SMART FARMING IN ANDHRA PRADESH, INDIA: AN OPEN INNOVATION APPROACH

Date: November 10, 2017

PROF. SOLOMON DARWIN
PROF. HENRY CHESBROUGH
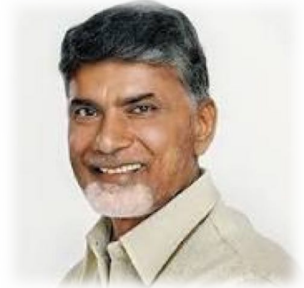Researchers: Werner Fischer, Shreya Evani, Judah Darwin, K. Harshadeep & Arun Sharma

"Agriculture is our wisest pursuit, because it will in the end contribute most to real wealth, good morale and happiness" – Thomas Jefferson

Research presented in this paper is based on:

a) Feedback from over 40 Corporate Partners working with UC Berkeley on the smart village project since summer 2016

b) One-on-one field surveys with over 10,000 farmers in Andhra Pradesh, India, and

c) Open Innovation research being conducted on Business Model Innovation at UC Berkeley.

Table of Content

"Villages are the source of wealth"
Chief Minister Naidu
Mori Smart Village Inaugural, Dec. 29, 2016

"The government believes that agricultural growth is only possible by combining advanced technology with effective policies. It is the government's aim to make Andhra the most advanced agricultural state in the country."
Chief Minister Naidu
Hans India, Sep. 2016

"Agricultural productivity is one of the most basic things that can help the poor to move towards a more prosperous life."

"I have seen first-hand that agricultural science has enormous potential to increase the yields of small farmers and lift them out of hunger and poverty."
"Innovations that are guided by smallholder farmers, adapted to local circumstances, and sustainable for the economy and environment will be necessary to ensure food security in the future."
Bill Gates

Executive Summary

The bottom of the wealth pyramid offers a huge untapped growth opportunity for global businesses to expand markets. However, it represents the poorest socio-economic group on earth. In India, 70% of its people live in its 650,000 villages. Suffering from an array of pain points, the rural population needs empowerment and access to digital tools, resources and information to become economically self-reliant. In the summer of 2016, UC Berkeley was appointed by the Chief Minister of Andhra Pradesh, Shri Nara Chandrababu Naidu, as the State's research partner to offer possible solutions through a scalable smart village project. According to Professor Solomon Darwin, "A smart village is a community empowered by digital technologies and open innovation platforms to access global markets".

UC Berkeley's research is focused on addressing these challenges through development of business models for businesses that incorporate digital technologies and open innovation platforms to access global markets. This approach relies on global and local firms working together to form a business ecosystem to address the needs. The benefits of the ecosystem approach includes: cost elimination, time saving, risk reduction, transparency, speed-to-market, data richness, shared asset utilization and new revenue generation, among others. This is essential to establish scalable and sustainable enterprises in this expanding market. Two-way exchange between corporates and rural people is essential.

Global brands seeking growth cannot ignore the emerging economies that are growing at over 10% GDP representing 5.5 billion people vs 1.5 billion in rich nations growing only at 2% GDP. However, this requires new business models based on scale and Open Innovation Ecosystems. The existing business models driven by higher margins prevalent in developed economies do not work. Our objective is to develop scalable and sustainable business models for global brands as well as aspiring firms to expand markets to ultimately enhance the happiness of people in rural villages.

This white paper discusses the findings and analysis of the ongoing research since summer of 2016 and is based on:
   a) One-on-one exchange, interviews and surveys with over 10,000 farmers in 472 villages serving Open innovation laboratories on ground through co-creation/co-innovation approaches.
   b) Feedback based results from ongoing research on business model viability with over 40 partnering firms such as Google, Cisco, IBM, and Ericsson, as well as startups.
   c) Open Innovation research being conducted on Business Model Innovation by academic researchers worldwide through the Berkeley Innovation Forum network at the Garwood Center for Corporate Innovation.

Entrepreneurial approach to empower people is critical when compared to traditional approaches such as government aid programs that help villagers in the short term but lack the foundation for sustainable economic development.

The following are key takeaways of this paper:
   1) Rural populations in villages are ready to embrace digital technology to empower themselves.
   2) Global brands and startups are ready to invest in rural villages to expand their markets.
   3) The State of Andhra Pradesh, through the leadership of the current administration is ripe for investment. Chief Minister Naidu seeks to create policies to address the unmet needs of his people.
   4) Co-innovation approach to develop business models by engaging villagers and corporates is showing traction.
   5) Open Innovation Ecosystems approach is now embraced by all partnering firms as a new way to deliver value to villagers given the scale and scope.

The research presented in this paper focuses on Smart Agriculture Ecosystems but our work includes other ecosystems to provide holistic solutions to rural populations in the areas of health, education, security, transportation, energy, communication and entrepreneurship. Our objective is building and empowering people to increase the happiness index of rural India through Open Innovation Ecosystems. As Professor Solomon Darwin states, "Open Innovation is happening in 472 villages of India to create value for rural populations and not in the ivory towers of Silicon Valley."

1. Overview

The chief minister of Andhra Pradesh (AP), Hon. N. Chandrababu Naidu, upon taking charge in his new position, completed a series of visits to rural villages in his state of 60 million residents. Thirty-five million of these residents live in rural areas. Chief Minister Naidu seeks to create a new policy mechanism to address the many unmet needs of his constituents in AP. In June of 2016, he decided to launch an experiment called Smart Villages in consultation with outside experts including professors from UC Berkeley's Haas School of Business that serves as a research partner to provide possible outcome based models and solutions. According to UC Berkeley Professor Solomon Darwin, "A smart village is a community empowered by digital technologies and open innovation platforms to access global markets".

This initiative is primarily funded by private organizations, with the state government providing leadership and a supporting role. On December 2016, Phase 1 prototype was completed, in Mori Village, Andhra Pradesh. It validated two things: 1) readiness of the villagers to embrace digital technology to empower themselves and 2) willingness of global technology firms such as Google, Cisco, IBM, and Ericsson, among other corporate partners to invest in prototyping business model experiments in India. The Garwood Center for Corporate Innovation at UC Berkeley's Haas School of Business was appointed as a research partner for the Andhra Pradesh Government.

The objective of this experiment is to implement Open Innovation at the grassroots level in order to devise and deliver affordable digital technologies that rural villagers want and are willing to pay for. These affordable technologies must then be embedded in new business models that technology suppliers can scale and sustain throughout Andhra Pradesh, and later, all of India. Scalability is something that India offers to these industry partners, given its 650,000 villages where 70% of its 1.3 billion people live.

Rural villagers had an overwhelmingly positive response to the successful Phase 1 prototype of smart villages. Given the success of Phase 1, Minister Naidu requested UC Berkeley to pursue 472 villages as laboratories of innovation. The Phase 2 goal is to explore and create new business models where industry partners can scale and prosper through providing value to the poor, rural population.

The initiative began in the summer of 2016 in Mori village. To date, more than 40 companies from India and outside of India, have chosen to deploy staff and equipment to the village to support the goals of this project.

This whitepaper focuses on Smart Farming, and Open Innovation Ecosystems approach to address the farmers' pain points. A formal case study of Phase 1 can be found in the Harvard Business School case management system.[1] UC Berkeley also conducted forums, and hackathons to nurture innovation and exchange knowledge; it brought private

"UC Berkeley's approach of firms coming together as an ecosystem through an integrated process to deliver value to the farmer is something that has not been tried before. The efforts being made by the university in bringing together large and small firms as an ecosystem to:

   a) Eliminate costs,
   b) Facilitate speed to market,
   c) Increase transparency,
   d) Lower risk for all
   e) Increase efficiency in the supply chain
   f) Time save for all
   g) Increase yields and revenues
   h) Enhance data richness
   i) Promote Uberization of Assets

This approach is supported as endorsed personally by our Hon. Chief Minister and we are hoping for great results in the future."
"Our state government in the agricultural sector is committed to be the key facilitator in the whole supply chain process to remove obstacles, bottlenecks and tighten the weakest links in the systems to improve the happiness of the farmer."

Rajsekhar Budithi, IAS, Principle Secretary, Department of Agriculture

---

[1] https://cb.hbsp.harvard.edu/cbmp/product/B5886-PDF-ENG

investment to otherwise isolated villages. Accordingly, corporations and start-ups can make profit through helping rural people.

2. Lessons Learned from Previous Rural Development Initiatives

Villages in India have received government aid through several programs over the years. Although these programs help villagers in the short term, they do not lay the foundation for sustainable economic development. Typical job programs, for example, do little to improve villagers' knowledge or skills. Moreover, once government funding for a program ends, there is little to sustain further at the village level. Creating economic opportunity would help the village and the government, which could reduce expenditures on aid while improving villagers' lives. This creates a virtuous cycle, as greater knowledge and skills lead to higher income, which promotes an increase in health and well-being leading to further knowledge development.

Many companies have long histories of giving to villages in the developing world, but charitable donations often have no connection to the companies' mission or core competencies. Such as an oil company contributing money to promote health and wellness initiatives. As a result, the effects are not sustainable, and the companies have no incentive to expand their efforts beyond the charity provided. In many cases, governments and companies have not involved villagers in the design of their aid programs; the programs often did not address villagers' actual needs.

These outcomes are not unique to India. Traditional aid programs have often led to unintended consequences, negative outcomes, and reduced economic growth, according to economist Dambisa Moyo, author of *Dead Aid: Why Aid is Not Working and How There is a Better Way for Africa*. Although the book addresses aid given to African countries, many similarities exist to aid given to individuals in developing countries. Aid, Moyo argues, "has failed to deliver the promise of sustainable economic growth and poverty reduction … it has not lived up to expectations. It remains at the heart of the development agenda, despite the fact that there are very compelling reasons to show that it perpetuates the cycle of poverty and derails sustainable economic growth."[2]

One of the biggest problems with traditional aid is that it instills dependence. Finite, limited aid programs that address specific goals can help alleviate important problems, but much aid in low-income countries is pervasive and essentially continuous, writes Moyo. "Without the inbuilt threat that aid might be cut, and without the sense that one day it could all be over, African governments view aid as a permanent, reliable, consistent source of income and have no reason to believe that the flows won't continue into the indefinite future. There is no incentive for long-term financial planning, no reason to seek alternatives to fund development, when all you have to do is sit back and bank the cheques."[3]

Aid can also harm otherwise successful local businesses and, paradoxically, create the need for more aid. Moyo cites the scenario of a mosquito-net maker in Africa who employs ten people who altogether support as many as 150 people.[4] An influx of free mosquito nets from a well-intentioned aid program helps some people in the area, but puts the net-maker out of business thus making the 150 people his business was supporting suddenly dependent on aid. And the ability to provide more nets in the future now depends upon further philanthropic support, instead of local business people responding to local market incentives to supply them. To date, "more than US $2 trillion of foreign aid has been transferred from rich countries to poor over the past fifty years," writes Moyo, yet there is not very much to show for this effort.[5] One reason: aid programs are frequently evaluated in the short term, which is largely irrelevant to their effect on the target

---

[2] Dambisa Moyo, "Dead Aid. Why Aid is Not Working and How There is a Better Way for Africa" (New York, NY: Farrar, Straus and Giroux, 2009), Page 28.
[3] Ibid, Page 36
[4] Ibid, Page 44. In Africa, Moyo writes, it is not uncommon for a working family member to support as many as fifteen relatives.
[5] Ibid, Page 28

region's long-term problems. "Aid effectiveness should be measured against its contribution to long-term sustainable growth, and whether it moves the greatest number of people out of poverty in a sustainable way. When seen through this lens, aid is found to be wanting."[6]

Exhibit 1- Comparison between Development-led Aid and Smart Villages Approach

Government-led Aid Initiatives	Smart Villages – Open Innovation-led Initiatives
During the period of substantial aid, local prices often inflated, pushing many basic items out of reach for the already poor.	Minimal staff in village, minimal impact on local prices.
Village residents acquired little or no skills that might help them to be more productive.	Strong focus on skills development and training.
Residents were still kept away from larger markets, so much of the value that they produced was captured by middle-men.	Digital technology platforms enable direct linkage to local, regional, national and even international markets.
Corruption was endemic, reducing the amount of money that actually reached the local residents, and creating political barriers that last long past the end of the aid itself.	Digital technology platforms enable much greater transparency and reduce opportunities for corruption. Open innovation connects the all providers together into a coherent platform.
There was no way to scale any success beyond the immediate rural area.	Companies contributing talent and resources are looking to expand their markets, will scale once they understand what villagers want, and are willing to pay for.
Once the aid ended, little economic benefit remained.	The business models for the village and for the companies are sustainable, so market capitalist incentives will sustain the activities in the village, once government support is withdrawn.

Farmers' Needs

University of California, Berkeley's approach for innovation is simple and profound, perpetually stimulating the Silicon Valley culture in Andhra Pradesh. In Phase 1, the UC Berkeley team created a co-innovation space for all parties to engage; realizing that to innovate solutions for communities the solutions needed to be conceived from inside the community. Due to an established relationship between UCB and farmers, UC Berkeley's Smart Village team conducted a survey of over 10,000 farmers about their needs in just a few days.

Farmers must cope with unpredictable access to water presenting the farmer with several issues. For example, Mori has a system of gates that releases water through canals to farmers, but farmers say the water is not released when they need it, and sometimes no water is available. This greatly affects irrigation making it difficult to plan and produce good yields. In addition, the village's lack of cold storage facilities results in a large share of farmers produce going to waste. Farmers also lack access to current information on market prices for their crops and often sell for less than the market value. In addition, only 20% of farmers own the land they cultivate reducing overall margins on the farmers profit.

The environment is suited for lentils, peanuts, sesame, and avocado, making them high margin crops. While farmers would like to grow higher margin crops, knowledge of how to farm these crops is limited. It is also difficult for farmers to have access to education and information that would increase their knowledge base.

---

[7] Ibid, Pages 44 and 45.

Many farmers now harvest shrimp (a high-margin product) from man-made ponds in the village. Consequently, salt is added to the water in these ponds, which increases the soil salinity. Excess salt in the soil hinders the growth of crops by limiting the amount of water available for crops nourishment.[7] Shrimp farms must be deep to be effective, however digging the pond draws seawater into the aquifer, further salinizing the soil and reducing yields for other crops, such as rice. Although shrimping near rice fields is banned to prevent salinization damage, it is still practiced according to a survey of villagers (as published in the formal case study of Phase 1).[8]

These and other village conditions have caused many residents to leave, seeking better lives in some of India's large cities and the Middle East. In agricultural villages such as Mori, emigration creates shortages of labor. This also deprives the village of talent and entrepreneurial initiative. To Chief Minister Naidu, these trends and events underscore the importance of developing Indian villages.

3. UC Berkeley-Andhra Smart Village Project

"Johnson Controls is excited to be a part of the UC Berkeley Smart Villages initiative that brings together the best of todays' digital technologies, platforms and partnerships with other businesses and the government to solve societal challenges to build more safe, sustainable and smarter villages in India." This initiative sets the standard on how businesses, government and knowledge centers like UC Berkeley can work together to solve everyday problems in a self-sustaining manner."

Robert Locke, SVP, Corporate Development
Johnson Controls / Tyco

In rural areas, villagers have an opportunity to become prosperous, but often lack basic tools, such as information about market prices for their farmed produce. Simplicity can help keep costs low for companies that are developing products and services to meet the needs of rural areas. Villages are also close to being green fields—that is, the general lack of infrastructure and services means fewer legacy constraints exist on those entering the market. For example, distributed energy generation innovations like small-scale solar are not competing with clean, stable power sources in villages.[9] Instead, they often compete with lack of access, inefficient and unreliable power systems, or pollution-emitting generators.

Deeming a geographical unit "smart" is not a new concept. The idea of smart cities is already being implemented in places such as Dublin, Ireland, where the city applies analytics to data to help optimize a wide range of public services and works to engage citizens, business leaders, and scholars to improve city life.[10]

For Chief Minister Naidu, the motivations for transforming villages such as Mori into smart villages are similar to those driving leaders in Dublin and around the world. Specifically, he wants to empower villagers with access to (1) smart and clean technology, (2) transparent information, (3) easy-to-use digital tools, and (4) resources to develop entrepreneurial

---

[7] Source: Soil Quality Information Sheet, Soil Quality Resource Concerns: Salinization, United States Department of Agriculture Natural Resources Conservation Service, http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053151.pdf

[8] https://cb.hbsp.harvard.edu/cbmp/product/B5886-PDF-ENG

[9] Source: Developing world: Small-scale innovation brings vital help to poor communities, The Financial Times, https://www.ft.com/content/34eb8824-fe25-11e0-bac4-00144feabdc0

[10] Source: Optimizing Critical City Infrastructures, presentation by Tom Leahy, Executive Manager, Dublin City Council: http://smartcitiescouncil.com/resources/optimizing-critical-city-infrastructures

skills and direct access to global markets. That process will not require substantial infrastructure development or large outlays of money. Rather, it will require uninterrupted Internet connectivity, community engagement, and skill building, along with Open Innovation practices to link these activities together. With these resources, villagers can identify and pursue entrepreneurial paths to economic independence.

The meaning of the term "smart village" follows the definition developed by Professor Solomon Darwin that states, "a smart village is a community empowered by digital technologies and open innovation platforms to access global markets." Specifically, Darwin emphasizes that a smart village meets six criteria:

1. **An Ecosystem**: The village leverages its resources, as well as those of surrounding villages, distant places, and other entities to generate revenue and lower its costs and risk.

2. **A Platform:** The village allows external and internal businesses to exchange resources to profit for economic development.

3. **A Brand:** The village creates an identity and becomes known for its unique value.

4. **A Community**: The village is a self-organized network of people who collaborate by sharing ideas, information, and resources to build a strong ecosystem. If and when projects fail, the community remains and rebuilds itself.

5. **A Business Model:** The village creates value for its people and others outside the village by utilizing lean and cost-effective state-of-the-art technologies. The village captures some of the value it creates for itself.

6. **A Sustainable Unit**: The village operates using a triple-bottom-line, focusing on people, profit and planet.

Ultimately, making a village smart is intended to enable villagers to improve their employment, per capita income, standard of living and their happiness level. The process is also intended to enable villagers to become economically independent while simultaneously creating business opportunities for firms bringing their products and services to the village. In turn, government expenditures in the area can go down or be redirected to new, higher value projects.

This definition matters, because it underlies the design of the Smart Villages initiative. The target recipients are the villagers themselves, and the digital technologies are the delivery vehicle for the services in the initiative. Note, that unlike Smart Cities, there is little public investment in infrastructure, beyond digital connectivity in the village.[11] To date, we estimate that roughly US $6.5 million has been spent in Phase 1 & 2. About 80% of these funds are from the private sector, with the AP government supplying about 20%. In turn, about 95% of the funds spent stay in Andhra Pradesh, with about 5% going to UC Berkeley for research and evaluation of the project's performance.

The majority of the funds given from the state to the UC Berkeley team is used for the operation expense of running an on-ground force of over 550 people. The ground team interacts with villagers on the village, province, and district levels to nurture the afore mentioned relationship. This relationship formulated through a variety of solutions that were pitched from on ground teams in the districts Chittoor, Krishna, West Godavari, East Godavari, and Srikakulam. These technologies and solutions were mobilized from the Silicon Valley to India and have been engaged on ground in an unprecedented speed. The Garwood Center of Corporate Innovation at UC Berkeley focused time, money, and resources to give companies speed to market and villagers an ease to their pain.

---

[11] The total budget of the town council in Mori Village is roughly $8,000 per year, for too little to support any investment in IT infrastructure.

4. The Role of Open Innovation and Shared Value

Open innovation is based on the concept of harnessing knowledge flowing from the outside in one's own innovation processes, and allowing unused knowledge to flow outside for others to use in their innovations. The companies participating in Open Innovation are seeking to innovate new products and services for the bottom of the pyramid. Mori village is an ideal testbed for these companies to use in their explorations. These villagers have many needs and few resources. The buying power and will of the villagers is profusely difficult to understand. Therefore, business models thriving in Mori, (40,000 in AP, more than 650,000 throughout India, and millions across the developing world) will likely root in numerous other villages as well. The rural world is a large and rapidly growing market, making these experiments are well worth taking for the participating companies, if they can be linked together in a coherent way.

The pilot stage of the Smart Villages project succeeded in attracting more than 40 companies and organizations to Mori village. These companies are not providing charity, however. They are making small business development investments to learn about the needs of rural villagers for products and services they can provide. Importantly, these investments will reveal what villagers value enough to pay for it directly with their own funds. This is a kind of business model discovery that we see in Lean Startup approaches to business model innovation.[12]

> "The time is now for the initiatives of Open Innovation in the Agriculture Ecosystem, and I believe this approach will be welcomed and adopted with great acceptance and appreciation, and will set the foundation for a new standard for farming in the future."
>
> Douglas Ry Wagner, PhD, CEO, of Agrinos

These companies are certainly providing resources to the village for little or no money upfront. But each participating company sees an opportunity to expand their sales to rural villagers, as a result of the Smart Villages initiative. Their participation is more like business development for the bottom of the pyramid, than it is another round of charitable donations to the poor. It really is an example of open innovation, both for the companies and also from the perspective of Chief Minister Naidu. Previous approaches were government-led, with less input and support from the private sector. Moreover, the private sector participation was primarily charitable, rather than business-driven.

There is a further ecosystem effect that is emerging in the Smart Villages project. The presence of one company in the village makes it more attractive for subsequent companies to also locate a person in the village. The result is a vibrant ecosystem of possible products and services for local villagers. Note that no single company or organization could martial all these disparate resources. It takes an ecosystem of organizations, all seeking to understand villagers' needs and their willingness to pay, to obtain this open innovation ecosystem.

Another perspective that informs the design of this initiative is that of Shared Value. Shared value, as Porter and Kramer define it, does not involve a company sharing the value it has already created; that is, it is not redistribution. Rather, "it is about expanding the total pool of economic and social value."[13] That is, shared value is an approach to innovation in which companies look for ways to grow and sustain their own businesses and create societal value by addressing society's needs and challenges. This approach adds value to the society in which the organization operates, which in turn expands the market for the organization to provide its products or services going forward.

---

[12] See Eric Ries, The Lean Startup, 2011, for an introduction to this approach in the context of high technology startup companies.

[13] Michael E. Porter and Mark R. Kramer, "Creating Shared Value," *Harvard Business Review* (2011), Page 50.

By way of explanation, Porter and Kramer contrast the shared value approach to the fair-trade movement, which focuses on paying higher prices to farmers for the same crops, a form of redistribution. "A shared value perspective, instead, focuses on improving growing techniques and strengthening the local cluster of supporting suppliers and other institutions to increase farmers' efficiency, yields, product quality, and sustainability. This leads to a bigger pie of revenue and profits that benefits both farmers and the companies that buy from them."[14] Porter and Kramer cite studies of cocoa farmers in the Côte d'Ivoire that indicate fair-trade increased farmers' incomes by approximately 10 to 20 percent, but shared value investments increased their incomes by more than 300 percent.

Indeed, at least one example of shared value has already arrived in India. Porter and Kramer explain: "Thomson Reuters has developed a promising monthly service for farmers who earn an average of $2,000 a year. For a fee of $5 a quarter, it provides weather and crop-pricing information and agricultural advice. The service reaches an estimated two million farmers, and early research indicates that it has helped increase the incomes of more than 60 percent of them—in some cases tripling incomes."

For companies, the first step in pursuing shared value opportunities is assessing their products and services in terms of how they address or create societal needs, benefits, and harms. Companies can also identify sources of shared value by changing their perspective on their relationships with suppliers. "The traditional playbook calls for companies to commoditize and exert maximum bargaining power on suppliers to drive down prices—even when purchasing from small businesses or subsistence-level farmers," according to Porter and Kramer. However, marginalized suppliers' productivity and quality levels often plateau or begin to fall. Companies can reverse this trend, thereby ensuring access to inputs and potentially reducing the total environmental impact of their products, by helping suppliers gain strength. For example, obtaining reliable supplies of coffee is essential to companies like Nestlé, which includes Nespresso. Many coffee growers run small farms and face many constraints, including low productivity, poor quality, and environmental degradation.

"To address these issues, Nestlé redesigned procurement. It worked with its growers, providing advice on farming practices, guaranteeing bank loans, and helping secure inputs such as plant stock, pesticides, and fertilizers," Porter and Kramer write. Nestlé also began measuring the quality of the coffee produced at the point of purchase, a change that made it possible to pay quality premiums directly to growers. As a result, yields and quality increased, as did farmers' incomes. "And, the environmental impact of farms shrank. Meanwhile, Nestlé's reliable supply of coffee grew significantly. Shared value was created."

Companies that fail to build shared value in their markets will sooner or later find their ability to grow to become impaired. Companies must seek to grow the pie, in order to be able to sell more of their own wares. And companies working in Mori village possess extremely useful skills and knowledge that can help grow this pie, whether it is Ericsson helping to manage water with sensors, or Hiro delivering health care through its specially designed bicycles, or IBM providing farmers with better weather data to help them know when to plant, when to fertilize, and when to harvest. In short, the people in Mori village becomes a more connected, more knowledgeable and more capable supplier to many more markets than it was previously able to address.

---

[14] Ibid, Page 50.

"World Bank is interested in empowering rural people through digital technology and scalable business models that UC Berkeley brings to the table. The Open Innovation Agriculture and Rural Ecosystem approach developed through Smart Village Program could be scaled up through the institutional investments currently being made in AP. These models are sustainable for economic development of the state in the long term."

Paramesh Shah, Global Lead for Rural Livelihoods and Agricultural Jobs,
World Bank, Washington DC

5. Past Agricultural Ecosystem (Pre-Bifurcation Era)

The Smart Village project in AP is projected to cover eight verticals (Agriculture, Entrepreneurship, Communication, Transportation, Safety & Security, Education, Energy and Healthcare) to foster sustainable economic growth for rural India. It does so by deploying digital technology and developing sustainable Open Innovation business models, based on a coherent portfolio of multiple projects with over 40 national and international companies involved.

To emphasize the need to address the individual village pain points with digital technology and Open Innovation business models, initial surveys were conducted in all 472 villages, which revealed drastic pain points with respect to all eight verticals. In-depth research to analyze these findings creates an optimal foundation to co-innovate with the private sector, government and academia in order to scale sustainable business models to address the specific needs of India's poor.

The agriculture vertical is a significantly relevant sector for rural India, the state of Andhra Pradesh and the Berkeley-Andhra Smart Village initiative. More than 50% of the population of India is dependent on agriculture. Within this sector, marginal farmers are the largest group of cultivators. Eighty-five percent of operating farmers in India have about two or less hectares of land.[15] Unfortunately, on many occasions, great desperation leads to suicides among small-hold rural farmers in India. As stated in 2015, "Andhra Pradesh (including the now Telangana) farmers have had the highest rate of suicides in the country for some decades now."[16] Indebtedness and high vulnerability to risks in agriculture production are considered as the main reasons. Such pain points include low scale of operation, lack of information, restricted access to and cost of credit, poor communication linkages with broad markets and customers and consequent exploitation by intermediaries with respect to input procurement and distribution of agricultural produce.[17] The monthly per capita consumption expenditure is frequently higher than the monthly per capita income for small and marginal farmer households.[18] These findings reveal the daunting situation rural farmers in India are facing.

The past agricultural ecosystem from the Pre-Bifurcation area of Andhra Pradesh (prior to 2014) offers isolated solutions for individual problems. The following illustration shows the hypothetical representation derived from conducted surveys with 10,000 farmers (see Appendix).
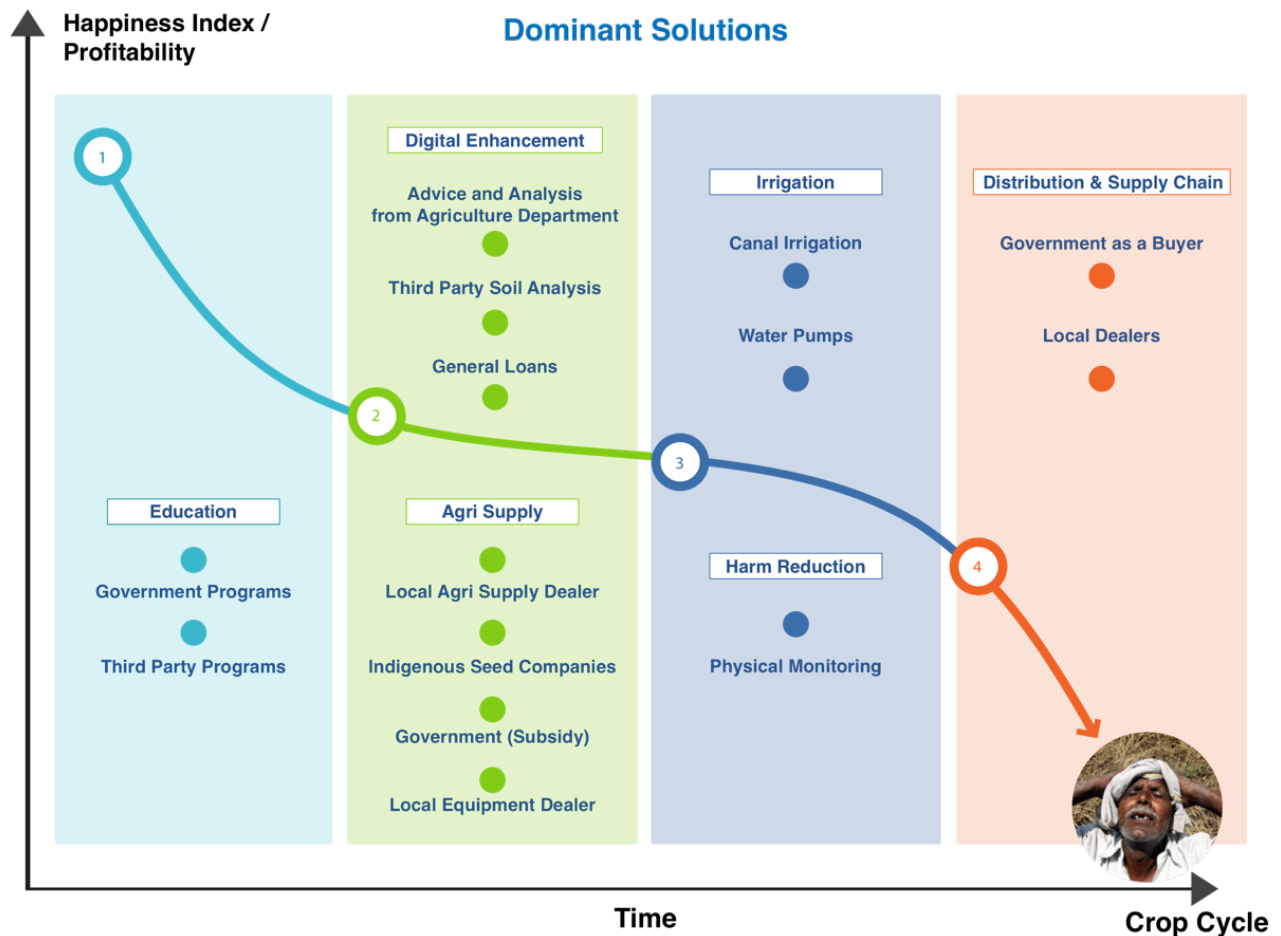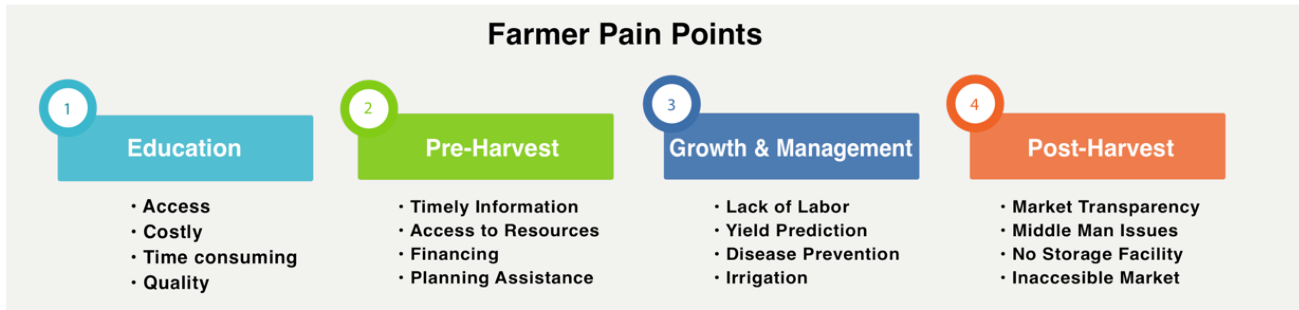
---

[15] S. Singh, "New markets for smallholders in India–Exclusion, policy and mechanisms," *Economic and Political Weekly*, 47: 95-105. (2012)

[16] The hindubusinessline, article published: March 27, 2015, http://www.thehindubusinessline.com/news/national/assocham-study-on-farm-structure/article7039970.ece

[17] S.M. Dev, "Agriculture and rural employment in the budget," *Economic and Political Weekly*, 40(14): 1410-1418. (2005)

[18] S. Mishra, "Risks, farmers' suicides and agrarian crisis in India: Is there a way out," *Indian Journal of Agricultural Economics*, 63(1): 38-54. (2008)

Past Agricultural Ecosystem
(Pre-Bifurcation of Andhra Pradesh)
Hypothetical Representation based on Surveys*

Farmer Pain Points

1 Education
- Access
- Costly
- Time consuming
- Quality

2 Pre-Harvest
- Timely Information
- Access to Resources
- Financing
- Planning Assistance

3 Growth & Management
- Lack of Labor
- Yield Prediction
- Disease Prevention
- Irrigation

4 Post-Harvest
- Market Transparency
- Middle Man Issues
- No Storage Facility
- Inaccesible Market

Happiness Index / Profitability

Dominant Solutions

Digital Enhancement
- Advice and Analysis from Agriculture Department
- Third Party Soil Analysis
- General Loans

Irrigation
- Canal Irrigation
- Water Pumps

Distribution & Supply Chain
- Government as a Buyer
- Local Dealers

Education
- Government Programs
- Third Party Programs

Agri Supply
- Local Agri Supply Dealer
- Indigenous Seed Companies
- Government (Subsidy)
- Local Equipment Dealer

Harm Reduction
- Physical Monitoring

Time

Crop Cycle

Bottlenecks and Weak Links:
1. Cost Aggregation
2. Time Inefficiency
3. Access to digital solutions
4. Complexity / Isolated Solutions
5. Decrease in Yield
6. Reduced Farmer's Happiness

Illustration I: Past Agricultural Ecosystem

Therefore, the initial focus within the Berkeley-Andhra Smart Village initiative addresses the existing pain points of the agricultural sector. To understand the source of the farmer's distraught, it is crucial to analyze the present agricultural ecosystem on how existing solutions address individual pain points.

"Wipro is proud to partner with UC Berkeley and the Government of Andhra Pradesh (AP) on an open innovation initiative to develop high impact solutions in the areas of Credit Reputation Management and Citizen Assistance for the rural economy. These solutions leverage next-gen technologies such as Artificial Intelligence, Blockchain, and Machine Learning, amongst others, and will enable the flow of information, micro-capital and ensure increased returns for the rural population of AP. I strongly believe that this partnership will foster an increased collaboration between industry, academia and government to develop solutions that benefit our economy as a whole."
K.R. Sanjiv, CTO, Wipro

Past Agricultural Ecosystem: Key Research Findings from the Agricultural Survey

The agricultural ecosystem survey includes over 10,000 rural farmers in Andhra Pradesh and was conducted in 472 villages in five Districts of Andhra Pradesh, namely Chittoor, Krishna, East Godavari, Srikakulam and West Godavari in November 2017. The UC Berkeley-Andhra Smart Village Project has a strong relationship with each of the 472 villages since at least one village intern is working closely with the respective village community. Consistent one-on-one interaction and interviews enable great relationship building and lay out optimal conditions to conduct relevant and robust surveys in the context of the Smart Village initiative. A detailed analysis described below provides insights about pain points and the satisfaction with present dominant solutions for each relevant segment from the perspective of farmers in Andhra Pradesh.

1. Education on Modern Farming

The majority of farmers are presently using the knowledge of fellow farmers or ancestors as a source to educate themselves on farming practices. Additionally, education is offered by agriculture officers from the Government, which every fourth farmer is using. Along with not having access to relevant programs and high expenses in terms of costs and time, the perception about the ineffective and inconsistent education on farming overweighs as a major reason (40%) for an overall dissatisfaction. Although Government is facilitating multiple programs on modern farming, a large number of farmers (88%) are unsatisfied[19] with the available education programs on modern farming. To compensate missing awareness and to address given pain points, existing education programs need to be complemented and improved upon to ensure effective learning and broad awareness about modern farming.

2. Pre-Harvest Phase

Timely information and planning assistance is crucial to each farmer in the pre-harvest phase during his crop cycle. Although Government is providing soil analysis and advisory for each farmer, only small numbers of farmers are using this service (27%). Still, 31% of the farmers are lacking access to soil analysis and advisory to determine the best crop type and seeds to use according to the soil properties. This means, technology involvement is relatively rare, which can lead to

---

[19] Dissatisfaction is derived by combining below average (1-3) and average (4-6) from the rating system, which measures on the scale from 1 (dissatisfaction) to 10 (satisfaction).

wrong crop planning and therefore to decreased yields. Consequently, the majority of the asked audience (93%) is not content with the existent solutions (i.e. from Agricultural Department (27%), local shopkeeper (18%) or fellow farmers (47%). There is a strong need to provide analysis and advice with digital technology.

During the pre-harvest phase, multiple inputs are needed to ensure successful agricultural operations for the whole crop cycle. Currently, farmers are using their own seeds and fertilizer (32%) or are getting needed supplies from local distributors (20%). In this context, every third farmer is facing too high seed costs. Farmers lack subsidized agricultural inputs due to a non-transparent access to resources or the present procedure to procure these inputs is perceived to be difficult. Moreover, farmers lack relevant agricultural gear and are not able to purchase new equipment as costs are too high (¼ of the farmers). Consequently, inefficient operations arise when farmers are more dependent on labor instead of leveraging efficient farming equipment.

In order to compensate for high operational costs or to afford new equipment, 52% of the farmers are dependent on the government in the way of subsidy or loans. Every third farmer faces the problem that the loan approval is taking too much time and paper work. Furthermore, high interest rates for loans (22%) and missing availability of small loans with relevant payback periods (18%) impede economic growth for small hold farmers. More suitable and seamless investment opportunities are hereby needed to address farmer's needs. Additionally, such initiatives act as incentives for farmers to facilitate modern farming approaches by transforming their traditional practices with digital enhancement.

In conclusion, almost 90% of all farmers are dissatisfied with existing pre-harvest solutions with respect to soil analysis and advisory services, acquiring agricultural inputs, access to agricultural equipment and getting agricultural loans.

3. Growth and Management Phase

When it comes to sustaining consistent growth of the crop, irrigation plays a crucial role. Almost two thirds of the farmers are currently getting their water supply through canal irrigation, whereas one sixth are irrigating their fields through water pumps in the studied area. However, a significant number of the interviewed farmers are still relying on rainfall as the only source for irrigation (20%). In general, large numbers of farmers (41%) are presently struggling to irrigate their fields in an efficient manner because of missing proper irrigation systems. Furthermore, inconsistent water supply is negatively affecting the growth of the crop (18%). The large majority of the farmers (80%) are thus dissatisfied with the existing irrigation solutions. Consequently, there is a great potential for adapting digital technology to improve irrigation for farmers.

In order to prevent diseases and to monitor the crop to better predict and increase the overall yield, farmers take informal advice from fellow farmers (47%) and every fifth farmer gets regular guidance from agricultural offices. Very few farmers are using digital technology for crop monitoring and disease prediction. Thus, every fourth farmer lacks proper advice on disease prediction and yield monitoring. In addition, maintaining and increasing yield requires the application of multiple products as well as the performance of various activities. Therefore, farmers face the difficulty of knowing, what type of fertilizer and pesticide to use (every third farmer) as well as being able to physically monitor their crop daily (21%). The majority of the asked audience (80%) is dissatisfied with the existing solutions for crop monitoring and for disease prediction/prevention in general.

4. Post-Harvest Phase

After harvesting, farmers are struggling to exchange their produce for a fair monetary income. Almost every second farmer is dealing with middle man issues, low market prices and inaccessible markets. Missing market access prevents farmers to increase their overall benefit. Currently, government (25%) or middle men (57%) are the most common buyers for agriculture produce. This leads to an overall dissatisfaction among the farmers (92%). Therefore, strong market linkages and logistics are needed, to empower rural farmers.

Conclusion. Past Agricultural Ecosystem

Private and public services, products and initiatives to date have been offered in an isolated manner to the farmers during the crop cycle. The Government provides a variety of solutions but it appears that the availability of these services is highly restrictive and fragmented (i.e. one person per Mandal is responsible for conducting & validating soil analysis), associated with limited access (i.e. long distances to travel for education programs) or poor understanding of customers' needs (i.e. when the government acts as the primary buyer for agricultural produce). Private companies provide individual solutions in isolation, but farmers seem to lack awareness as well as education and have limited financial help to incorporate these in their farming operations. Further, there is a complex integration across companies' individual solutions that most farmers are not capable of performing.

Overall, the existing ecosystem seems to struggle with solving the pain points of small farmers in rural India. Isolated approaches lead to aggregation of the overall costs, increase the complexity for the farmer, and decreases his overall profitability and happiness. To change the existing agricultural ecosystem, a more open, holistic and efficient system is therefore needed.

6. Vision for the future. An Open Innovation Agricultural Ecosystem

Our research hypothesis is that applying the Open Innovation approach and digital technology to the challenges of India's rural agricultural sector can solve most of the prominent pain points for rural farmers.

By facilitating collaborations among various relevant companies and creating an integrated solution for the farmers, the overall costs for the customers of these digital technologies (i.e. the rural farmers) decrease. In addition, a reduction in complexity, greater awareness and education will be fostered and therefore, the adoption of modern farming methods will increase among rural famers. This leads to improving yields, to self-sustainable empowerment within the agricultural sector, and an increase in well-being and happiness.
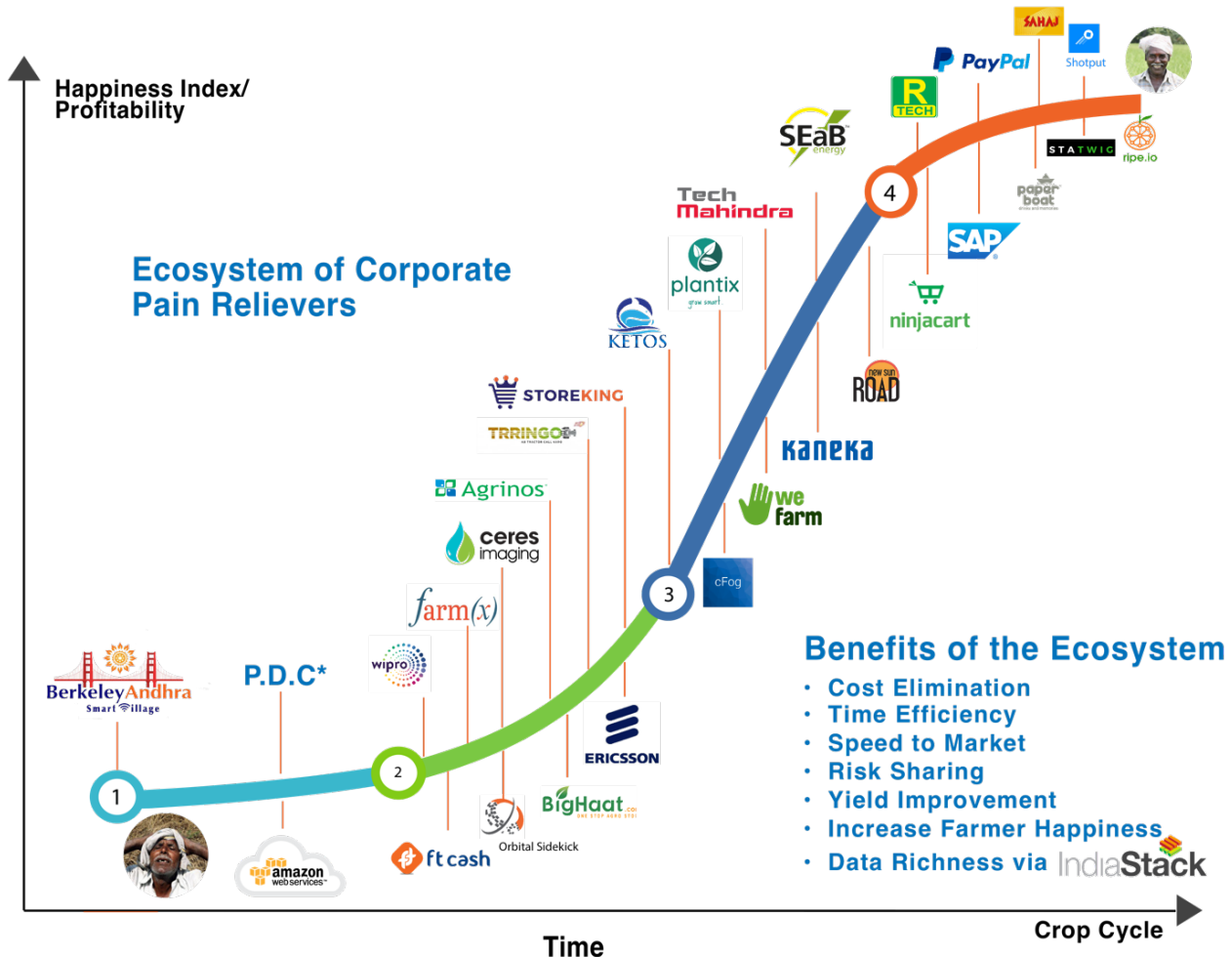
"Open Innovation in emerging economies is now happening in villages – not in the Ivory Towers of Silicon Valley."

Solomon Darwin, Executive Director Garwood Center for Corporate Innovation, University of California, Berkeley, Haas School of Business

Illustration II: Open Innovation Agricultural Ecosystem

This special organization and execution is required to conduct research and pivot ideas in the 472 villages working with various units of the Government of Andhra Pradesh and the ecosystem of participating companies.

Organizational Chart
UC Berkeley – AP Govt.

HONORABLE CHIEF MINISTER - Chairman

EXECUTIVE BOARD – UC Berkeley & AP Govt.

SMART VILLAGE TEAM

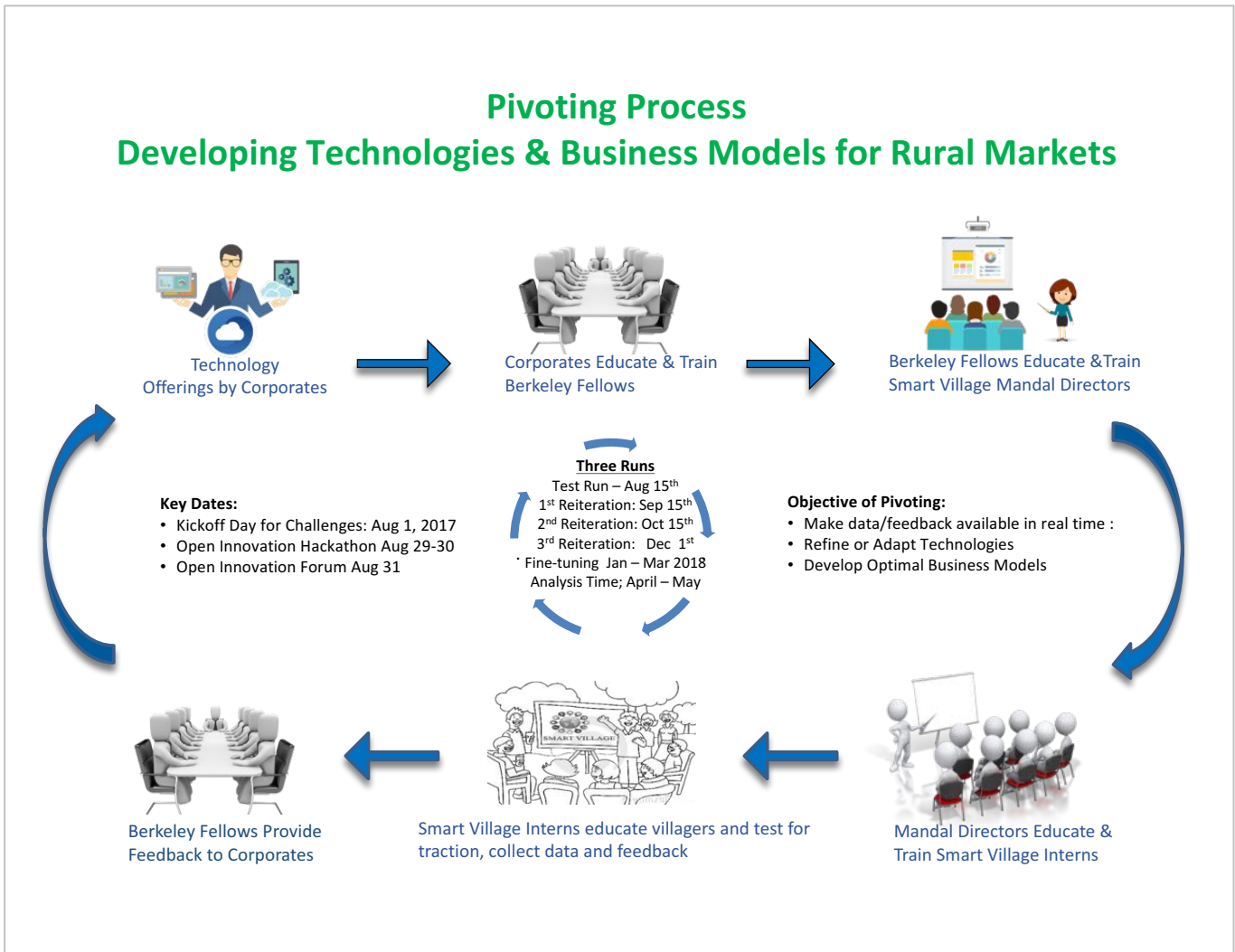| SRIKAKULAM			EAST GODAVARI			WEST GODAVARI			KRISHNA			CHITTOOR		
DISTRICT COLLECTOR			DISTRICT COLLECTOR			DISTRICT COLLECTOR			DISTRICT COLLECTOR			DISTRICT COLLECTOR		
Villages	Mandal Province	Village Interns	Villages	Mandal Province	Village Interns	Villages	Mandal Province	Village Interns	Villages	Mandal Provinces	Village Interns	Villages	Mandal Provinces	Village Interns
54	2	108	13	1	26	15	1	30	23	2	46	48	1	96
89	2	178	11	2	22	13	2	26	14	2	28	64	2	128
42	2	84	16	2	32	20	2	40	31	2	62	38	1	76
43	2	86	08	2	16	14	2	28	33	1	66	60	2	120

Smart Village Team

Berkeley Faculty   =   2
Berkeley Fellows   = 10
Province Directors = 34
Village Interns   = 570

Others: Berkeley and Stanford Faculty and college volunteers

Illustration III: UC Berkeley Smart Village Organizational Chart

The Pivoting Process being applied to develop business models for participating firms through an approved co-innovation process:

Pivoting Process
Developing Technologies & Business Models for Rural Markets

Technology Offerings by Corporates

Corporates Educate & Train Berkeley Fellows

Berkeley Fellows Educate &Train Smart Village Mandal Directors

Key Dates:
- Kickoff Day for Challenges: Aug 1, 2017
- Open Innovation Hackathon Aug 29-30
- Open Innovation Forum Aug 31

Three Runs
Test Run – Aug 15th
1st Reiteration: Sep 15th
2nd Reiteration: Oct 15th
3rd Reiteration: Dec 1st
Fine-tuning Jan – Mar 2018
Analysis Time; April – May

Objective of Pivoting:
- Make data/feedback available in real time :
- Refine or Adapt Technologies
- Develop Optimal Business Models

Berkeley Fellows Provide Feedback to Corporates

Smart Village Interns educate villagers and test for traction, collect data and feedback

Mandal Directors Educate & Train Smart Village Interns

Illustration IV: UC Berkeley Pivoting Process

7. Value Proposition of the Open Innovation Agriculture Ecosystem

Providing a holistic solution for farmer's pain points in each relevant segment requires the combination of resources, expertise and knowledge flows from multiple companies with objective facilitation by the Government. Therefore, the Open Innovation Agriculture Ecosystem can offer relevant solutions for all needed segments by consolidating the value propositions of over 24 participating companies.

Professional Development Center

Government endorsed but corporate run PDC's (Professional Development Centers) organized by the Berkeley-Andhra team addresses unemployment and missing education in rural areas. Over 20 national and international corporations and industry experts have signed up to offer certificated programs in a broad variety of courses to equip the rural population for economic development. Each curriculum provides theoretical training, access to tools and resources for practical project work, certification and placement coaching. A UC Berkeley PDC Corporate Board ensures overall quality standards, timely delivery, curriculum execution and partners with the World Bank for state-wide scaling. The PDC programs offer innovative, relevant and low cost, high value courses to build entrepreneurs, place people and create awareness for digital technology. Corporate partners benefit from such participation by creating skilled and certified laborers for their operations in emerging markets.

Until June 2018, five Professional Development Centers will be piloted in the respective five Districts of Andhra Pradesh: Srikakulam East Godavari West Godavari Krishna and Chittoor. After successfully piloting this initiative, a state-wide adoption will follow.

1 Education

Company	Course Content
1. Collabera	IT / Staffing
2. Dell	IT / Hardware
3. IBM	Artificial Intelligence
4. Creya	Design Thinking
5. Hero & Hella	Automotive
6. Hitachi & Tyco	Electronics
7. Tech Mahindra & OSSS	Employment & Skill Development
8. Care & Apollo Hospital	Healthcare
9. Ambuja Neotia	Construction
10. USHA	Tailoring
11. Global 3D Labs	3D Printing
12. BigHaat, Agrinos & Plantix	Agriculture
13. C-Fog	Agriculture & IoT Systems

Farmers are offered courses on modern agriculture, disease diagnosis and advice or yield improvement using new fertilizer technologies. The agriculture courses are designed based on existing pain points such as time, costs and inconsistency with the crop cycle. Thus, 95% of the 10,000 farmers interviewed showed high interest in attending agriculture courses from the PDC initiative.

"Dell EMC is pleased to support the UC Berkeley project for developing new business models for global brands to participate in untapped rural markets in India. At the core of every new business model is the ability to exploit new technology. Dell Technologies, as the largest provider of essential IT infrastructure technology, is always interested in how that technology will translate in to real world impacts. We anticipate that large firms will increasingly impact emerging economies across the ecosystem, and our partnerships in research and education with Berkeley will help us understand and influence this trend."

John Roese, President, Dell EMC

Pre-Harvest, Growth & Management and Post-Harvest Phase

Combining and consolidating isolated solutions from relevant, innovative companies with Open Innovation business models is a unique approach to address the farmers' pain points (derived from the agricultural survey). The key objective hereby lays in ensuring a simple integration across companies' individual solutions.

Consequently, farmers can easily perform and utilize services during the pre-harvest phase with flexible and hassle-free loans, access to farm analysis and advisory in real time, receiving the correct agricultural inputs in a transparent and efficient way, access to high efficient agricultural equipment on a rental basis. An ecosystem approach for the pre-harvest phase is preferred and highly appreciated by nearly every farmer (90%) from the surveyed audience.

To this date, applying Open Innovation in an ecosystem formation is fully integrated among five agricultural companies with the main scope on the pre-harvest phase and growth & management phase. It is intended to be continuously extended and improved upon. BigHaat, India's largest one stop digital store for agriculture inputs, is facilitating accessibility for quality products

	Company	Value Proposition
Loans	1. Wipro	Providing micro loans with low interest rates for farmers by using blockchain reputation system.
	2. FT Cash	Empowering farmers and entrepreneurs through financial inclusion using digital payments and loans.
Farm Analysis and Advisory	3. FarmX	Precision Agriculture solutions to optimize farmers yield by rich data analytics in farm management.
	4. Orbitalsidekick	Developing a space based hyperspectral sensor infrastructure to provide data that helps with yield estimation and precision farming.
	5. Ceres Imaging	Spectral imagery technology to provide data for yield estimation and precision farming.
	6. Ericsson	Connected Aquaponics and Water Grid Management IoT solutions to improve farmers yield and to optimize water distribution.
Agri Input & Equipment	7. Agrinos	Highly effective 'Green Biofermentation Technology' products with unique Plant Growth Promoting Microbes and Biostimulants to deliver greater crop yields and crop quality.
	8. BigHaat	India's largest one stop digital store for agriculture inputs to facilitate accessibility for quality products and knowledge.
	9. Trringo	Revolutionary tractor and farm equipment rental business making farm mechanization accessible, affordable and reachable to every farmer.
	10. Storeking	Transforming already existing small stores to digital access points for rural India.

Pre-Harvest (2)

and knowledge. In this ecosystem, BigHaat acts as a smart, central marketplace and supplier for various agriculture inputs. In order to address great demand for organic agriculture produce and to provide high quality organic fertilizer supply to a vast number of farmers, Agrinos now distributes their products through BigHaat. Agrinos, a US-based company, provides highly effective green bio fermentation technology products to increase crop yields and quality. In addition, BigHaat is collaborating with technology solution provider related to the farming sector. C-Fog offers shrimp farmers valuable information on critical parameters like PH-Level and DO-Level with respect to the pond water. To make the system self-sustainable and independent of power grid, C-Fog therefore collaborated with Kaneka, a Japanese high quality solar panel manufacturer. Combining complementary expertise and resources provides eventually an optimal solution for this case.

"Agrinos contributes the most modern approaches to sustainable farming available to farmers around the world"
Douglas Ry Wagner, PhD, CEO of Agrinos

Such system detects e.g. viruses or diseases of shrimps in real-time and gives advice, which specific medicine to immediately apply. By collaborating with BigHaat, the farmer does not need to worry about getting needed supply. He gets displayed the specific medicine and can directly order it through BigHaat. Door step delivery ensures easy access and overall order fulfillment. Another similar market linkage for farmers is provided through Plantix, a German based company, which lets farmers diagnose plant diseases by taking pictures of the infected crop. By collaborating with BigHaat, the farmer can now directly purchase the proposed fertilizer or pesticides from BigHaat.

This agriculture ecosystem shows that Open Innovation in ecosystem formation works in the rural context and creates a mutual benefit for the customer and the participating companies. Competing companies and complementary industry sectors converge to exchange knowledge and provide unique customer solution for rural farmers. Such ecosystems are difficult to imitate, this leads to competitive advantages for participating parties. From the transactional cost perspective, collaborations generate scale, which effects and minimizes risks by sharing investment costs. Collaborations diversify the product and service portfolio by combining expertise and resources. This leads to an accelerated speed to market[20] and to better and more innovative solutions, which serve the majority of the less fortunate.

3 Growth & Management

	Company	Value Proposition
Monitoring and Managment	1. Pre-Harvest Solutions	FarmX, Orbitalsidekick, Ceres Imaging, Ericsson
	2. Ketos	Provides farmers with real-time, actionable data on water usage, pressure and quality/safety through remote, continuous automated smart monitoring.
	3. C-Fog	Integrated approach to aqua farming using IoT sensors, machine learning and predictive analysis to provide actionable insights to increase shrimp yield.
	4. Plantix	AI-Driven Mobile Crop Advisory Application which can diagnose plant diseases, pest and nutrient deficiencies.
	5. WeFarm	Sharing vital information for farmers to improve lives without access to the internet.
Energy Provider	6. TechMahindra	Smart Energy Micro Grid Systems for Village to improve reliability and quality of power supply.
	7. Kaneka	Transforming every household and farm into renewable energy producer and user by providing high quality solar solutions without up-front investment.
	8. SeAB	Modular easily configurable and scalable waste management systems to address bio waste to provide energy, fertilizer and bio gas in return.
	9. New Sun Road	IoT-powered operations and management platform for renewables-based power systems such as village microgrids and commercial or agricultural productivity centers

Sustaining growth of the crop is dependent on several crucial parameters. Building on the solutions from the Pre-Harvest Phase, which enable information richness as well as general farm controlling through smart sensors and actuators, relevant solutions are integrated to address farmer's needs within the Growth and Management Phase. Over 85% farmers agree that receiving smart advice about their automated irrigation system is a helpful resource. Moreover, monitoring crops without being physically present, predicting and preventing diseases enhance the farmers capability to increase their overall yield. Surveyed farmers (86%) have shown keen interest in the implementation of such an integrated system.

Despite the regular power supply from the main station to the substations, there are frequent power cuts from the substations to rural homes and businesses especially during summer and rainy seasons due to outdated infrastructure. This prevents farmers from performing their daily farming activities, especially during the Growth and Management Phase and beyond.

---

[20] Source: Glaister, Buckley 1996. Strategic Motives for International Alliance Formation.

Micro Grid systems for villages combined with high quality solar panels along with revolutionary bio-to-energy systems assure reliable energy supply in an ecofriendly and self-sustainable way. The farmers, and the whole village community benefit from such initiatives, and are equipped with reliable green energy.

After harvesting with innovative and efficient technology support, farmers now face multiple options to distribute their agricultural produce within the Post-Harvest Phase. Transparent market access, and various distribution channels empower the agriculture sector by eradicating the dependency on middle men and limited access to market. Digital technology improves throughout the supply chain; value chain paves the way for the future. Supply chain transparency increases the profits for the farmer, as a result, consumers are willing to pay more due to increased awareness of the product's origin. Over 9,000 of interviewed farmers (90%) highly appreciated these solutions to address their needs in the Post-Harvest Phase.

The conducted agricultural survey demonstrates that the majority of the farmers in Andhra Pradesh (90%) has accepted the UC Berkeley Open Innovation Ecosystem and is interested in adapting and using the offered solutions to their farms. All five districts show high interest. Furthermore, nearly 60% of the overall asked audience are willing to invest in using and deploying the Open Innovation Agriculture Ecosystem.

These results are independent of the educational background or the geographic location (see Appendix). 60% of the farmers are not satisfied with their income level and every second farmer perceives that agriculture is a low-income profession. However, UC Berkeley's research and surveys show that farmers are ready to implement Open Innovation research findings in agriculture for rural India. Therefore, the Open Innovation Ecosystem will empower and add value to the agricultural sector of Andhra Pradesh, and eventually across whole India.

Post-Harvest

Company	Value Proposition
1. R-Tech	Innovative certified tree climbing solution to empower coconut industry.
2. Ninjacart	India's leading Agri Marketing platform connecting farmers directly with businesses through smart supply chain.
3. PayPal	Providing a virtual digital mall solution for villagers and farmers to display their products to access new markets and customers.
4. SAP	Providing access to national markets by connecting Entrepreneurs to the largest b2b tradeplatform
5. Sahaj	Information center for villages to provide multiple electronic services for the rural population.
6. Paper Boat	Juice company using local farmer supply to provide authentic, indigenous and traditional beverages.
7. ShotPut	Simplifying commerce and logistics with hi-tech operations.
8. ripe.io	Provide full food supply chain transparency with blockchain technology.
9. StatWig	StaTwig is blockchain startup that uses Internet of Things (IoT) to record journey of the products across the supply chain from manufacturer to customer to create extra layer of visibility, transparency and authenticity.

8. Call to action: The path forward

University of California, Berkeley has engaged innovative solutions to problems that plague the rural world. Farming is one of the most crucial vectors in a smart village because it is what drives a village economy. Whether it's agriculture, horticulture, or aquaculture, there are pain points that the technologies introduced by UC Berkeley's corporate partners can address. Phase 2 of the smart village project will determine the solutions that benefit the villager through extensive on ground research and pivoting projects across five districts in Andhra Pradesh. UC Berkeley has created a unique opportunity for innovation in AP; It created an ecosystem that benefits companies, the government, and empowers the rural people with valuable solutions for their pain points. Through our strong presence in villages, the UC Berkeley partnered companies are incentivized to invested in rural Andhra Pradesh.

One example of this is KETOS, which provides a water analysis IoT network with end-to-end solutions, and conducted a pilot in the early stages of the smart village project deploying 20 devices in 20 locations and co-innovated with villagers, to find the best use case. Through the co-creation, KETOS developed an improved, advanced product that has abridged years of research and development.

Such projects, which involve private investments, are possible through sharing of knowledge across organizational boundaries to co-develop innovative solutions, which fit perfectly in the rural market of India. With such innovations, the government has a tremendous opportunity for accelerated rural development and digitalization that was otherwise only possible in metropolitan or developed urban hubs such as Hyderabad or Vishakhapatnam. This also gives government access to real-time data to govern people at pinnacle efficiency. All of this ultimately benefits the people through robust local economies, diversified financial options, employment options, and commercial options, and stronger morale. The people that create the backbone of the nation gain an increased happiness index and bolstered faith in a primed government driving a new, opportunistic market for national and international corporations and start-ups.

Phase 3 of the UC Berkeley Smart Village initiative is adopting these innovations in the entire state. Companies involved, are not only looking at the 472 villages in the Phase 2 market, but the opportunity to enter into the entire rural market in Andhra Pradesh during Phase 3. According to the Government of Andhra Pradesh the profession of farmers and artisans is the area with the most need for improvement. For men, the average daily wage is 299.66 per day, resulting below the poverty benchmark of 10,000 INR a month. For women, it is even less: 213.38 a day, about 6,500 a month.[21]

"Transforming a village through technology starts with empowering the people at the grass roots level in the rural areas. The Smart Village initiative driven through the Berkeley team setup locally in Andhra was a great partnership for the KETOS team to join forces and channel the best of people, talent, technology and resources to result with the right fit for every village and every individual in the new world."
Meena Sankaran,
Founder & CEO, Ketos Inc.

A farmer who was once sad, depressed, and oppressed by the mental and communal restraints is now uplifted through a digitalized delivery of solutions. The farmer gains education in UC Berkeley's Professional Development Center and corporate programs designed to improve farming techniques.

---

[21] Andhra Pradesh Socio Economic Survey 2016-17

She or he is now educated and has access to numerous applications to buy the correct and suitable agricultural inputs such as seeds, fertilizer and equipment.

Educated farmers walking through their now flourishing, lush farms can notice an abnormality on one of their plants and use their smartphone to scan for diseases and receive instant diagnosis and relevant solutions. IoT sensors and advanced imagery technology plug into a network of data sharing to provide real-time analysis of weather trends, soil hydrology mapping, nutrient levels, and nearby growth/disease patterns. This optimizes the farmer's growth and maintenance operations and peaks efficiency, effectiveness, and yields. This increase in knowledge and resources, which directly leads to sustainable empowerment, saves money and time for the farmer who cashes in the highest possible yield for more profits through digitalized supply chains. The once helpless farmer is now properly rewarded for the hard work and sweat put into his farm. Consumers cooking in their kitchen in small village communities or large metropolitans can now scan their food and appreciate the high-quality goods via the transparency given through revolutionary blockchain technology. The influx of money in agriculture is now incentivized to be used and reinvested in such advanced technology that provides quality standards for commercial buyers and consumers. Eventually, educated farmers and villagers equipped with digital tools have unimaginable potential to revolutionize the industry by making agriculture a lucrative field.

In Phase 3, this adoption will also come with new policy change such as redirection of welfare and aid funds towards new innovations, Private Public Partnerships, and subsidies for expensive but game changing and revolutionary technologies to pave the future for sustainable economic prosperity. While this new growth will continue upwards, the state must find new policies to keep up with growth pressure from national and international parties and possible repercussions such as inflation, fluctuation in buying power, increased property value etc.

Growth in urban hubs of India has recently been inevitable thus the vision for '100 Smart Cities' and the overall smart city trend in India.[22] However, through the smart villages concept, this may not be the case anymore. Increased employment opportunities in rural areas creates incentives for citizens of AP to settle in rural communities. This allows a complemented redistribution of funds to help develop rural areas, further incentivizing population settlement in smaller, but growing communities. Chief Minister Chandra Babu Naidu's administration will be looking to implement modern policies, a path that AP is already on. Phase 3 will be much more than scaling technologies to the rural world, but maintaining growth, production, and standard of living for the constituents bringing a score of opportunities of new research, knowledge and innovation. This is a unique holistic attempt to address the villages' pain points in all verticals by entrepreneurial driven Open Innovation business models.

---

[22] Source: https://economictimes.indiatimes.com/new-sections/social-infrastructure/india-in-need-of-a-structured-infrastructure/lifenologyshow/45305494.cms
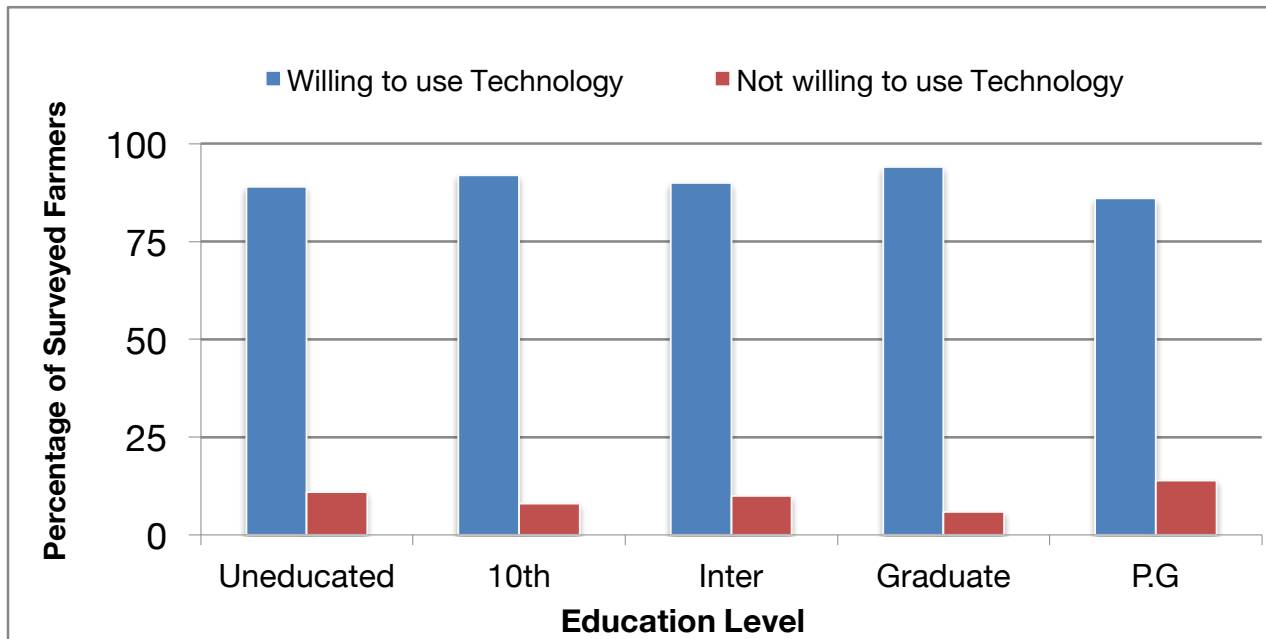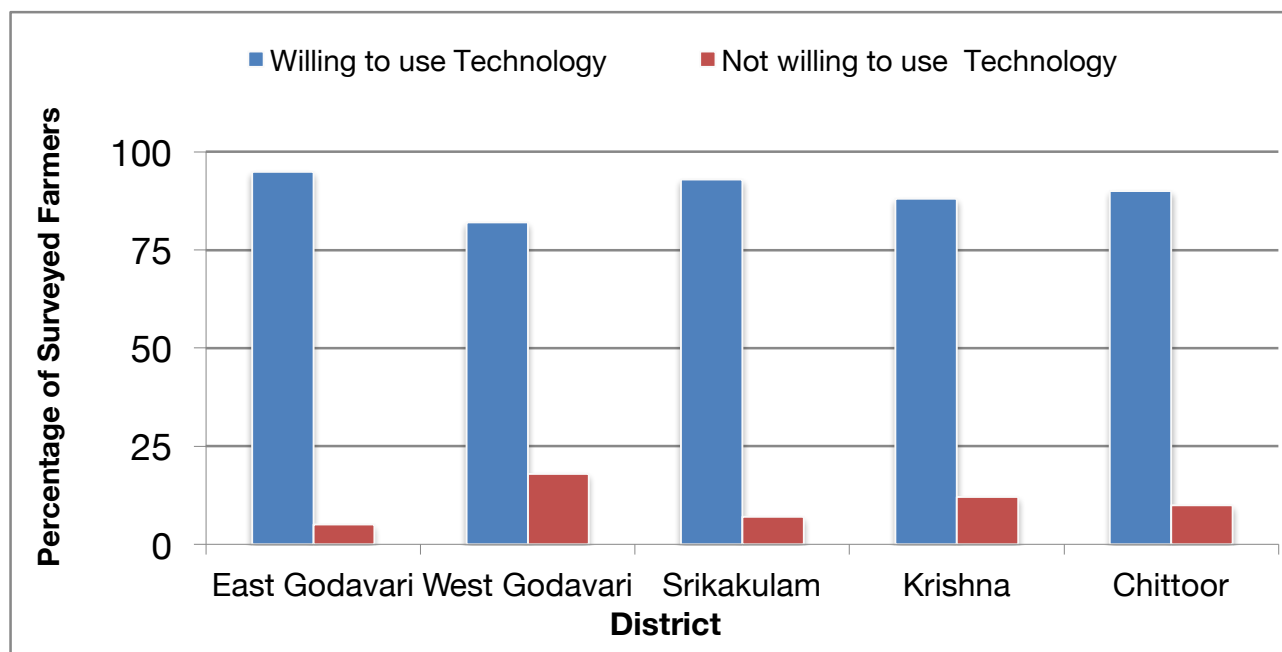
9. Appendix

9.1 Agriculture Survey Data

Overall Validation

1. 90% of the farmers would like to use the OI Agriculture Ecosystem for their farming operations.
   a. Results obtained are independent of the farmer's Education:

   b. Results obtained are independent of farmer's Geography (District) of the farmers:

2. 58% of the farmers are willing to invest in using and deploying the OI Agriculture Ecosystem.
    a. Results obtained are independent of the farmer's Education:
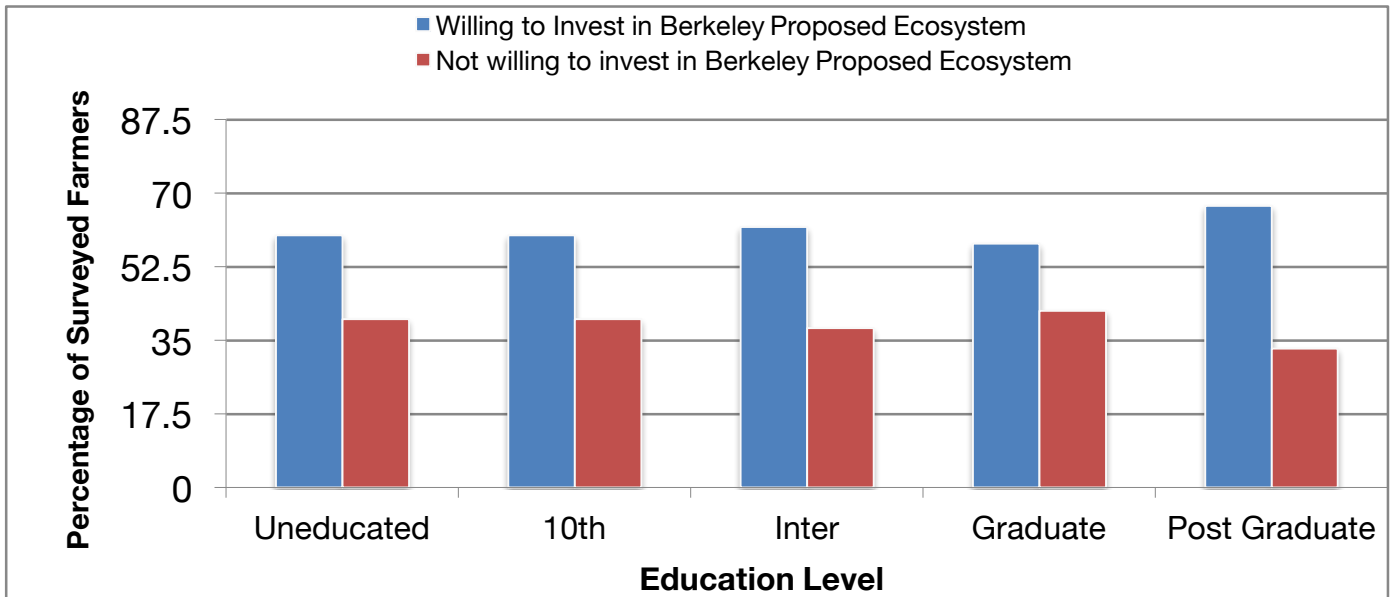
    b. Results obtained are independent of farmer's Geography (District) of the farmers:
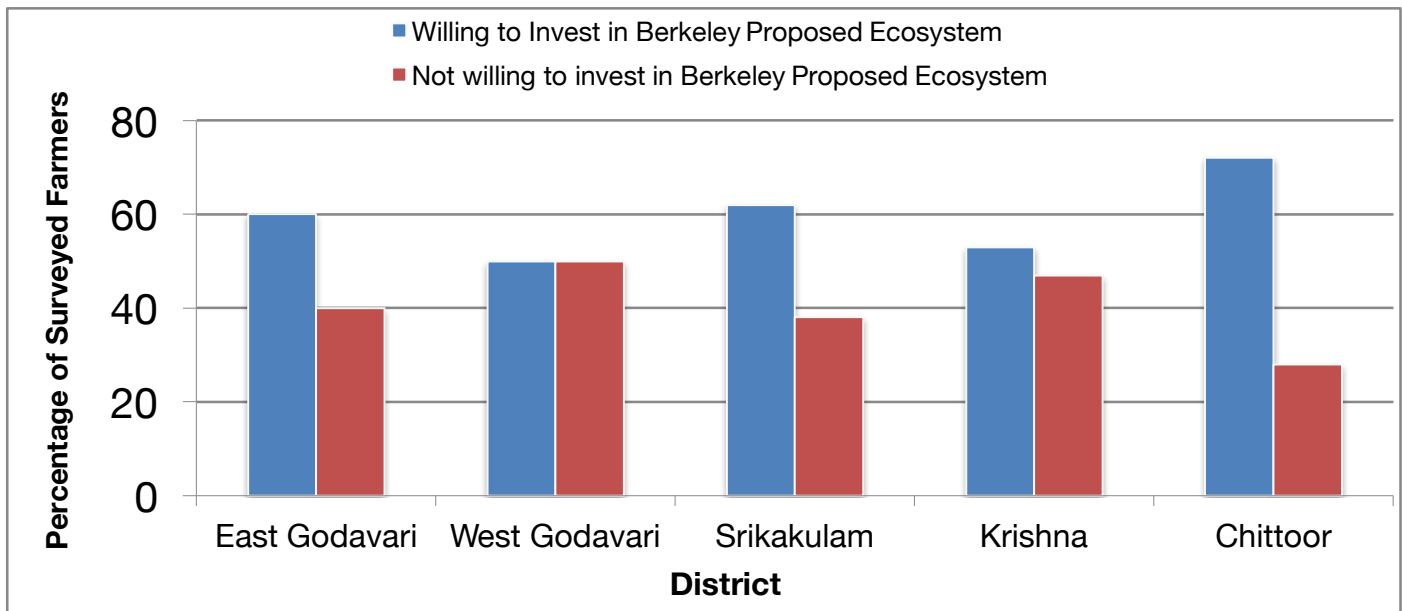
3. 60% of the farmers are not satisfied with the income level from farming operations.
4. 53% of the farmers think that the agriculture is a low-income profession.

Education on Modern Farming

Problems:
1. 40% of farmers finds the current education on farming ineffective and training on farming to be inconsistent
2. 20% of farmers skip farming education workshops due to time crunch and high travelling cost.

Current Solutions:
3. 47% of the farmers use knowledge acquired from fellow farmers and ancestors as source for education
4. 27% of the farmers are getting education from agricultural offices

Satisfaction Level on current education on modern farming:
5. 36.6% rated the current system as Below Average (1 - 3 Ratings).
6. 51.6% rated the current system as Average (4 - 6 Ratings).
7. 11.8% rated the current system as Above Average (7 - 10 Ratings).

Willingness to adapt the UC Berkeley proposed Model:
6. 95% of famers are interested in participating in PDC programs with respect to agricultural training.

Soil Analysis and Advisory

Problems:
1. 31% of farmers are lacking soil analysis and advisory.

Current Solutions:
2. 47% of the farmers rely on soil analysis from fellow farmers or ancestors.
3. 27% of the farmers are getting soil analysis and advisory from agriculture offices
4. 18% of the farmers are getting soil analysis and advisory from shopkeeper

Satisfaction Level on current Soil Analysis & Advisory:
5. 37% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
6. 56% of the surveyed farmer rated it to be Average (4 - 6 Rating)
7. 7% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
8. 86% prefer the soil analysis and advisory solution offered through the OI Agriculture Ecosystem

Acquiring Agricultural Inputs

Problems:
1. 34% of farmers stated High Cost Seeds as a major pain point.
2. 17% of farmers stated that they are unable to produce to full potential as there is no subsidy on seeds for them.

Current Solutions:
3. 32% of the farmers are using own seeds and fertilizers.
4. 20% of the farmers are getting their Agricultural inputs from local distributors on credit.

Satisfaction Level on current system for getting Agricultural Inputs:
5. 38% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
6. 52% of the surveyed farmer rated it to be Average (4 - 6 Rating)
7. 10% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
8. 85% prefer the OI Agriculture Ecosystem to get the correct Agricultural Input by home delivery.

Access and Using of Agricultural Equipment

Problems:
1. 24% of farmers lack farm equipment.
2. 15% of farmers find new equipment too expensive.
3. 15% of farmers face the labor shortage issue.

Current Solutions:
4. 55% of the farmers are renting equipment from local distributors.
5. 26% of the farmers are purchasing new equipment with the help of Government subsidies.

Satisfaction Level on current systems for accessing Agricultural Equipment:
6. 39% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
7. 50% of the surveyed farmer rated it to be Average (4 - 6 Rating)
8. 11% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
9. 88% prefer the OI Agriculture Ecosystem to get access to Agricultural Equipment on rental base.
10. 82% prefer the OI Agriculture Ecosystem to use automated equipment for their operations.

Financial Services

Problems:
1. 36% of farmers face the problem that approval of loans is taking too much time.
2. 22% of the farmers face to high interest rates for loans.
3. 18% of the farmers miss small loans with relevant payback periods.

Current Solutions:
4. 52% of the farmers depend on government loans.
5. 16% of the farmers are using loans from private institutions.

Satisfaction Level on current solutions for financial services (farming context):
6. 40% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
7. 47% of the surveyed farmer rated it to be Average (4 - 6 Rating)
8. 13% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
9. 88% prefer the OI Agriculture Ecosystem to get hassle free loans without paper work.

Monitoring and Harm Prevention

Problems:
1. 26% of farmers lack proper advice on yield/disease prediction.
2. 23% of farmers lack advisory on what type of fertilizer and pesticide to use.
3. 21% of farmers state that daily physical monitoring is difficult.

Current Solutions:
4. 47% of farmers take guidance from fellow farmers.
5. 19% of farmers say that there are regular crop visits from agricultural offices.

Satisfaction Level on current systems for Monitoring and Harm Prevention:
6. 58% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
7. 22% of the surveyed farmer rated it to be Average (4 - 6 Rating)
8. 20% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
9. 87% of farmers prefer the OI Agricultural Ecosystem to get advice on harm prevention and yield prediction.

Irrigation

Problems:
1. 41% of farmers lack proper irrigation systems.
2. 18% of farmers face inconsistent water supply.

Current Solutions:
3. 64% of the farmers get water supply through canal irrigation.
4. 20% of the farmers get water supply through rain fall.
5. 16% of the farmers get water supply through water pumps.

Satisfaction Level on current systems for Irrigation:
6. 34% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
7. 46% of the surveyed farmer rated it to be Average (4 - 6 Rating)
8. 20% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
9. 86% prefer the OI Agriculture Ecosystem to get an automated irrigation system and getting advice and monitoring

Market Access and Distribution

Problems:
1. 38% of the farmers are facing middle man issues.
2. 26% of the farmer are facing low market prices.

Current Solutions:
3. 57% of the farmers distribute their produce through middle man.
4. 25% of the farmers distribute their produce through government.

Satisfaction Level on current solutions for Market Access and Distribution:
5. 39% of the surveyed farmer rated it to be Below Average (1 - 3 Rating)
6. 53% of the surveyed farmer rated it to be Average (4 - 6 Rating)
7. 8% of the surveyed farmer rated it to be Above Average (7 - 10 Rating)

Willingness to adapt the UC Berkeley proposed Model:
8. 90% prefer the OI Agriculture Ecosystem to get transparent market access and better yield.

General Information: Educational Background

1. 70% of the farmers have less than high school education.
2. Out of these, 88% are willing to invest in the OI Agriculture Ecosystem.
3. 42 % of the farmers are tenant farmers
    a. 45% stated that they are missing support from the government.
    b. 27.5% stated high rental fees for renting the land as a major pain point
    c. 22% state missing recognition as farmers from their surroundings
4. 62.5% of the farmers cultivate on their own land

9.2 Bibliography

Solomon Darwin & Henry Chesbrough 2016. Prototyping a Scalable Smart Village to Simultaneously Create Sustainable Development and Enterprise Growth Opportunities. https://cb.hbsp.harvard.edu/cbmp/product/B5886-PDF-ENG

H. Chesbrough, 2003. Open Innovation: The New Imperative for Creating and Profiting from Technology, HBS Press: Boston, MA.

Michael E. Porter and Mark R. Kramer "Creating Shared Value," Harvard Business Review, 89/1-2 (January/February 2011): 62-77.

D. Moyo, 2009. Dead Aid: Why Aid Is Not Working & How There Is a Better Way for Africa, Farrar, Strauss & Giroux: NY.

C.K. Prahalad, 2005. The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits, Wharton Publishing; PA.

Singh, S. (2012) New markets for smallholders in India–Exclusion, policy and mechanisms, *Economic and Political Weekly,* 47**:** 95-105.

Mishra, S. (2008) Risks, farmers' suicides and agrarian crisis in India: Is there a way out?, *Indian Journal of Agricultural Economics,* 63(1)**:** 38-54.

Dev, S. M. (2005) Agriculture and rural employment in the budget, *Economic and Political Weekly,* 40(14)**:** 1410-1418.

Glaister, K., Buckley, P. (1996). Strategic Motives for International Alliance Formation. *Journal of Management Studies* 33:3, S. 301-332, 1996.