individual innovators and gaining further insights into the themes.

Section I

Innovation Journey

The following are identified as the phases in the journey of dew rain harvest systems from incidental observation to commercialization:

1. Incidental observation and exploration
2. Linking with existing knowledge base
2.1 Linking with Local Knowledge Base
2.2 Linking with Institutional Knowledge Base
3. Independent Learning and Knowledge Augmentation
3.1. Early Empirics
3.2 Linking with International Literature and Practice
3.3. Experimentation
4. Resource Mobilization
4.1 Seed Funding
4.2 Competing for an award
5. Product development and demonstration
5.1 Small Trial condensers
5.2 Pilot Prototype Condensers
5.3 Demonstration and acceptance
6. Commercialization

Each phase involved the innovator in an way different from the preceding phase. The activities, resource implications, support sought from the external environment were different. Successful transition from one phase to the other depended on the way the innovator leveraged on his knowledge base and network and the response of those whose help was sought by the innovator. It also depended on the voluntarism of those who came in contact with the innovation process or the innovator on their own. The innovator avoided getting stuck or discontinuing the journey by articulating the societal problem being solved by the innovation. A chronology of the developments from April 2001 to November 2006 is given in **Table 1.** The following paragraphs delineare the phases further.

I.1 Incidental Observation and Exploration

I.1.1 Setting

Kothara village lay in the middle of a hot arid region in north-west India. It bordered with the Arabian Sea in the west and the Rann of Kutch in the north. The rann is the hottest area in the country. Rainfall is very low and very erratic (coefficient of variation

75%) in Kutch. The coastal belt is particularly short of drinking water (see map in Figure 1). The innovator and his team had been working from Kothara since June 2000 on development of greenhouse specially suited to hot arid areas and also on development of solar cafeterias for schools. The team consisted of five engineers, two office managers and three community workers. Their overall mandate was to develop alternative technologies to help develop arid zones. The innovator was associated with the Indian Institute of Management, Ahmedabad, where he initiated a long term Program of research on the problems of agriculture in hot, arid Areas. The activities of the Program were supported by a grant from Cummins Foundation. (Cummins Corporation is a US based company specializing in wide range of diesel engines and generating-sets of high quality. Cummins (India) Foundation created by the company is based in Pune. It supports innovative efforts to improve energy and drinking water in rural areas.)

I.1.2 Curiosity and Exploration

Though the innovator and his team had been around for several months, the innovator noted the dew condensation for the first time in April 2001. He discussed his observation with Mr. Ratan Jadhav (RJ), the engineer who was then part of the team working in Kothara. RJ also had seen dew in the area. The response was 'let us see if we can do something with it'. This prompted them to explore further. They decided to note the days when dewfall occurred and also talk to people working on the site about dew in their area and note their inputs. Innovator also wrote to professional friends (Dr. Pitam Chandra of Indian Agricultural Research Institute, Delhi) and (Dr. P.C. Pandey, Central Arid Zone Research Institute, Jodhpur, Rajasthan, India) asking about any study of dew in India. Dr. Chandra stated that dewfall in Delhi area was limited to winters, but had never been measured. Dr. Pandey indicated that long time ago there was a scientist there who made a study of dew over sand dunes in deserts of Rajasthan but the scientist had since retired and the work has not been continued by anyone. Dr. Pandey also said that some journal in their library had articles on dew from overseas. Innovator then traveled to Jodhpur and spent three days in their library. Review showed that some individuals in Israel, France and Chile were studying dew phenomena. [for instance Zangvil, 1996]

Certain aspects about this phase are worth noting. The site of observation was not new. The innovator and his team were already there to work on their greenhouse project. The green house project in the desert itself was an innovation. This opened up 'leveraging possibilities'. Since the team was in the 'research mode' it interpreted the dew condensation observation as an 'opportunity for research'. The innovator's professional network of scientists in research institutions enabled him to speed up the exploration. The members of the network were knowledgeable and helpful. They were located in reputed institutes of research with well stocked libraries in the country. This was another 'axis for leveraging'. The innovator had built credibility for pursuing an idea to its concrete form through his earlier innovations of 'Vastrapur Cartons' (Sharan and Rawale 2001), 'Earth Tube Heat Exchanger' (Sharan et al. 2001). This credibility enabled him to elicit quick response from the network members. **Table 2** provides a list of these innovations. The next phase in the journey was to link the exploration with existing knowledge base.

Table 2: Track of the innovator

No.	Year of Innovation	Innovations
1	1998	Demonstrating an effective method of resurrecting trees in orchards of Kutch, felled by powerful cyclone.
2	2000	Earth Tube Heat Exchanger for Greenhouse Cooling
3	2001	Aircondition System based on Earth Tube Heat Exchange for Zoos.
4	2001	Vastrapur Cartons
5	2002	Himachal Cartons
6	2002	Arid Area Greenhouse

I.2 Linking with Existing Knowledge Base

In this phase the innovator linked his exploration with local knowledge and laboratory knowledge to define the innovation possibilities. He also recognized the context that gave impetus to actions for innovation. Linking was made possible by the innovator's background and network, the villager's willingness to share and the research institutions in the vicinity. The monetary resource implications of the activities were within the innovator's means.

I.2.1 Linking with Local Knowledge

The innovator interacted informally with village folks, lay individuals, to know if dew really occurred regularly, including in summer, and whether the quantity was noticeable and the occurrence was frequent. He talked to around fifty individuals. Mr. Madhubhai Mannkad of Krishi Vigyan Kendra, Mundra, and a very knowledgeable person told the innovator that 'Kutch is rich in dew' and that effort needed to be made to make use of it. Residents of the coastal villages confirmed that it was a regular and significant occurrence in the region. The interaction revealed a perception that the dew water was unfit for drinking.

Interaction with the village folk was facilitated by the fact that the Innovator and his team were working on a greenhouse construction project in one of the villages and were residing there. Familiarity with the faces created the 'insider effect' and enabled them to link themselves with the local knowledge base. This would have been difficult for a 'new comer'. Similarly, the innovator was not new to such 'grass root interactions'. He did not have to develop additional skills to engage in a conversation with the villagers. He could leverage on his years of experience as a field based researcher. From linking with local knowledge, the innovator progressed to linking with Laboratory knowledge.

I.2.2 Linking with Neighbourhood Institutional Knowledge

The innovator visited the Cyclone Detection Radar Station, Bhuj, Gujarat, which also was the regional meteorology observatory- and the scientists of Gujarat Agricultural University, the Gujarat Institute of Desert Ecology, to obtain data on dew fall and also the ideas on its possible use. All these places are within 100 km of Kothara. The view held by scientists was that there was dew but it was too insignificant to bother. Mr. KC Shroff of Excel Industries, an agro chemicals company, and an active promoter of a Non Government Organization in the area, felt that dew should be studied. Here again, we need to note that linking individual exploration with Lab knowledge was facilitated by the background and credibility of the innovator. The innovator had been in touch with some of them in his professional capacity. Here the innovator was benefited by the existence of an observatory in the vicinity of the innovation site.

The grass root exploration and interaction with laboratories in the neighbourhood pointed to the following:

- Dew was occurring regularly – to some it was in large quantities and to some others it was in insignificant quantities
- No effort was made to collect the dew systematically and do something useful about it.
- There was a perception that the dew water was not worthy of drinking

I.2.3 Articulating the Context for Innovation:

The innovator could have stopped his exploration by documenting the knowledge gained, written a paper and gone back to the green house construction issues. He did not. The possibility of an additional water source in an arid zone was heartening to the innovator. He had noted that the area suffered from water shortage and if something could be done to harvest dew and convince the villagers about the worthwhileness of dew as a source of drinking water; he would have offered a solution to the water problem of the village. Shortage of drinking water was especially acute in the coastal belt. As stated, around Kothara itself there are over 150 villages categorized as 'no source' villages that is there is no source of fresh water. These are supplied daily by tanker-trucks from long distances. The expenses are paid for from public funds.

Being concerned with the development issues of the arid zone, he was not disheartened by the response of the meteorological department or the mixed reaction of the villagers. He decided to explore further on his own with the help of his team located in Kothara. We may note that it is the possibility of linking with a larger societal issue that prompted the innovator to stay on. This paved the way for independent learning and experimentation. The developmental context recognized by the innovator provided the impetus for moving further. Having articulated the developmental context for the innovation, the innovator moved to actions for the innovation.

I.3 Independent Learning and Knowledge Augmentation

The context for innovation and the activities needed to be carried out to develop options and solutions determined the demand for new knowledge and other resources like funds and technology. The innovator responded by augmenting his knowledge base through experimentation and library search. He ascertained both the quantity of dew and the quality of the dew for drinking. He built further insights from the literature and practices across the globe and set up his own experiments to build a device for condensing dew.

The phase was facilitated by the innovator's training in scientific research and experiment design.

I.3.1 Early Empirics

The innovator was keen to ascertain the quantity of dew that got collected. This posed measurement problems. Devising a suitable method of measuring dewfall presented a difficulty. Since it was not monitored in the country, dew gauges were not readily available and (unlike rain gauges) not widely known. Publications from overseas (Baier (1966), Raman et al. (1973), Zangvil (1996), Malek et al (1999)) showed that several different types of devices had been used by scientists suited to their purpose and often constructed by them. Innovator reasoned that the purpose of measurement in his case was to predict how much water could be had from dew condensation on existing roof of village houses. Accordingly, he decided not to look for dew gauges or devices used by other researchers but to devise a tool on his own. It was decided to use the roof of the existing greenhouse itself as the condensation surface and add gutters and collection system to it. It had also the advantage that extra expenses were not needed and the process could begin right away. Most importantly, the data would permit drawing conclusions about the areas required to get a given quantity of dew water in this area.

Certain aspects of this phase need to be noted. The green house provided a ready infrastructure to leverage on. As a consequence this did not demand additional resources. The innovator would have lost time he were to build the infrastructure de novo. The background of the innovator and his experience in fabrication induced him to progress further and devise a 'rough and ready to use' gauge. In his earlier experiments with 'Earth Tube Heat Exchange' design he had realized the importance of locale specific data and its measurement. The innovator did not have to incur additional monetary expenses as the salaries of the team members were paid for by the Centre. They volunteered in the spirit of 'research and exploration'. Access to such 'free resource' made exploration easier. A 'de novo' proposal making and application for funds would have delayed the empirics phase.

Year-long daily measurements showed that dew occurred over a hundred nights over a season of nine months from September to May. Total collection over the season was close to 10 mm. This was modest compared to the rainfall in the area - 300 mm - but it was more uniformly spread over the months. Samples of dew water were tested and found potable. This encouraged the innovator and his team to proceed further as it linked well with the developmental context defined by the innovator.

I.3.2 Linking with International Literature and Practice

The innovator needed to build large condensers to be able to make water available for steady use. The innovator studied the technical literature on dew condensation for additional ideas on the path for the future. The innovator had access to the internal and technical libraries in the country. He had his own collection of technical books. He even referred to his class notes from hydrology courses taken in graduate school at Cornell University. This was a part of the 'discipline of research' developed by the innovator for his earlier innovations. Literature review (Nikalayev et al. 1996) indicated that the earliest efforts to condense dew for human use were made by the Greeks. Greater such efforts were made in the early part of last century. These were well documented. They were mostly unsuccessful, mainly because the structures erected for the purpose were massive and did not cool down to dew point temperature of the surrounding air during the night. Interest in development of successful dew condensers had emerged again in the recent years.

Using vastly improved understanding of the mechanics and thermodynamics of condensation, scientists were engaged in developing dew harvest devices (Nilsson et al 1994; Nilsson 1996; Beysens et al 2003; Muselli et al 2002; Milimouk et al). Valuable insights on dew formation, conditions conducive to condensation, materials and substrates that gave high yields had emerged from the work of these groups. Some scientists were developing bio-mimics that is, surfaces patterned after organisms living in deserts that have shown great ability to extract moisture from air using the specialized parts of their body (Parker and Lawrence 2001). Innovator contacted on phone Chris Lawrence, the co-author of paper on beetles to ask if their plastic mimic was ready for trial. Lawrence indicated that work was at an advanced stage in his Laboratory in UK, but no details could be given out because it was being developed for a commercial firm who had the rights. Such interaction was made possible by the profile of the innovator as an academician.

I.3.3 Experimentation

This was a phase of learning through trial and error. The innovator worked on the knowledge that windshield of cars, metal roofs and blades of grass attracted greater condensation than wood planks, concrete surfaces. Similarly, tar road surfaces attracted more condensation than the unpaved shoulders of the road. He began to identify the properties that were important in a material to increase the dew condensation. Initially, small pieces of metal sheets, glass panes and other scrap at the project site were put up at night for observation. One night a metal sheet with aluminum paint was tried. It attracted no dew, where as a plain metal sheet nearby did. All this tinkering indicated that the problem required more disciplined effort.

1.4 Resource Mobilization

To go ahead with the activities the innovator needed funds and people. This demand marked an independent phase in the innovation journey. The innovator raised resources through two means- one familiar and the other unfamiliar.

1.4.1 GEDA Proposal

The innovator decided to set up an experiment. He had learnt this need and process of setting up an experiment in his doctoral work. Taking this forward engaged the researcher in external interactions different from the earlier ones. The journey moved from the 'free phase' where existing resources and infrastructure could be leveraged to conduct the exploration, to 'monetary phase' where he had to mobilize funds for the experiment. He had to go through the process of proposal preparation, review and approval. Those who reviewed the first proposal sent out for support brought back the comments that dew could not be thought of as a significant source of moisture for human use. After the Innovator made presentations showing the amount and frequency of dew collection from the plastic roof, a small grant of Rs. 290,000 was obtained from the Gujarat Energy Development Agency. The grant made it possible to get started in 2002. The innovator had to go through this process, despite being himself the Chairman of Research Committee of the Agency. Here again the innovator's earlier record of taking a project to satisfactory completion helped. The outcome of initial experiment was quantitative data on frequency of occurrence and quantity of dew and also the efficacy of plastic as condenser. That was presented (Sharan and Prakash, 2003) in the Annual convention of the Indian Society of Agricultural Engineers. The main message conveyed in the conference was that the dew was not a negligible phenomenon in the coastal region and that it could be of some practical utility in arid areas. The reaction was the suggestion that we should formally write to the Indian Institute of Tropical Meteorology, Pune, requesting them to begin monitoring dewfall at several coastal locations. Innovator followed-up that advice and wrote to the Institute. The exchange is still on.

Based on the responses the innovator and his team set the objective of Innovation as follows:

- to develop dew harvest systems for use of people living in the coastal areas of Kutch
- to ensure that the systems are affordable, easy to erect and maintain

A new team - distinct from that of the greenhouse- was formed to pursue the above objectives. The team was led by the Innovator and had two other members Hari Prakash (agricultural engineer) and Haroon Abu Bakr (a field worker with no formal education).

I.4.2 Competing for an award

The innovator submitted the innovative idea for a competition and won an award of $20,000 from the World Bank in 2004. From April 2001 to February 2004 (when GEDA grant came) all the expenditure – materials, salary, travel - was borne by the greenhouse project. After that the GEDA and later the World Bank award resources were used for the dew work. The idea of sending for the competition was suggested to the innovator by his friend on the last but one day of the deadline for submitting the idea to the World Bank. In this phase, there has been an element of chance. The innovator happened to meet the friend who happened to tell him about the World Bank competition. The innovator was able to carry on his activities further.

I.5 Product development and Demonstration

Based on the insight the team began the product development exercise. Initially they built a small trial condenser and set it up for demonstration. It may be recalled that changing the perceptions of the villagers was as critical as developing a condensers to get the dew.

I.5.1 Small Trial condensers

First twenty four small (1 m^2 surface area each) condensers were built for study - effect of material of construction, of orientation and ambient conditions on yield. Condensers were made of materials – polymers and metals - easily available in the local market place, and affordable. Thin plastic films and also thin metal sheets gave good yields. Plastics generally gave higher yields than the metals. Film made of polyethylene mixed with small amounts of titanium-oxide (T_iO_2) and barium-sulphate (BaSo4) referred to as PETB film gave better yield among the plastics. This composition was recommended by Nilsson, T. (1996). Their work was done in mid-nineties.

1.5.2 Scaled-up prototype condensers

The early experiments led to the conclusion that plastic films with special composition would make good practical and inexpensive condensers. Another conclusion was that the GI roofs that existed in the area could also be used for dew harvest. Though, the yields would be less than the plastics but there would be no need for extra investment. The team working in the project learnt these lessons by analyzing the data that resulted from measurements.

Next , larger prototype condensers (18 m^2 surface area each) were made of the two materials PETB film and thin galvanized iron roofing sheets (GI) .This indicated that the yields would be slightly reduced by making the surface areas larger. Smaller units turned out to be more efficient than the larger ones, every thing else remaining the same. Size and aspect ratios of the larger units were worked out, so also the method of installation. It was noticed that film could not be bonded with the insulation. This came to light only in scaling-up the size. There was no difficulty in making the small condensers with the help of commonly available adhesives. The solution was then found by using special ribbons made out of ultra-violet (UV) stabilized plastic. These were actually used to anchor the greenhouse films to prevent flutter.

This phase brought the researcher in another external interaction. Although, Ahmedabad area had a large number of plastic processors, there were not many who would support small orders. It was difficult to get small quantities of plastic film with specified composition. The team needed about 25 kg of film, but the processors required a minimum order of 1000 kg to run a special master-batch. Innovator sought a meeting with the President of plastic processor's association (Mr. Vajubhai Vagasia) and explained the importance of the work. That helped and he got an agreement that they will support our small orders. This facilitated interface management. The innovator leveraged his 'professional status' to get the interaction with the President of the plastic processor's association going and increase the chances of success of the experiments.

Since the film with special composition made by the processor for the first time, it was important that its properties – especially the emmisivity in infra-red range and reflectance in solar spectrum – be measured. High emmissivity and also high reflectance for rapid cooling at night and for reducing heat gain during the day. The nearest place with facilities to measure these was Indian Space Application Centre, Ahmedabad. They helped, but it took some time to get permission from authorities.

!.5.3 Demonstration and acceptance

It was important to make the people in the area aware of the development of practical dew harvest systems. It was also necessary to change the mindset of the people who opined that dew water was harmful. The innovator chose to build two units for demonstration and install these in places where people could visit and see. It was decided to install one unit in a school and one in a large temple complex. People had high regard for both these places. The erections were made by the project team. At both the places the dew water was used for drinking and when in excess, for watering the plants in the kitchen garden.

The Temple complex belonged to the Jain community. These people were pre-disposed favorably to dew water which they associated with natural purity. This was the reason why they agreed to become a demo unit. Here the person who took keen interest in collection and use of dew water was Mr. Pran Jivan, a staffer of the complex. The school principal (Mr. Soda) accepted the idea after visiting the temple complex and talking to Pran Jivan and also tasting the dew water there.

The Principal readily encouraged other villagers to adopt the system. Mr. Soda was an enlightened individual and having seen the use of dew water without any harmful effect, began clarifying to others that it was good as safe water. Seeing the school principal drink dew water and seeing the health of plants watered by it, the villagers began to have a favorable opinion about the experiment. The Temple unit made a similar impact. It took about two years to gain acceptance. It was only in the summer of 2005 that new enquiries began to come for dew installation.

It is worth noting in passing that the innovator was able to access `free resources' for demonstration and promotion. This enabled the researcher to stay within his means and focus on the innovation.

Gradually the scientists (ecology, crop-science) in the region began to make their own investigation in the dew phenomena. They also visited the projects to see the results. The visitors included scientists from the Gujarat Institute of desert Ecology, Gujarat Agricultural University and several NGOs of the area. Innovator received at least two communications from engineers who read about the work in Kutch and wanted to build further on that by using recent new technologies. Innovator responded to each communication. So far there has been no publication of results from these scientists.

The innovator was invited to give public lectures on dew harvest at Vikram Sarabhai Community Science Centre, Centre for Environment Education, and Electrical Research and Development Association, Baroda. After one of these talks Mr Kartikey Sarabhai, Director of CEE, suggested that the Innovator write a monograph on this technology for publication by them. Innovator accepted the suggestion and a book was published in May 2005.

The innovator and his team participated in public 'melas' whenever held – usually two in a year- and put-up stalls (see photo in figure 2) explaining to visitors the features of dewrain systems. The events attracted the attention of media and TV Channels like Door Darshan, ETV, Star and Gujarat TV made news clips on the projects and telecast in the region. To these channels the project offered something new and different. The telecasts - which had visuals of the installations and details of dew water recovery, also in one case interview with the temple authorities and the school principal. These telecasts provided free publicity to the innovation.

I.6 Commercialization

In 2005 a commercial unit was developed by the team. Commercial systems were the models that could be purchased by the people. Two models were being promoted - small for individual families (20 liters per night mean yield), large for community use or for bottling and sale (100 liters per night mean yield and greater depending on the area available for installation). Family size systems were usually installed over the roof of building) and were called Condenser-on-Roof (CoR). The larger ones were installed over the ground and called Condenser-on-Ground (CoG). The greatest difficulty in commercialization was the expectation on the part of the people that these should be subsidized from public funds like many other things – solar cookers, greenhouses, rain harvest systems. Innovator firmly believed that subsidies were often abused - sellers sold inferior products, users were indifferent to quality and neglect maintenance. Overall, it hindered improvement in products rather than helped it. He therefore never looked for subsidy for these systems. Gradually people saw the point and began accepting these on merit.

Realizing that rooting the innovation in the local milieu and empowering the villagers to adopt and improvise the innovation was crucial to sustained commercialization; the innovator trained the local people to build dewrain systems on commercial basis. Local hands were selected to work with the project team in prototype building, installations and measurements. The selection of individuals was made with a view to eventually help the emergence of a small enterprise that would build systems for customers as business. The team looked for intelligent and interested individuals, not so much for schooling. The local hands were involved in all the installations thus far. It was discussed in the group that a business enterprise needed to be created to carry on installations and improvements further.

We need to note certain aspects of this phase. Moving from the lab to the commercial phase was relatively easier in view of all round excitement created by the demonstration units in the school and the temple. The larger definition of the problem enabled the Innovator to connect to the others – the Jain Temple authorities who were also keen on solving the water problem. A concrete product was able to attract funds easily. The green house project site continued to provide support to the innovation journey.

In this section we mapped the journey of dewrain harvester systems as it moved from curiosity to commercialization. We identified the key activities and outcomes during the journey. We also identified the facilitators and constraints. The overall view was that the Journey was facilitated by the back ground of the innovator, the home work done, the larger definition of the problem and linking with the local community that shared the need for solving similar problems. The linking with local and lab knowledge and independent learning to augment the received knowledge were crucial to the successful journey. Based on the account presented in this section, we identify the following themes in leveraged innovation management

Section II

Key Themes

Probably, this is the first account of innovation journey of its kind. We have tracked the innovation journey of a product developed by an 'academic innovator'. We have looked at both technical and managerial aspects of the innovation journey. Academic innovators tend to give up at some stage of the journey or the other, owing to other 'academic attractions'. Here the innovator has followed the idea through to its commercial stage. The literature on innovation (Henry and Walker, 1991, Stefik and Stefik, 2004, Govindrajan and Trimble, 2005, Kantor, 2006) has focused on innovations in the corporate network contexts. They have identified the structure, systems, and processes needed to spur innovations within the corporate context. We have not come across studies that have traced the innovations and innovation journeys of 'academic innovators'.

We classify the innovation presented here as 'leveraged-innovation'. We saw how the innovator and his team were able to leverage on past successes, credibility, network existing infrastructure, and societal goodwill. These would not be available to a new innovator or to zero base innovation. Like other innovations, this also had the phases of exploration, linking with existing knowledge bases, independent learning, experimentation and demonstration. The transitions from one phase to the other were smoother and the anxieties were sorted out early. While the internal excitement was always high, the external excitement gained momentum with the demonstration units and visible results. The commercialization phase therefore did not pose the usual uncertainties. Since the innovator had a researcher's orientation, he documented various stages of the progress, shared the results with professional audience and sought advice and assistance. Since the end problem being tackled was affecting the disadvantaged regions favourably, advice and assistance was forth coming easily. The innovator was able to avoid the strategic, structural and process traps (Kanter 2006). The innovator crossed one hurdle after the other. The larger statement of the end use in terms solving the problem of water shortage helped to get motivated all through. He levegered the lessons from the past, coupled them with new lessons from experiments and exploration. (Govindarajan and Trimble, 2005).

Unlike 'zero base innovations' where the innovator works with unknowns most of the time, the 'leveraged innovations' provide an opportunity for 'leveraging' on some knowns to face the unknowns'. However the leveraging does not happen unless the innovator looks for 'leveraging opportunities'. The innovation journey of the dewrain system is the outcome of sustained attention and combining local knowledge with scientific enquiry. The innovator's orientation to problem solving, created a structured approach and facilitated the progress from phase to phase. The role of helpful others in providing the impetus for the project should also be recognized. We identify the following themes in managing this class of innovations.

II.1 Innovator's Profile as axis for Leveraging

We may note that the innovator's background has played a significant role in fostering the innovation of dew rain harvesters. The journey was smoother and on predictable lines. The innovator was not new to the 'business of innovation'. He had been innovating. His involvement in related activities helped him to move confidently, despite early skepticism by others. It should also be recognized that the innovator was trained in the 'scientific approach to problem solving'. He was immensely helped by his prior orientation to solving the developmental problems of arid zones. He was familiar with the territory and the possible sources of support for his enquiry. He could contact his co-professionals in the near by laboratory and the University. Being an academic enabled him to seek knowledge from as many sources as possible. He also leveraged on the discipline of documentation and organized research. His credibility as an innovator enabled him to get the attention of funding agencies. He 'borrowed' from his past and invested in the new innovation. The innovator was not new to the region either. He had been spending time at the site to work on his earlier innovation of building an earth tube heat exchanger and a green house supported by the tube. This involvement helped to build contacts and credibility. The leveraging and network building activities at various phases of the journey were facilitated by the innovator's background and experience.

The key issues that arise in this context are: Which aspects of the background of the innovator facilitate or hinder the progress of the innovation journey. The journey has phases like homework, linking with extant knowledge and practice, new learning, development, demonstration and commercialization. Each phase demands an interface with the innovator and the environment in which he/she is operating. The interface is effective if the back ground is compatible with the demands. If there is a gap between the demand and supply, the innovator has to rely on `helpful others'. The inability to bridge the gap would truncate the journey. We have not come across literature that has posed this issue of demand supply gap and studied the gap filling strategies for successful innovations.

II.2 Larger Purpose Statement as a Shock Absorber and a Support Mobiliser

It is not that factors work in favour of the innovator from the start. There are dampeners within and outside the innovator's infrastructure. When encountered with dampeners, what helps the innovator to sustain his/her journey is the larger purpose of the innovation. In this case the innovator defined the larger purpose as 'solving of chronic water shortage problem'. He did not define it as 'collecting dew from roofs'. How do innovators define the end purpose or pose their larger problem not only keeps the innovators efforts active but also enable him to build a larger base of supporters for the innovation. For example, support from the school authorities, especially from the school principal, and the temple authorities was forthcoming because the innovation touched the core of the villager's problem. We note that demonstration of the units in the school and the temple played a key role in changing the mindset of the villagers. Kanter (1991) refers to this skill of the innovator as articulating and communicating a ***vision***. This aspect has not been explored further in the literature to assess the nature of internal and external support the vision would generate and how it would prevent the journey from 'derailing'.

The study and search processes were possible because the innovator stated the problem in a larger context of solving the water problem of the arid zone. It enabled him to stay on despite early discouragement from professionals. The larger problem enabled the innovator to link with other work he was doing in the area. This, in a way provided access to free resources for the project in the initial stages of construction and later stage of experimentation and demonstration. The larger definition of the problem enables the innovator to augment his search for similar efforts else where solicit support. The goal - contributing to the solution of drinking water problem- was very important. Had it not been so, the outcome would be research papers and publications, not practical marketable devices. This was seen in case of our earlier innovations specially the 'Earth-Tube-Heat-Exchangers (ETHE)'. After that innovation won a major award many engineers in the country began building the ETHE in there department for research. But Innovator pursued market oriented applications. Others simply published one or two papers and stopped there. Innovator continues to introduce those systems in the market with additional improvements. Most recently, the Innovator initiated collaboration with the Indian Institute of Bombay, to add a heat pump to the ground heat exchangers he has been developing. This was done to meet demand from home owners who wanted the system adapted for human comfort.

II.3 Leveraging on Early Facilitators

The innovation journey was facilitated by the locals, co-professionals and the green house task members. They enabled the innovator to define the scope of his exploration and exploit the known assets. This part of the innovation journey where the outsiders play a crucial role in defining the scope and limits of exploration is not addressed well in the literature. The concentration has been more on what the innovator and his internal context did and less on the external context that reacted to the early ideas and experiments. The experience also points to the need to link the 'leverageable ideas' with an external facilitation network as early as possible. This not only speeds up the journey but also helps the innovator define the scope of his exploration. Formation of an early network for the innovation is crucial to bring order to the exploration process. The innovator need not 'reinvent the wheel by default'.

II. 4 Disciplined Enquiry as Facilitator

For curiosity to convert into a commercial product, the innovator has to be disciplined in terms of the process of enquiry and evaluation of the options before him. In this case the innovator's linkage with the academia and practice elsewhere helped him to develop structured approach and progress, almost on predictable lines. A part of the disciplined approach is also deliberately asking the question who else has that problem? In this case the innovator needed to devise ways to make condensation occur rapidly but without the use of electricity or any other external energy. In this case the innovator asked this question. The answers were - plants and small animals in desert where there was no water in fluid form , only vapor in the air; engineers who were in very humid areas where air needed dehumidification to render it healthy; inside spacecrafts where it was important that vapor did not settle on control panels or sensitive instruments; product designers who developed non-fogging mirrors for bathrooms etc. Each answer lead to a new professional link and if the problem was solved in satisfactory ways by some body else the 're-inventing' was avoided. While 'trial', 'error', 'serendipity' and 'eureka' are identified as a part of the innovation journey, it helps if the innovator is disciplined and prepared.

II.5 Discovering and Leveraging Free Resources

The innovation under study has been a beneficiary of access to free resources at various phases of the innovation journey. The innovator did not have to seek funds or people support till he reached the phase of experimentation. He could explore freely without the need to prove anything to anyone. Similarly, the demonstration and publicity for the 'experimental unit' was taken care of by the temple and the school authorities. This is an interesting insight. This aspect of the role of access to 'free resources' in enhancing the effectiveness of the innovation journey has not been explored in the literature on innovation management. Another view of 'free resource' is that the resources generated by the existing activities in the internal and external context of the innovator are subsidizing the 'exploration exploitation of the innovative idea'. These are the resources that do not make a charge on the innovator's scarce resources. They reduce the cost and increase the speed of the journey. The innovator needs to identify such possibilities of accessing free resources and linking them with his own. They could be voluntary support from the beneficiaries, access to unutilized or underutilized equipment or infrastructure in the neighbourhood, free consultancy or advice or access to already researched material without a charge. Access to free resources reduces the overall cost of innovation and increases the flexibility of the innovator. The innovator needs to acknowledge their support explicitly and provide the credit due to them to create possibilities of sustained access for future work.

Early sharing and getting more eyes to view and more mouths to discuss it played a crucial role in the demonstration phase. Even good ideas need resource mobilization effort. Innovation does need positive support all through their journey. In the case of dewrain system, innovator organized for demonstration in public place and shared the findings of his work in professional conferences. This led to a mindset change and facilitated speedier commercialization. Innovation history is full of illustrations of products that could not make the grade because the market was ready. The demonstration and public participation processes make the market ready. Early demonstration also provides an opportunity to seek feedback and improvise.

II. 6 Harnessing 'Innovation Spin Offs' as Leveraging

Innovations do get triggered by observing the obvious and asking an unasked question. They also get triggered by linking the unlinked or de-linking the linked. While it is recognized that one innovation leads to another, little attention is paid to the spin offs from an activity or accomplishment or failure in the innovation journey. While the innovator himself/herself may or may not be sensitive to the spin offs, some one else should. In a way the 'dew condenser' is a spin off from the green house project and other innovations of the innovator. The innovators presence at the site enabled him to note the condensation of dew on the roof of the cottage where he was staying. It was an act of a curious mind. The villagers, who had been observing the dew formation even in summer, did not ask whether it was possible to collect it and use it for drinking purposes.

As innovation is the outcome of a chain of activities, each activity has the potential to spin off new ideas for innovation, network development, and access to free resources, unintended positive consequences, and new learning possibilities. Conscious sensitivity to spin offs might promote a stream of innovation. This has been overlooked even in the literature on corporate innovations. The literature on spin offs (Klepper, Thomson, 2006) has focused on how new enterprises are spawned from the current ones. Attention has been on the role of life cycle of the company, the extent of agreement and disagreement among the stakeholders on strategic issues and strategic orientation of the enterprise. Similar effort needs to be made to look at the innovation spin offs. Studies of spillover effects in clusters and industries (Besant, 2002, Spencer, 2003) focus on the issue of how one innovation and the activities around help other innovations. Systematic efforts have yet to be made to link, for example, the innovations by the same individual or the firm and derive a frame work for understanding innovation spin offs. We can look at two types of harnessing spin off opportunities. The innovator himself harnessed the opportunities as in this case and others harness the opportunities as in the case of Silicon Valley innovations. (Stefic and Stefic, 2004). Documenting comprehenisively the innovation journey and sharing it with various stakeholders might highlight the 'spin off' and harnessing opportunities.

In this section we looked at the innovation journey and raised some issues in innovation management. We identified the advantages of stating the relevance of the innovative idea in the larger context, disciplined search and the role of early facilitators. We also noted that the innovator benefits from access to 'free resources' also creates opportunities for 'spin- offs' The background of the innovator plays a significant role in the various phases of the innovation journey as it responds to demands for interaction with the environment of the innovator and the innovative idea. We also identified the gaps in the literature on innovation management in this context.

Section III

Conclusion

The concept of harvesting dew for human consumption and the new systems of harvesting are both new to India. In this paper we have mapped the innovation journey from incidental observation and posing an innovative triggering question to commercialization. The product has been developed by an 'academic innovator'. He leveraged his background, experience, contacts and credibility to travel from the phase of observation to knowledge linking, experimenting, and creating new knowledge for further linking, resource mobilization, product development, demonstration and commercialization. We have identified the key phases in the innovation journey and documented the activities and outcomes in each phase. Based on this we have identified a class of innovations called 'leveraged innovations' and their characteristics. As noted the innovator had several axes to leverage on and speed up the innovation process. The 'exploration' was limited and focused. Exploitation was maximum. The themes in managing leveraged innovation related to the role of the profile of the innovator in leveraging, linking the innovation question to a larger purpose, early facilitation of innovation journey, discovering and levering free resources and harnessing spin offs .

The phases identified and the insights could provide the basis for building a template for mapping innovation journeys. The facilitators and challenges in each phase could be analyzed and support provided for a smoother innovation journey. The approach adopted for mapping and the themes identified could be useful to the scientists and administrators working in national and international laboratories.

Not many individual innovators are gifted with initial independent and network advantages of the innovator under study. How do these less gifted innovators struggle through and complete their innovation journey is not studied adequately. What would they leverage on? What determines the leveraging process? Focusing on this can help us identify determinants of leveraged innovations by individual innovators. The journeys of corporate innovations and their facilitating and constraining factors have been well documented in the literature. Similar documentation and analysis are wanting in the context of individual innovators. There are immense possibilities of learning from their journeys.

Table 1: Chronology of development of dew harvest systems

1.	April 2001	Incidentally notice large dew condensation on the roof of cottage at Toran Beach Resort, Mandavi, Kutch.during a brief stay
2.	September 2002	Measurement of dew from greenhouse roof begun; before this we talked about dewfall with the people in villages and also the Meteorological observatory department in Bhuj, Gujarat.
3.	November 2003	A proposal for research submitted to Gujarat Energy Development Agency for funding (Rs. 300,000)
4.	December 2003	Research note – Dew condensation on greenhouse roof at Kothara - published in the Journal of Agricultural Engineering February 2004
5.	GEDA	approves the proposed research work to build test condensers of six different materials, funds were for research assistants salary and materials, innovator's salary was always provided by IIMA. (Construction of 24 test condensers begins)

6.	January 30, 2004	The concept of dew harvest for human consumption in coastal villages submitted in competition - India Country Level Development Market place of the World Bank. Innovative and wins Development Marketplace - award of $ 20,000.
7.	April 2005	Dr Daniel Beysens , President and Mrs Iryna Milimouk, Secretary, of the International Organization of Dew Utilization, visit Kothara and see the project. We also reach an understanding to collaborate in this work.
8.	June 2005	Trial of six materials for suitability to make large condensers completed, two materials selected, demo units using these installed in Sayara and Suthari. Approached by Dr Dinesh Mishra of the Gujarat Mineral Development Corporation, Environment Division to build a large dew plant at Panandhro village, the site of their lignite mines.
9.	February 2006	Work at Panandhro begins and is completed in November 2006.
10.	May 2006	Book 'Dew Harvest' by the innovator released. Published jointly by Foundation Books, Delhi and Centre for Environment Education, Ahmedabad. (The book project was first suggested by Karthikey Sarabhai, Centre for Environment Education, Ahmedabad.)
11.	July 2006	First joint paper - Sharan, Beysens and Milimouk Accepted for publication by the International Journal of Arid Environment (UK). The paper contains analysis of Kothara condensers.
12.	November 2006	Request received from Tata Chemicals to build dew harvest systems at Dwarka. (All working systems requested by clients are paid for by them. We give them estimates and they bear the cost. We charge a small design fee from clients.)

Figure 1: Map of Kutch

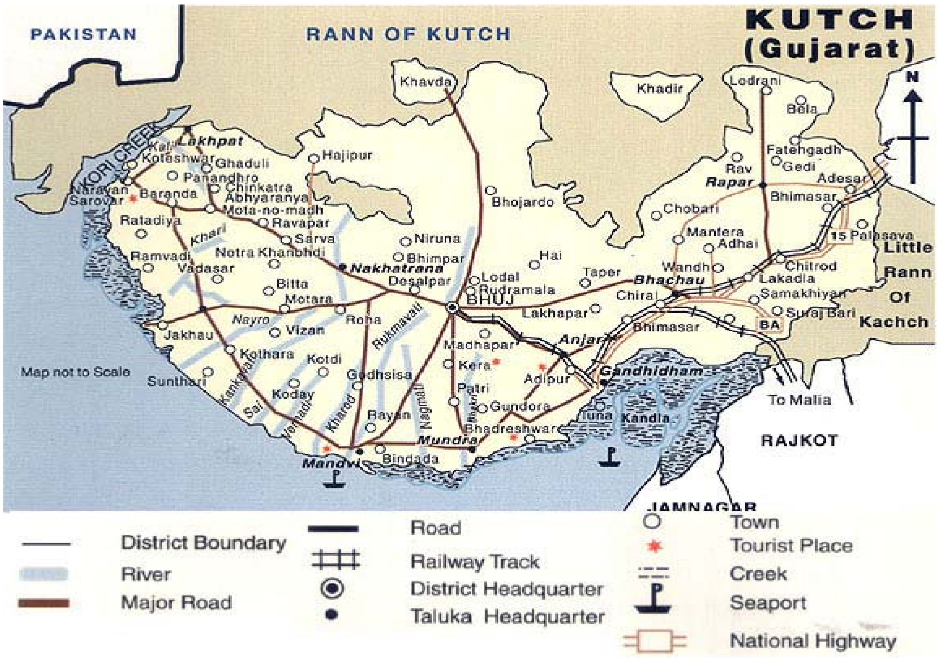

Figure 2: People trying out dew water at a public fair

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