Roadblocks to Application of Blockchain in Indian Agriculture- A study on Madhya Pradesh

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Author's Declaration

I, the undersigned **Nikhil Dubey** hereby declare that I am the sole author of this thesis.

To the best of my knowledge this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted as part of the requirements of any other academic degree or non – degree program, in English or in any other language.

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ABSTRACT

This dissertation aims to examine the roadblocks (if any) that would challenge the future policy of blockchain in Indian agriculture. This work uses qualitative research methods and analyses the outcome of elite interviews and focused group discussion conducted in various agro-economic zones of the state of Madhya Pradesh. By conducting a stakeholders' analysis, the dissertation notes that, observing various aspects of agricultural sector in Madhya Pradesh, the time is ripe for the government to launch the blockchain policy on a pilot basis.

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This work of research would not have reached its conclusion without the guidance and assistance of a few noteworthy individuals. First and foremost, I am thankful to my supervisor Dr. Cameran Ashraf, who has been a consistent source of motivation and guidance since the beginning of my coursework at CEU. He helped me narrow down my research focus and gave direction to my research question.

I am further thankful to Alok Nayak whose insights on Blockchain gave me a better understanding of the area. The thought provoking discussions with him on IndiaChain gave life to my thesis.

Lastly, I am thankful to the Government of Madhya Pradesh as they allowed me to complete my research work and extended my joining date. Without them this thesis would not have reached its fruition.

Table of contents

Introduction

The current age of technology which began with the emergence of internet appears to be at a whole new level. Seldom, the whole world has been gripped by technology and its manifestations this intensively. Teenagers with a descent level of technological access are already information engineers even without an engineering degree. Colonies are being planned in space.[1] A multinational giant is sponsoring a project almost aimed at winning over death. And, if not enough, gene-editing has a substantial scope of become a household affair with CRISPR kits available online.[2] Things may sound a bit intimidating but not everything about this technological transformation is scary.

The subject matter of this dissertation is blockchain, a mechanism/technology which is changing the way data is stored and treated. The discussion on blockchain gained prominence with the emergence of Bitcoin, a cryptocurrency, that instead of being stored in banks is stored on electronic wallets. This decentralized peer to peer mode of payment is based on the technology of blockchain which uses encryption mechanics and consensus based games to store information which is tampering-proof. The technology of blockchain that laid the foundation of Bitcoin soon started to find its application in other areas where data played a critical role. The storage of histories has been central to our day to day lives and blockchain just makes it simple, transparent and cost-effective. For instance, the emergence of double-entry book keeping in 15th century transformed the manner in which information vis-à-vis the wealth of individuals or group of individuals was stored by third party accountants or banking

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[1] McCray, W. Patrick. *The visioneers: how a group of elite scientists pursued space colonies, nanotechnologies, and a limitless future*. Princeton University Press, 2013.

[2] Kuiken, Todd. "Learn from DIY biologists: the citizen-science community has a responsible, proactive attitude that is well suited to gene-editing." *Nature* 531, no. 7593 (2016): 167-169.

institutions.[3] However, for managing this information and hiring professional accountants for the purpose, huge sums have to be paid to the parent banks. Also, the data and figures in this mode could be fudged on the discretion of the accountants and auditors. The financial crisis of 2008 is the most recent example of the same.[4] It is here that blockchain gains provenance. By being a peer to peer mode of database management, blockchain creates a decentralized database. The storage of information takes place with the consensus of blockchain managers or miners who take part in updating the ledgers to get the devised incentives. And hence, any manipulation of the stored information without consensus is rejected by the software in use.

Blockchain, hence, marks a novel way of database management. From the discussion above it would appear that the technology of blockchain only has its application in the financial sector. However, the essence of blockchain lies in its ability to provide a data management solution that is decentralized and immutable to tampering.[5] This characteristic of blockchain has invited attention from stakeholders coming from a range of other fields. Storage of voters' identity information in blocks makes the electoral data immune to fudging, paving way for fair and transparent elections. [6] Similarly, in health sector, blockchain has application in drug traceability, improvement and authentication of health records, promoting smart contracts for the treatment of patients and electronic health records management. [7] Furthermore, large

[3] Yamey*, Basil S. "The historical significance of double-entry bookkeeping: Some non-Sombartian claims." *Accounting, Business & Financial History* 15, no. 1 (2005): 77-88.

[4] McSweeney, Brendan. "The roles of financial asset market failure denial and the economic crisis: Reflections on accounting and financial theories and practices." *Accounting, Organizations and Society* 34, no. 6-7 (2009): 835-848.

[5] Walsh, Clara, Philip OReilly, Rob Gleasure, Joseph Feller, Shanping Li, and Jerry Cristoforo. "New kid on the block: a strategic archetypes approach to understanding the Blockchain." (2016).

[6] Koven, Jackie Burns. "Block The Vote: Could Blockchain Technology Cybersecure Elections?." *Forbes. Accessed December* 14 (2016).

[7] Ekblaw, Ariel, Asaph Azaria, John D. Halamka, and Andrew Lippman. "A Case Study for Blockchain in Healthcare:"MedRec" prototype for electronic health records and medical research data." In *Proceedings of IEEE Open & Big Data Conference*, vol. 13, p. 13. 2016.

multinationals such as IBM are already investing on blockchain projects in supply chain management and logistics.[8] The field is wide open.

The area which is, however, central to the scope of this dissertation is agriculture. In February 2018, NITI Aayog, the primary thinktank of the Government of India announced IndiaChain.[9] The goal of this project is to create a nation-wide blockchain network. This announcement primarily followed the 2018-19 budget speech of the finance minister of India in which he made two slightly conflicting announcements. The finance minister held that cryptocurrencies are not to be treated as 'legal tender' as per the directions of the Reserve Bank of India. However, the finance minister simultaneously argued in favor of the blockchain technology and its application in making India a digital economy. IndiaChain, thus, appears to create a nationwide blockchain network. The areas where NITI Aayog envisages blockchain penetration include digitization of certificates, education, creation of land records, electricity distribution and agriculture.[10] The idea, it appears, is to make the most of this internet 2.0 era.

The reason for selecting agriculture as a subject matter for this dissertation is the critical position it occupies in the Indian socio-economic and political landscape. The 2011 national Census holds that over 60% of the Indian population is still largely rural and out of which around 70% is still dependent on agriculture for its livelihood.[11] With an estimated GDP growth rate for the current year to be 7.3%, the agricultural sector is estimated to grow at a meagre 2.1%.[12] The poorly performing agricultural sector which employees more than half the Indian

[8] Ibid.

[9] Niti Aayog eyes use of blockchain technology , The Economic Times, Jan 04 2018, retrieved from https://economictimes.indiatimes.com/news/economy/policy/niti-aayog-eyes-use-of-blockchain-technology/articleshow/62360134.cms

[10] Ibid.

[11] Chandramouli, C., and Registrar General. "Census of India 2011." *Provisional Population Totals. New Delhi: Government of India* (2011).

population is a key policy issue for the Government of India. The sector is plagued by a number of systemic impediments. The Indian agricultural productivity per unit of land is one of the lowest among the emerging economies.[13] Due to the low productivity, the majority of the rural population (around 70%) is below poverty line. The government policy intervention to tackle rural poverty appears to fail in every successive policy cycle due to leakages and rampant corruption. Further, the lack of technical know-how and excessive subsidies on fertilizers resulted into the quality of soil degrading crop after crop. These challenges and the promise of blockchain technology to effectively mitigate them encouraged this study.

The state of Madhya Pradesh has been selected for field study for a variety of reasons. Firstly, this is the state where I come from and hence, possess a significant demographic and policy understanding of the same. Secondly, the state population is predominantly dependent on agriculture for its livelihood. The state occupies the topmost position in the production of oilseeds and pulses.[14] Madhya Pradesh has observed an agricultural growth rate of 18% p.a. which is highest in the country. The state has further surpassed rich agrarian states like Punjab and Haryana in terms of annual wheat production.[15] These figures are reflective of the importance of the agricultural sector for the state's economy and that of the state's position in the overall agricultural sector of India. Any policy intervention in the agricultural sector will, thus, have a direct relevance to the state and its people.

This thesis draws its theoretical framework largely from the theory of good governance. The international development paradigm in the beginning of 1990s stressed the importance of a

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[13] Ray, Deepak K., Nathaniel D. Mueller, Paul C. West, and Jonathan A. Foley. "Yield trends are insufficient to double global crop production by 2050." *PloS one* 8, no. 6 (2013): e66428.

[14] Shukla, A. K., M. C. Meena, P. K. Tiwari, C. Prakash, P. Singh, G. S. Tagore, H. K. Rai, and A. K. Patra. "Current status of micronutrient deficiencies in soils and crop-specific recommendations for different agro-climatic zones of Madhya Pradesh." *Indian J Fert* 12 (2016): 26-35.

[15] Ibid.

governance model that is effective, efficient, participative, transparent and responsive in form. International organizations such as the World Bank, United Nations Development Program and Organization for Economic Cooperation and Development started conditioning their aid to countries which according to them embraced the principles of good governance. It can be argued that blockchain technology has a strong essence of transparency. This is because the database is immune to external manipulation. Further, if the blockchain model adopted is a decentralized one, participation is also encouraged.

The core goal of this research work is to study the attitude of various stakeholders involved in the agricultural sector towards technology in general. Further, as per the NITI Aayog, the foundation of IndiaChain would be the trinity of bank account, unique identity number and mobile phone number of an individual.[16] The name given to this trinity is JAM, expanded as Jan Dhan, Aadhar and Mobile, first two being the names of government schemes on universal banking and unique identity number for every Indian citizen respectively.[17] These would be linked together to create a robust blockchain database. Hence, the study makes an attempt to gauge the understanding of the agrarian population in Madhya Pradesh on the three foundational elements of the blockchain. I argue that the success of any policy on blockchain depends on the degree of understanding the beneficiaries have on the three foundational elements stipulated above. Each element is critical in its own right for the effective penetration of blockchain in the agricultural sector as a whole and to simultaneously garner benefits from it.

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[16] Niti Aayog eyes use of blockchain technology , The Economic Times, Jan 04 2018, retrieved from https://economictimes.indiatimes.com/news/economy/policy/niti-aayog-eyes-use-of-blockchain-technology/articleshow/62360134.cms

[17] **JAM (short for Jan Dhan-Aadhaar-Mobile) trinity** is a government of India initiative to link *Jan Dhan* bank accounts, Mobile numbers and Aadhar cards (biometrics based unique identity) of Indian citizens to minimize the leakages of government subsidies.

The study utilizes qualitative tools of research methods. I conducted focused group discussions in different agro-economic zones of Madhya Pradesh. Simultaneously, I conducted a few expert interviews of a range of other stakeholders. These include government officials at the block level, head of a bio-fertilizer company, village headmen and founder of a blockchain startup in India. I also intended to conduct a questionnaire survey but due to the paucity of time and resources, this could not be realized. The study hence, largely remains a qualitative one.

Chapter 1 – In Blockchain we trust?

In 2008, an entity by name Satoshi Nakamoto, conceptualized Bitcoins. Occupying everyday news headlines today, Bitcoins is regarded as a currency of trust. A currency of trust, simply stated, would be one that could be transacted in a peer to peer manner without any third party controlling the transaction at any stage. Nakamoto's Bitcoin promised to achieve the same by proposing an algorithm backed virtual currency.[18] Any data that is relevant to any transaction made in Bitcoins is stored in blocks (files) that store information which is encrypted and hence cannot be tampered with.[19] This mechanism of storing encrypted information or data without the assistance of a third party on files called blocks, is called blockchain. The use of *chain* symbolizes the connection of several blocks of information together to enable the creation of a database that has information pertaining to every stage of a transaction.

What began as a technological basis of Bitcoin has transformed into an independent area of interest within its own right. Blockchain based applications are causing sectoral disruptions that appear to be all-pervasive and all-encompassing. The aim of this chapter is to place blockchain in a larger framework beyond Bitcoin. This chapter, thus, aims to give an idea about the past, present and anticipated future, of the blockchain technology. The inter-sector application of the blockchain is discussed to explain the attention that the technology has attracted from scientists, investors, banks and, governments alike.

When Bitcoin was introduced in the public domain, blockchain was merely seen as the core technological foundation guiding it. The research interest in blockchain, therefore, largely moved parallel to that in Bitcoin and other cryptocurrencies. However, blockchain as a technology soon came out of its exclusive application in cryptocurrencies. The ability to create

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[18] Nakamoto, Satoshi. "Bitcoin: A peer-to-peer electronic cash system." (2008).

[19] Ibid.

a distributed ledger, immune to manipulation, through a self-sustaining peer to peer method without involvement of any third party, found its application in many other fields ranging from as cryptic as gambling to as humanitarian as bringing the unbanked in the financial system.

1.1 Reforming the Health Sector through Blockchain

Deloitte, a leading consultancy service provider, in 2016 published a report on the application of blockchain in reforming the healthcare's information technology infrastructure. The report held that with the application of blockchain, data exchanges from digital health records, electronic health devices and Internet of Things (IoT) devices can take place in a safe and secure manner.[20] Following such observations, IT conglomerate IBM and the U.S. Food and Drug Administration (FDA), have already collaborated to promote research on blockchain and its application on agriculture. Conn (2016) regards the significance of blockchain technology in reforming the manner in which exchange of sensitive patient-information can take place for healthcare research. This can improve claims-adjudication and make it less time consuming for the patients, hospitals, insurance companies and the governments.

Benchoufi and Ravaud see blockchain technology reforming the clinical research quality.[21] They see *smart contracts*, which are automated contracts backed by blockchain, playing a key role in securely automating the clinical trials which are to date plagued by lack of ethics. Blockchain can further impart reliability to clinical studies as it improves the traceability of information at every stage of a clinical trial. The terms of the trial, consent, primary and secondary outcomes and other relevant information can be saved on the blockchain metadata. Blockchain makes this information inviolable and hence, imparts transparency to the whole

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[20] Shelkovnikov, Alexander. "Blockchain applications in the public sector." *Deloitte, available at: https://www2. deloitte. com/.../ch-en-innovation-deloitte-blockchain (accessed 3 August 2016).[Google Scholar]* (2016).

[21] Benchoufi, Mehdi, and Philippe Ravaud. "Blockchain technology for improving clinical research quality." *Trials* 18, no. 1 (2017): 335.

procedure. Currently, the research on the application of blockchain in health sector is at its nascent stage. However, as multinational giants such as IBM, Microsoft and the Linux Foundation are showing interest in the field, significant leaps are visible.[22]

1.2 Educating through Blockchain

The application of blockchain technology in the education sector is a fascinating thought. If the technology could penetrate the education sector as planned, it will have a revolutionizing effect on every other sector considering the close linkage of education sector with anything else that exists. According to Tapscott and Tapscott, blockchain can play a disruptive role in the higher education sector.[23] By the time a student finishes their higher education, there is a bundle of data they have inherited without any conscious effort. This data ranges from their birth certificate issued by the corresponding medical authority to their academic transcripts issued by the institutions they have attended over the years. There are multiple issues with this valuable data every student owns.

Firstly, such a data is required by the student at every stage of their academic or career progress. Companies require such data to select candidates suitable for jobs. Universities require such a data to grant admission to prospective students. However, the task to verify the authenticity of such information provided by the candidates is a costly and time-taking exercise.[24] Secondly, on the student's side, the security of their information is critical. There are ample instances of this information being compromised through the database of several

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[22] Cachin, Christian. "Architecture of the Hyperledger blockchain fabric." In *Workshop on Distributed Cryptocurrencies and Consensus Ledgers*. 2016.

[23] Tapscott, Don, and Alex Tapscott. "The impact of the blockchain goes beyond financial services." *Harvard Business Review* 10 (2016).

[24] Ibid.

universities. It is here that blockchain could prove to be quite valuable. By allowing for the information to be restored on encrypted files, blockchain can pace up things in the higher education and job sector. The technology can could possibly promote fairness and prevent fudging of academic credentials and work experience related information of candidates.

Further, blockchain could also play a role in changing the age old redundant pedagogy. According to Charles Vest, the age of internet could usher in the era of meta-universities.[25] These universities would assemble the best study materials and guidance from across the world and allow the students from world over to customize that based on their requirements. Blockchain could make this a reality. Tapscott and Williams believe that blockchain can catalyze the creation of 'global network of higher learning'. The arrival of internet and its easy access is already changing the way education is getting delivered to those who cannot afford expensive courses in universities. Massive Open Online Courses (MOOC) are delivering low cost quality education to the last mile.[26] If blockchain could be viewed as internet 2.0, the disruption it could possibly cause in the education sector is unthinkable.

1.3 Lubricating Supply Chain Management through Blockchain

Burke and Vakharia identify the role of Supply Chain Management (SCM) as facilitating the delivery of right products or services at the right place in the right quantity for the right price.[27] However, seldom this righteousness is maintained in our modern supply chains.[28] A University of Michigan report (2016) of key issues with Supply Chain Management notes that compliance

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[25] Vest, Charles M. "Open content and the emerging global meta-university." *EDUCAUSE review* 41, no. 3 (2006): 18.

[26] Tapscott, Don, and Anthony D. Williams. "Innovating the 21st-century university: It's time." *Educause review* 45, no. 1 (2010): 16-29.

[27]

[28] Burke, Gerard J., and Asoo J. Vakharia. "Supply chain management." *The internet encyclopedia* (2004).

at various stages in a supply chain is a missing factor. Several firms fail to meet their compliance targets and this effect the quality of the end product. Further, supply chains currently are crowded with 'n' number of intermediaries. In order to extract gains at every stage of the supply chain these intermediaries distort the compliance mechanism at various stages of the supply chain. Quite often fake and counterfeit products enter the supply chain against the knowledge of the end user.

Apte and Petrovsky believe that such distortions in modern-day complicated supply chains could be rectified with the assistance of blockchain.[29] The data at every stage of the supply chain if encrypted in the blocks would turn unfalsifiable and ensure compliance. This would make it possible for the end-user to trace the product reaching them from the very beginning of the supply chain. According to Apte and Petrovsky, if blockchain technology is combined with external audit and inspection, a reduction in the supply of counterfeit, fake and environmentally damaging products could be checked effectively.[30] Blockchain technology has a promising application in mitigating the compliance issues currently existing in the supply chain industry.

1.4 Other Applications of Blockchain

The Blockchain-Bitcoin affair proved to be rather successful. Thereafter, the application of blockchain technology in other domains was conceived and the previous sections of this chapter briefly put that into perspective. It would not be an exaggeration to say that Blockchain has been one of the most promising emerging technologies of the decade. In fact, Blockchain trended on top of the Gartner Hype Cycle for emerging technologies in the year 2016.[31] This

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[29] Apte, Shireesh, and Nikolai Petrovsky. "Will blockchain technology revolutionize excipient supply chain management?." *Journal of Excipients and Food Chemicals* 7, no. 3 (2016).

[30] Ibid.

[31] Fisher, S. "Gartner Hype Cycle 2016: blockchain, no big data." *Accessed on* 2 (2017).

popularity of blockchain is due to its universal applicability in precisely anything that touches our everyday lives.

Amongst the most notable investors in the blockchain technology, Deloitte has collaborated with a number of finance based startups to develop smart identity solutions for banks and insurance companies.[32] This would streamline the Know Your Customer (KYC) norms and would be beneficial for the financial inclusion of the unbanked simultaneously putting a certain degree check on financial frauds.

Further, NASDAQ, the leading depository trust and clearing corporation is using Linq, its customized blockchain platform to complete and record the security transactions. According to Underwood, this would impart transparency to the volatile security market preventing the collapse of security markets due to financial frauds[33].

In one of the interesting applications of blockchain, a blockchain startup called Everledger has developed a project that traces the origin of diamonds.[34] The company believes that this would inform the buyer if the diamond they are purchasing is a 'blood diamond' or not. More importantly, this would prevent counterfeit diamonds from entering the market. According to Everledger CEO, Leanne Kemp, this application of blockchain could be used in several other related areas like the market of vintage cars, wines, artefacts etc.

Going further, one of the most aspiring application of blockchain is that in reforming the governance systems in developing countries. Casey and Dahan highlight the role that blockchain could play a key role in streamlining any transaction that requires trust. [35]

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[32] Thavanathan, Jenitha. "Process Innovation with Blockchain in Banking-A case study of how Blockchain can change the KYC process in banks." Master's thesis, NTNU, 2017.

[33] Underwood, Sarah. "Blockchain beyond bitcoin." Communications of the ACM 59, no. 11 (2016): 15-17.
[34] Ibid.
[35] Casey, M., and M. Dahan. "Blockchain technology: Redefining trust for a global, digital economy." *Retrieved August* 24 (2016): 2017.

Blockchain projects in countries like Georgia and Honduras are trying to bring about sort of land reform by creating systematic land registries. Among the many advantages of doing so is to give poor people a reliable land title on their name so that they could approach banks for credits. Casey and Dahan also believe that the technology could bring almost two billion unbanked population of the world into the mainstream financial system. This can substantially mitigate global poverty in significant terms. On a similar line, this application of blockchain to record digital identities of people can make it easier for small and marginal enterprises to raise finances from the lending institutions. It is for these reasons that some of the countries are taking disproportionate interest in the technology. Countries like Malta are opening their doors for blockchain based companies and moving forward towards transforming into *cryptoeconomies*.

Blockchain, thus, has immense potential to completely transform our day to day lives. The application of this technology is not merely restricted to the financial sector as noted above. It can be broadly seen as a reinvented version of the internet. The most phenomenal aspect of this technology is its ability to create a 'trustless' architecture through algorithms that do not lie. Nevertheless, there have been a few concerns with the security of the data that is recorded on the blocks. As the technology is in the early stage of its inception, there have been a few incidences of hackers breaking in and steeling the information from some private blockchain databases.[36] Further, questions have been raised on the robustness of miners' consensus which forms the backbone of the blockchain technology. Some skeptics argue that if > 50% of the miners are convinced to fake a consensus the data in the blockchain could be manipulated. However, Apte and Petrovsky feel that this concern is a bit far-fetched and would be only

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[36] Palladino, Santiago, and Zeppelin Solutions. "The parity wallet hack explained." *Zeppelin Blog* 19 (2017).

possible in case of private blockchains.[37] In public blockchain projects such as Bitcoin, this manipulation of miners is almost next to impossible due to the large number of miners in the system. Thus, one safe assumption about blockchain could be that it is here to stay. However, time will tell how quickly it is going to revolutionize our lives.

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[37] Apte, Shireesh, and Nikolai Petrovsky. "Will blockchain technology revolutionize excipient supply chain management?." *Journal of Excipients and Food Chemicals* 7, no. 3 (2016).

Chapter 2 – Building an Agricultural Blockchain

Nothing is as central to the lives of humans as is food. According to the World Bank, the food and agriculture sector globally is an estimated $4.8 trillion industry.[38] This is roughly equal to 10 % of the global gross domestic product. Another World Bank report claims that around 800 million people, which is 78% of the total population of the poor, live in rural areas and rely on farming and livestock for their livelihood. A couple of inferences could be drawn from these contrasting figures. Firstly, agricultural sector is a gigantic industry in terms of output. Secondly, a substantial portion of the global farming population is living under poverty. The link between agriculture and poverty gained prominence in the global policy making with the advent of United Nation's Millennium Development Goals. These goals made an effort to look beyond economic growth and focus more on poverty reduction.[39] Hitherto, the growth in non-agricultural sector was accorded greater importance compared to that in agricultural sector. The Lewis model (1954) in fact argued that the agricultural sector is backward and unproductive and the labor from agricultural sector should be guided towards more productive and advanced industrial sector. Agricultural dependence was (still very much is) regarded as a characteristic of a backward economy.

The global demand for food has, however, been on a consistent rise. By 2050, the global leaders have a daunting task of feeding 9 billion population.[40] Thus, agricultural sector across the globe requires urgent policy intervention to increase growth and raise the standard of living of the

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[38] Maloni, Michael J., and Michael E. Brown. "Corporate social responsibility in the supply chain: an application in the food industry." *Journal of business ethics* 68, no. 1 (2006): 35-52.

[39] Christiaensen, Luc, Lionel Demery, and Jesper Kuhl. "The (evolving) role of agriculture in poverty reduction—An empirical perspective." *Journal of development economics* 96, no. 2 (2011): 239-254.

[40] Tomlinson, Isobel. "Doubling food production to feed the 9 billion: a critical perspective on a key discourse of food security in the UK." *Journal of rural studies* 29 (2013): 81-90.

people dependent on it. It can be safely claimed that any policy reform in agriculture, by making it a profitable enterprise, would not only combat global poverty heads-on but would also contribute directly towards global food security. This chapter makes an attempt to highlight the role that could be played by blockchain technology in reforming the agricultural sector, turning it into a remunerative enterprise for each and every individual in the agricultural supply chain. The chapter demonstrates that blockchain technology has the capacity to significantly reduce the role of intermediaries who eat into the profits of the farmers. Simultaneously, on the retailers' front the technology will enable them to trace the quality of the products they purchase from the farmers. Lastly, the consumer located at the final point on the supply chain would have a clear idea of the quality of the agricultural product they consume.

The current supply chain of agriculture is plagued by visible distortions. On the supply side, farmers do not receive adequate remuneration for their produce. On the demand side inflationary food prices makes it difficult for the consumers to afford healthy food consumption. The primary advantage of blockchain technology is to directly connect farmer with the retailer or consumer situated at the last stage of the supply chain. This would not only allow the farmers to maximize their profits by bypassing middlemen who eat into those, but also normalize the inflationary tendencies for the consumer. The startups operating in the sector have a belief that the blockchain technology would allow the farmers to negotiate better prices while at the same time allowing the consumers to develop confidence in the quality of the product they consume.

The primary use of blockchain technology in agriculture is through smart contracts. Smart contracts are self-executing contracts.[41] The terms and conditions pertaining to parties in the

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[41] Omohundro, Steve. "Cryptocurrencies, smart contracts, and artificial intelligence." *AI matters* 1, no. 2 (2014): 19-21.

contract are entered in the form of codes on a decentralized blockchain. The contract is executed based on the information entered on the blockchain and is irreversible.[42] Also, the terms and conditions once entered cannot be rigged to the advantage or disadvantage of the parties to the contract.[43] One of the key issues in agriculture is the lack of authentic paperwork between farmers and contractors or retailers. Mostly, deals take place verbally and in case of violation on the end of either party, the disadvantaged party has no recourse in the court of law. Smart contracts could therefore minimize agricultural frauds in a big way by maximizing transparency in contracts between commodity buyers and farmers.

Further, currently the multinational companies who procure the farm produce from the farmers make payments through locally involved third party service providers. This results into additional costs to the companies and lower remuneration to the farmers. With the assistance of blockchain technology companies can make direct payments to their suppliers through mobiles.[44] This mobile based payment mechanism has a dual use for farmers. A report by Technical Centre for Agricultural and Rural Cooperation highlights that creating a mobile based payment architecture would contribute towards the robustness of the farmer financing and credit system.[45] The companies and banks providing farmer credit and financing can make use of mobile payment data and extend credit to the farmers based on the credibility.

Blockchain technology could also benefit small farm owners. It has been noted that small farm owners produce 70% of the world's food. At the same time, small and marginal land owners constitute the chunk of global poor population. Experts in blockchain suggest that Community

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[42] Ibid.

[43] Ibid.

[44] Lin, Yu-Pin, Joy R. Petway, Johnathen Anthony, Hussnain Mukhtar, Shih-Wei Liao, Cheng-Fu Chou, and Yi-Fong Ho. "Blockchain: The Evolutionary Next Step for ICT E-Agriculture." *Environments* 4, no. 3 (2017): 50.

[45] Chinaka, Malvern. "Blockchain technology--applications in improving financial inclusion in developing economies: case study for small scale agriculture in Africa." PhD diss., Massachusetts Institute of Technology, 2016.

Supported Agriculture (CSA) could significantly raise the income of small and marginal farmers.[46] CSA model works on the principle that a number of shareholders fund the activities on a farm in exchange of weekly supplies of fresh vegetables and other products cultivated on the form. This self-sustainable model has the capacity to improve consumers' health by simultaneously raising farmer income.

Another promising application of blockchain is improving the traceability of products at every stage of the supply chain. The unfalsifiable data recorded at every stage on the supply chain would give confidence to the buyers that the product they have received is the one they paid for.[47] The consumers would also be able to make informed choices about the products they choose to buy. Blockchain can provide real time data such as, the origin of the product, the environmental conditions in which it was cultivated and the kind of inputs that went into its cultivation.

Tentatively, it appears that blockchain can act as a connecting treat for farmers across the globe. The real-time information would allow the farmers to gauge the right prices for their produce based on global trends. This would also harmonize negotiation between farmers and the consumers and reduce the burden on the pockets of the consumers who face skewed prices of necessary agricultural consumables due to distortionary supply chains.

Blockchain, thus, could give a big-push to the agricultural growth across the world and more importantly in developing countries which are even today largely dependent on agriculture for their economic growth. Reviving agricultural growth would directly attack global poverty as farming population constitutes majority of the global poor population. The most notable

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[46] Ge, Lan, Christopher Brewster, Jacco Spek, Anton Smeenk, Jan Top, Frans van Diepen, Bob Klaase, Conny Graumans, and Marieke de Ruyter de Wildt. *Blockchain for agriculture and food*. No. 2017-112. Wageningen Economic Research, 2017.

[47] Underwood, Sarah. "Blockchain beyond bitcoin." *Communications of the ACM* 59, no. 11 (2016): 15-17.

advantage of blockchain technology is that it creates a level playing field for farmers, retailers and consumers without benefitting one at the expense of other. By removing the visible distortions in the agricultural supply chain, blockchain could totally reform the agricultural sector in the years to come.

Chapter 3 –Indian Agriculture: Problems and Promises

India as a country has always been a subject of fascination for the world. From orient, mystic, land of serpent charmers to fastest growing economy, largest youth population, and so on. This fascination that at one time arose because it was considered 'different', now rises because it appears 'paradoxical'. Consider this paradox: agriculture – largest profession, largest employment, surplus production, but highly unorganized sector, weather dependent, highly uninsured, high rate of farmers' suicides. The title of this chapter has been true for Indian agriculture for more than seven decades now – never ending **problems** and ever-increasing **promises**.

More than a source of livelihood, agriculture in India has been a part of its cultural identity. The Indus valley civilization which is estimated to be almost 4500 years old had an agricultural economy.[48] As the Aryans conquered the land, their access to iron made agriculture a more remunerative activity in the later-Vedic age.[49] Further, agriculture remained a central feature of the Indian economy in the following centuries which saw the rise and fall of different empires. It was during the colonial rule that the nature and character of the Indian agriculture changed for worse. As the East India Company expanded its authority in India in the first decade of 17th century, the prosperity of princes who ruled over different principalities diminished in a substantial manner. A number of professions which were hitherto sustained by the patronization of the princes, began collapsing. As a result artisans, painters and other

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[48] Basham, Arthur Llewellyn, and Saiyid Athar Abbas Rizvi. *The wonder that was India*. London: Sidgwick and Jackson, 1956.

[49] Ibid.

professional artists shifted towards agriculture for their living. [50] India's dependence on agriculture, hence, just began.

Moreover, the colonial policies on agriculture were so designed that they forced the farmers to grow cash crops which had high demand in Europe. This approach favored, firstly the company and then the British empire to feed the industrial revolution at home. Total dependence on cash crops which provided the remuneration to the colonizers left the farmers starving. This starvation was exploited by the wealthy landlords and a number of middlemen who would work on their behalf. Middlemen, hence, began to occupy a key position in Indian agriculture. These degeneracies of the system continued even after the independence. The land ceiling Act that marked the promise of the new constitutionally elected government could not deliver on its promise as land reform legislations across the states proved to be weak and ineffective.

This historical insight of the Indian agriculture is intended to give a clear picture of the problems currently in place. Farmers' suicides are common followed by numerous farmers' agitation movements the country over. As per the data of National Crime Records Bureau (NCRB), out of all the suicide deaths in India, farmers' suicides constitute 13.9%. Farmers currently constitute the chunk of the population below poverty line. According to Ministry of Statistics and Programme Implementation, out of all the agricultural households 36.4% are below poverty line. In this light it is impertinent to see the current agricultural policies in place aiming to revive the status of farmers in India.

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[50] Chandra, Bipan, Mridula Mukherjee, Aditya Mukherjee, K. N. Panikkar, and Sucheta Mahajan. *India's struggle for independence*. Penguin UK, 2016.

3.1 Indian State and today's blue-print for Agriculture

The Indian state, at least on papers, has robust plans for modernizing agriculture and making it worthy as a profession. Some key initiatives are highlighted below.

1. Soil Health Card Scheme

   Addressing the issue of deteriorating soil health in the country, SHC scheme benefits farmers by providing them fertility status of the soil of their land once in every three years. This scheme is recurring in nature and has dual objectives. On one side, it aims to improve soil health and theirby productivity and ultimately production; on the other hand, a strong soil data base is expected to come up from this scheme some years down the line.

2. Promotion of Organic Manure

   This one is more publicized than actual work on ground. The objective is very clearly to increase usage of organic manure in agriculture but the way it has been planned to be done is like paying lip-service to the cause. As of now, three ways have been thought of – promotion of city compost (mostly to highlight *Swachh Bharat Abhiyan*), incentivizing fertilizer industry, minimizing subsidy burden by rationalizing NPK pricing.

3. *Paramparagat Krishi Vikas Yojana*

   Linked again to the idea of organic farming, this scheme strived to promote commercial pesticide residue free production through certified organic farming.

4. Development of Rainfed Agriculture

   The rainfed nature of agriculture has been cited as on the most significant reasons for the uncertainties that farmers face. However, rainfed agriculture forms a large proportion of the sector. 'Rainfed farming communities cultivate a significant share of

22

area devoted to crops like pulses (77%), oilseeds (66%), and coarse cereals (85%). They rear 78% of the goats in the country. These farmers produce over 34 predominant crops (compared to the 3 or 4 crops in irrigated tracts).' Also, according to projections, 'about 50% arable land will continue to depend on rainfall' for cultivation. Thus, it is only a rational thought that rainfed agriculture be strengthened to ascertain food security of th country.

5. Irrigation

Improving irrigation for agriculture has two objectives for the state – (i) to increase irrigated area; and (ii) enhance water use efficiency. The big-ticket initiative in this area has been labelled *Pradhan Mantri Krishi Sinchai Yojana* (PMKSY). Achieving 'convergence of investment in irrigation at the ground level' is the major task for implementation'. Sustainable management of ground water resources, and promoting scientific agriculture through micro-irrigation are two other complementary initiatives.

Along with these major plans that the Indian state has been able to implement with some success, plans like enhancement of pulses production, farm mechanization, agriculture credit support, and farm insurance are still to see a bright sunny day. These are only being experienced through pockets of rays from between dark clouds.

3.2 The 'e' in Indian Agriculture

The following section attempts to describe a few notable policy interventions in agriculture which made use of Information Communication and Technology (ICT). These interventions are more like successful experiments which could now be treated as case studies.

1) **BHOOMI**: The word has its root in the Sanskrit language and means a piece of land. This was an e-governance project of the Government of Karnataka that is a management system for land records. The system took shape in the year 2001 and since then has

23

electronically registered all the land records in the state of Karnataka. The project went beyond computerization and by 2012 linked the portal with banks. Thereafter, farmers could avail farm credits from the banks. [51]

The project by creating a land record data base checked corruption and infused transparency in the system. It also integrated land registration department, land acquiring bodies and banks and financial institutions giving pace to projects which required land acquisition. The data base created also helped in the formation of suitable development policies. The success received by this project encouraged the Government of India to replicate the project in other states of India.

2) **e-Choupal**: In a rural setting, Choupal would stand for a 'village meeting place'. This e-governance project was launched by ITC limited, an Indian multinational in the state of Madhya Pradesh. [52] The project aimed at creating local level leadership among farmers, skill generation, spreading best agricultural practices and creating a sense of ownership of the assets created under the initiative. This initiative of a private sector enterprise is recognized for its scalability in other areas apart from agriculture.

   e-Choupal assisted the farmers in generating entrepreneurial ideas and provided resources for their materialization. This took place simultaneously along with skill development of the farmers and led to human resource development at the rural level.

3) **e-NAM**: It is an e-trading platform for agricultural commodities in India. This is the most recent e-governance project in the area of agriculture launched across the country by the Government of India in 2016. The project is still in its early phase of implementation. It aims to reduce red-tapism and licensing requirements for traders by

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[51] Goel, Suman, and Raj Kumar. "E-Governance: A Tool for Tackling the Corruption in India." *Health* 15 (2014): 32.

[52] Bowonder, B., Vinay Gupta, and Amit Singh. "Developing a rural market e-hub: The case study of e-Choupal experience of ITC." *Indian Planning Commission Report* (2002).

providing a single license valid for all markets in the state. Also, the project ensures single point levy of market fees, thus, trying to minimize the presence of middlemen.

This chapter attempted to place the past and present of Indian agriculture in perspective. The technology of blockchain has to perform in an agricultural system that has been described above. There has been examples of e-governance programs already in place and these could be complimented by the blockchain technology in the future.

Chapter 4-Theoretical Framework

Less State, More Technology- Good Governance

The theoretical construct of good governance saw its genesis in 1990s. With the World Bank at the helm of lending operations to developing and underdeveloped countries, the concept favored conditioning aid to those countries which are committed to growth and poverty alleviation and have institutions aiming at democratic, transparent and accountable governance.[53] The concept soon gained prominence and became the prime reason for the introduction of structural adjustment policies in several developing economies of the world. The primary aim of this approach as stipulated by the World Bank was to minimize corruption. In doing so, the role of state was to be minimized by downsizing the bureaucracy, devolving several governance functions in the hands of the people at the grassroots and establishing transparent auditing system.[54] Furthermore, according to Mandar and Asif, governance that takes into account rule of law, accountability, transparency, participation and people's control could be regarded as good governance. Good governance, hence, idealizes the phrase *government by the people*.

The key spirit embedded in the theoretical concept of good governance is governance that is responsive to the needs and requirements of the governed. The discussion in this dissertation is placed in the theoretical realms of good governance. One could argue that the adoption of blockchain by the government within its governance architecture has sound implications for strengthening the E-governance structure. Backus sees the efficacy of e-governance in simplifying and improving democratic, government and business aspects of governance.[55] E-

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[53] White, D., and D. Mahtani. "Nigeria vows to track use of debt relief funds." *Financial Times* (2005): 9-10.

[54] Palanithurai, G. "Good Governance at Grassroots." *The Indian Journal of Political Science* (2005): 289-312.

[55] Backus, Michiel. "EGovernance in Developing Countries." (2002).

governance sets the accountability of institutions by infusing transparency. It then gradually delegates the functions of governance in the hands of the people. By creating a public blockchain in the Indian agricultural sector, the government would be removing the bottlenecks that exist at various stages of supply chain.

The agricultural governance till date has been one that has failed to check corruption and deliver benefits to small farm owners. The government subsidies and cash transfers are released through a gigantic bureaucratic machinery that is plagued by institutional corruption. The constitutional recognition of institutions of self-government at the village level called the *Panchayati Raj Institutions* (PRIs) was aimed at administrative and fiscal decentralization and extending authority to the people at grassroots. However, these institutions have failed to live up to the expectations in so far as agricultural sector is concerned. Even otherwise, the Indian PRI machinery is grappled with a number of structural and procedural constraints (Kumar 2005).[56] They are marred by the phenomenon of elite capture and have significantly failed to become the voices of the rural population. The United Nation's World Development Report (2008) highlights some of these underlying issues prevalent in the Indian agriculture.[57] The report states that subsidies for inputs extended by the government, although, contributed to the growth in the agriculture sector, failed to assist the small and marginal farmers. The report highlights the role that the Information Communication and Technology (ICT) can play in increasing production levels in Indian agriculture. It has been argued that ICT can play a dominant role in checking land-registry related corruption which at 2008 level was measured to be $700 million a year.

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[56] Kumar, Mukul. "Perils of Participatory Democracy." *Economic and Political Weekly* 40, no. 46 (2005): 4857.

[57] McMichael, Philip. "Banking on agriculture: a review of the World Development Report 2008." *Journal of Agrarian Change* 9, no. 2 (2009): 235-246.

Blockchain technology would prove to be quite promising in reforming the agricultural supply chain in particular and rural poverty on the whole. The creation of a farmer-centric database that is unfalsifiable and free of any manipulation would infuse transparency in the entire system. The resultant reduced corruption would send a direct invitation to players from food processing industries and major commodity buyers to engage with Indian farmers. This would significantly raise farm incomes which are currently in a dismal state. Blockchain could also reform the entire land registry system as being done in countries like Honduras and Georgia. This would directly touch the lives of the small and marginal farmers who have to spend large sums of money in court cases which last for years.

Therefore, dependent on the blockchain model adopted, the infusion of blockchain technology in Indian agriculture would significantly decentralize agricultural governance. This would give greater say to farmers in determining the selling price of the final product, increase land yield and, encourage backward-forward linkages in the agricultural sector with the increased participation of corporate houses and players from the food processing industry.

Chapter 5- Methodology and Research Design

This thesis uses the qualitative research methodology. I conducted semi-structured interviews and focused groups in different agro-economic zones of the state of Madhya Pradesh. The rationale for using this approach was that it allowed me to come across diverse viewpoints prevailing in culturally different regions of the same state. I conducted interviews of village heads, government officials at the block level, head of an organic-farming firm and founder of a blockchain based startup in India. Simultaneously, I conducted 6 focused groups of small and marginal farmers, one each in a different agro-economic zone of the state.

During the interviews and the focused groups, I kept my questions semi-structured and open ended. This allowed me to strike a conversation with my respondents easily. This approach was specifically beneficial during the focused group discussion as it allowed me to build a rapport with my respondents. For instance, during the focused group discussions, when question was asked on how often the respondents use their bank accounts, rapport built through previously asked informal and open-ended questions proved to be helpful.

All the interviews except those with the head of an agro-products firm and the founder of a blockchain based startup, were conducted in Hindi. Focused group were also conducted in Hindi. Thereafter, I transcribed and translated these interviews into English for the purpose of my analysis.

Apart from the primary research, I tried consulting available literature relevant to various aspects of my thesis. One serious limitation here was that there is a serious dearth of academic literature in the domain of agricultural-blockchain. The area is still in its nascent stage and it appears that the development of academic interest in the field would take time. However, to my use I could access the research work conducted by several startups that have mushroomed

in this sector. My work, therefore, makes an attempt to contribute to the limited literature that exists in this area.

5.1 Elite Interviews

I designed three separate set of interview questions for the purpose of my research. The first set of questions were intended to get an idea of the understanding shared by government functionaries towards technology penetration in agricultural sector. As the village heads play a central role in the materialization of government schemes in rural areas and would play a huge role in streamlining any future government intervention taking place in agriculture, a separate set of questions was designed to observe their enthusiasm (if any) towards future government intervention in agriculture. Lastly, the last set of questions was intended to understand the outlook of individuals operating in the corporate sector who would be key stakeholders in any blockchain policy in agricultural sector.

5.2 Choice of Case Study

I chose Madhya Pradesh for the purpose of my study for a variety of reasons. Firstly, agriculture forms the backbone of the economy of the state. Around 82% of the total working population of the state is engaged or associated with agriculture and its allied activities (Census 2011). Secondly, the state is one of the fastest growing states in India in terms of agricultural production. This would, it can be assumed, make it a focal point for any policy intervention in agriculture in the future.

Lastly, being my home state, it was easy to perform field work given the very limited time I had at my disposal. I could also utilize my local contacts during the field work and this helped me conduct interviews of state functionaries and village-heads.

Chapter 6- Data Analysis, Observations, and Recommendations

The data collected through field work and available literature is analyzed through the stakeholders' approach. Various interviews and focused group discussions conducted in villages located in different agro-economic zones of Madhya Pradesh carry the insights drawn from common people, officials of the government, political heads of the village, an official of an agro-products based firm, and a blockchain expert. These, in my opinion, represent the key stakeholders that are going to play a role in implementation of agricultural wing of IndiaChain.

6.A.1 Farmers

In the village Sagoni, district Raisen, mercury reached 44 degrees centigrade in the last week of May. Even 10 A.M. in the morning felt like Sun has crossed midday. The dry land appeared too old for its age with the visible crevices. People, cattle and dogs all looked as if patiently waiting for the onset of monsoon. As I convinced a group of 12 people, all farmers, for a focused group, things began to unfold. A number of individuals gathered around me as if I was there to distribute cash. As the focused group began, I started with enquiring about their everyday routines. During the summer season, most of them did not grow any crops and waited for the Kharif (monsoon/post-monsoon) season to start so they could grow paddy in the fields. Some of them who had access to irrigation were growing Green Gram and were happy with the yield for this year. Further, most of them would sell their crops to the government at the *Mandis* (marketplaces where agricultural output is directly procured by the government). On asking why do not they contact companies located in cities to buy their products at higher prices directly, one of them said- " *Dalaal poora paisa kha jaate hain*!" (Middlemen snatch away all the profit margin).

When asked about their bank accounts, they enthusiastically raised their hands in unison and assured me that banking has become an imminent part of their lives. All of them had their *Kisan* Credit Cards (credit cards for farmers) and a couple of them fearlessly presented them to me. Some of them boasted of using internet banking from their android smart phones. In the meanwhile, a few of them relentlessly said-" AADHAR bhi hai!" (We also have the unique identity card). This came as a bit of surprise to me as I was more interested in AADHAR than Kisan Credit Cards and did not even have to ask a question about that. After they told that they have their AADHAR linked to their bank accounts already I wanted to know what makes them give their biometric identities to the government so easily. "*Jo sarkaar anivaarya kar deti hai, hum ko karna parta hai*!" (We have to follow anything that the government makes mandatory).

Meanwhile, the farmers who were part of the group were mostly marginal farmers. Most of them had less than 2.5 acres of land. Tractors and other machine tools were only possessed by a few. Rest of them would hire them during the cropping seasons. When asked if all of them had their soil tests done, they nodded in affirmative. However, they followed by saying that- " Soil testing bekaar ki baat hai!" (Soil testing has no use). When asked to elucidate, they argued that using the fertilizers in the quantity as stipulated by the government does not give them proper yield. And hence, they choose to follow their own gut feeling when it comes to the tilling of soil.

With minor variations the responses from the farmers across the state were similar. In Iqlani village, district Hoshangabad, farmers complained that the internet center of the *Panchayat* (village assembly) was non-functional for more than a year. Even after their repeated complains, nothing has been done in that direction. The T.V. room in the *Panchayat* office would allow them to get knowledge of new government schemes and the benefits that came along with them. The farmers also complained that the nearest bank is 12 Kilometers away and that makes banking a difficult task for them. In all the districts, even with proper irrigation

facilities, farmers sold their output directly to the government as according to them, government gave them highest returns. They also felt that this was safe and secure compared to openly selling their products in the markets where they would be manipulated by the middlemen. Farmers in the Burhanpur district appeared to be aware about cooperative farming and some of them even practiced it.

6.A.2 Village Heads

The *Panchayati Raj* Institution (PRI) existed informally during the colonial times. After the independence, the Indian state envisaged their addition to the governing architecture of the country at the local level. It was in the year 1992 that the 73rd constitutional amendment was passed which gave these bodies a constitutional recognition and simultaneously bestowed them with the power of village governance. For the purpose of our thesis it is sufficient to know that the head of a village Panchayat is elected every 5 years through elections held at the village level and spearheaded by the Election Commission of the federal unit of which the village is a part. Also, every large village or a group of 2 or 3 small villages together would have their own village assemblies. Further, all the adult members (above 18 years of age) of the village automatically become part of the village assembly.

The discussion on Panchayats is important because they play a central role in rural governance. Officially, they have a say in the formulation, implementation and monitoring of a public policy at the village level. The *Sarpanch* (village head), thus, occupies a critical position in materialization of any policy at the grassroot.

Nirbhay Singh Saadh, the *Sarpanch* of village Iqlani, appeared to be aware of his roles and responsibilities as a village head and immediately enumerated them when asked about them. For Saadh the major problem in agriculture sector in India is marginal farming. Due to the absence of land consolidation, the production cost is high and yield per hectare is low. This is

33

why, he thinks, farming is not a profitable enterprise in India. According to Saadh, more than 60% of the farming population in his village was that of marginal farmers. He believes that unless the yield per hectare increases farmers will be reluctant to perform contract farming. For Saadh, however, it is a positive sign that almost 90% of the total population of the village has AADHAR number and are connected to the mainstream banking system. *Jan Dhan* scheme has played a key role in connecting farmers to banks according to him. Saadh seemed enraged when asked about the role that the government can play in reforming the lives of the farmers. He mentioned how his application of opening a bank branch in the vicinity has remained unheard for years. He was also apprehensive of some government official who would try to hijack the authority of the elected *Sarpanch*.

Anand Ramji Gujar, a *Sarpanch* of a village in the Burhanpur district believed that the government has to find a way to remove middlemen from the agricultural system if the lives of the farmers have to be improved. He stated- "*Dalaal hataaiye tabhi na munaafaa zyada milega*!" (Remove the middlemen, only then farmers will gain more profits). Gujar was convinced that AADHAR will help remove middlemen from the system. On asking how, he said- "*Woh toh sarkaar hi jaane*!" (Only the government knows that).

A couple of village heads I could not get a chance to interact with were women. Their husbands are running the show on their name while they act as rubberstamps. Constitutionally 33% seats in every Panchayat elections are reserved for women. However, in a patriarchal setup it is their husbands who wield authority on their name.

6.A.3 State Functionaries

The state functionaries agreed to interact on the condition of anonymity. It is the year of elections and they did not want to take chances! A Block Development Officer (BDO) in Dewas district when asked about the blockchain, nodded in denial. She, however, asked me

34

out of curiosity about the technology and I explained to her in detail. She opined that due to *Jan Dhan, Aadhar* and Mobile, corruption has drastically reduced in the public distribution system and other government schemes. This has also removed leakages that caused huge loss to the state exchequer every year. She, however, feels that it would take time for something like blockchain to materialize as awareness among the people is still low. She lamented- " *Abhi bhi log angootha lagatey hain!"* (People still cannot sign and use their thumb instead). She questioned the nexus between *Sarpanch* (village head) and Panchayat Secretary (government representative in the village assembly) and held it responsible for poor development in the villages.

A BDO from the Gwalior district seemed skeptical about the association of private sector in the agricultural sector. According to him, farmers are the responsibility of the state and transferring this responsibility into the hands of private sector could make the present situation of farmers even worse. He added- "*Private waaley toh munaafakhori karne mein vishwaas rakhte hain*!" (Private sector only believes in making profits). He, however, also felt the need to remove the middlemen from the system. For this he suggested further reforms in Agricultural Produce Market Committee Act in every state. It is noteworthy here that this Act establishes a committee in every state the main job of which is to ensure remunerative prices for farm produce.

6.A.4 Private Sector

Lalit Chouksey is a General Manager of Magic-Agro Biotech Private Limited, a company which supplies organic fertilizers and other yield increasing products to farmers. On being asked about the blockchain technology he firstly confused it with bitcoin. However, after I gave him a brief overview he quickly picked up on it. According to Lalit, the government should focus on attitudinal change among farmers. According to him, farming rather than becoming a

technology intensive enterprise has become more labor intensive and archaic. He finds farmers rigid in their approach and reluctant while adopting new technology. He believes that poor infrastructure of agricultural R&D in India and failure to recognize farming a profession like any other, has resulted into this backward outlook among farmers.

Lalit feels that land registry portal in India should be made more robust and functional at all times. This would reduce unnecessary bureaucratic interference in the lives of farmers. Lalit welcomes IndiaChain with a lot of enthusiasm and believes that this would definitely resolve a number of issues that exist with the supply chain in India. It would also make farming more result oriented and scientific, he adds.

6.A.5 Blockchain Expert

Alok Nayak is among the handful of quality lawyers who are carefully looking at the Crypto-market in India. At his age, he is one of the youngest founder of a blockchain based startup called 'The Blockchain Story'. When asked about IndiaChain and its potential, Alok replied with a lot of enthusiasm. "This will be a gamechanger for the fastest growing economy of the world", he said. For Alok, IndiaChain will give a big-push to the Indian economy in every sector, from conducting free and fair elections to recording unfalsifiable First Information Reports (FIRs). On being asked about India's preparedness for this ambitious project, he pointed out that such grand projects do not materialize overnight and in a way India would never be prepared for it. He suggested that India should start as early as possible by implementing a number of pilot projects. He mentioned countries like Malta and Honduras, which even though are minuscule compared to the size of India, could provide India with valuable lessons.

6.B Observations

After venturing out in the field, conducting focused group discussions and interviews with various stakeholders, I arrive at the following observations:

o If bank accounts, AADHAR number, and mobile phone access is regarded as the foundational infrastructure for IndiaChain by the Government of India, then the infrastructural base is sound at least in the state of Madhya Pradesh.

o Against the popular belief, farmers have plausible awareness of government schemes and benefits thereof.

o There is a coordination problem between the functionaries of *Panchayats* and the government. Private sector would always be reluctant to dive in this area unless harmony is ensured between those elected and the bureaucratic machinery.

o Blockchain could resolve a number of issues in the supply chain as stated in the theory. The almost total absence of private sector in the agricultural sector of the state reveals that there is a huge potential untapped.

o As introducing this technology would be analogous to establishing an alternative bureaucratic structure that is horizontal and public-led, the existing bureaucratic structure could pose a serious threat to its roll out. Bureaucracy at the lowest level would, therefore, have to be taken into confidence before rolling out such a massive reform.

6.C Recommendations

There appear a few roadblocks in successfully implementing this policy in India as viewed through Madhya Pradesh. The possible short-term and long-term recommendations for mitigating them are:

o IndiaChain is an ambitious project. This would require behavioral change among masses. The scientific spirit would require a serious push and measures should be taken to boost creativity among individuals. A start could be made by quick inclusion of blockchain technology in the school curriculum.

o Till today, IndiaChain is just a mention. It is still in its planning stage. The roll out could take place through a Public-Private-Partnership (PPP) model. Private sector should be allowed to be an active player. They could use their capacity in spreading awareness among the masses.

o Large farmers who are techno-friendly could be encouraged to take initiative and spread the word around other farmers around them. In this regard, lessons could be learned from individuals like Mikhail Shlyapnikov, a Russian farmer, who launched his own Initial Coin Offering to raise money.

o An alternative incentivizing mechanism for the middlemen operating in the sector would have to be thought out for before rolling out IndiaChain for agriculture.

Conclusion

This dissertation made an attempt to gauge the roadblocks that exist in the implementation of blockchain policy in agriculture. By conducting a field-based study in the state of Madhya Pradesh, the primary goal of this thesis was to gauge the attitude of various stakeholders- farmers, state functionaries, political representatives at the village level and members of the private sector, towards the infusion of blockchain technology in Indian agriculture. The thesis made use of qualitative research methodology and the analysis was based on the focused group discussion and elite interviews conducted across the state. The primary finding of this thesis is that, looking through Madhya Pradesh, IndiaChain could be launched as a pilot project without much delay. The access to bank accounts and mobile phones provide adequate infrastructure base to the government. Further, the rich biometric database available through AADHAR database would complement the blockchain infusion.

The study revealed that governance in India is perplexed by lack of trust and coordination among various policy stakeholders. The lower bureaucracy which plays a dominant role in the functioning of any policy at the local level appears to suspicious about private sector, although this could vary from state to state. There also appears to be a tussle between elected members of the village assemblies and officials of the state. This lack of coordination could be a major roadblock for any policy transformation the Government of India aims to make.

This dissertation lastly makes a few policy recommendations in the end. Private sector could play a major role in the materialization of IndiaChain. A Public Private Partnership model could add wings to this idea. Following this research work, blockchain appears to be a promising tool for reforming Indian agriculture, The roadmap, however, has to be carefully planned by the government for a successful and effective rollout.

Bibliography

McCray, W. Patrick. *The visioneers: how a group of elite scientists pursued space colonies, nanotechnologies, and a limitless future*. Princeton University Press, 2013.

Kuiken, Todd. "Learn from DIY biologists: the citizen-science community has a responsible, proactive attitude that is well suited to gene-editing." *Nature* 531, no. 7593 (2016): 167-169.

Yamey*, Basil S. "The historical significance of double-entry bookkeeping: Some non-Sombartian claims." *Accounting, Business & Financial History* 15, no. 1 (2005): 77-88.

McSweeney, Brendan. "The roles of financial asset market failure denial and the economic crisis: Reflections on accounting and financial theories and practices." *Accounting, Organizations and Society* 34, no. 6-7 (2009): 835-848.

Walsh, Clara, Philip OReilly, Rob Gleasure, Joseph Feller, Shanping Li, and Jerry Cristoforo. "New kid on the block: a strategic archetypes approach to understanding the Blockchain." (2016).

Koven, Jackie Burns. "Block The Vote: Could Blockchain Technology Cybersecure Elections?." *Forbes. Accessed December* 14 (2016).

Ekblaw, Ariel, Asaph Azaria, John D. Halamka, and Andrew Lippman. "A Case Study for Blockchain in Healthcare:"MedRec" prototype for electronic health records and medical research data." In *Proceedings of IEEE Open & Big Data Conference*, vol. 13, p. 13. 2016.

Kumar, Mukul. "Perils of Participatory Democracy." *Economic and Political Weekly* 40, no. 46 (2005): 4857.

McMichael, Philip. "Banking on agriculture: a review of the World Development Report 2008." *Journal of Agrarian Change* 9, no. 2 (2009): 235-246.

White, D., and D. Mahtani. "Nigeria vows to track use of debt relief funds." *Financial Times* (2005): 9-10.

Palanithurai, G. "Good Governance at Grassroots." *The Indian Journal of Political Science* (2005): 289-312.

Backus, Michiel. "EGovernance in Developing Countries." (2002).

Goel, Suman, and Raj Kumar. "E-Governance: A Tool for Tackling the Corruption in India." *Health* 15 (2014): 32.

Bowonder, B., Vinay Gupta, and Amit Singh. "Developing a rural market e-hub: The case study of e-Choupal experience of ITC." *Indian Planning Commission Report* (2002).

Chandra, Bipan, Mridula Mukherjee, Aditya Mukherjee, K. N. Panikkar, and Sucheta Mahajan. *India's struggle for independence*. Penguin UK, 2016.

Basham, Arthur Llewellyn, and Saiyid Athar Abbas Rizvi. *The wonder that was India*. London: Sidgwick and Jackson, 1956.

Ge, Lan, Christopher Brewster, Jacco Spek, Anton Smeenk, Jan Top, Frans van Diepen, Bob Klaase, Conny Graumans, and Marieke de Ruyter de Wildt. *Blockchain for agriculture and food*. No. 2017-112. Wageningen Economic Research, 2017.

Underwood, Sarah. "Blockchain beyond bitcoin." *Communications of the ACM* 59, no. 11 (2016): 15-17.

Omohundro, Steve. "Cryptocurrencies, smart contracts, and artificial intelligence." *AI matters* 1, no. 2 (2014): 19-21.

Lin, Yu-Pin, Joy R. Petway, Johnathen Anthony, Hussnain Mukhtar, Shih-Wei Liao, Cheng-Fu Chou, and Yi-Fong Ho. "Blockchain: The Evolutionary Next Step for ICT E-Agriculture." *Environments* 4, no. 3 (2017): 50.

Chinaka, Malvern. "Blockchain technology--applications in improving financial inclusion in developing economies: case study for small scale agriculture in Africa." PhD diss., Massachusetts Institute of Technology, 2016.

Maloni, Michael J., and Michael E. Brown. "Corporate social responsibility in the supply chain: an application in the food industry." *Journal of business ethics* 68, no. 1 (2006): 35-52.

Christiaensen, Luc, Lionel Demery, and Jesper Kuhl. "The (evolving) role of agriculture in poverty reduction—An empirical perspective." *Journal of development economics* 96, no. 2 (2011): 239-254.

Tomlinson, Isobel. "Doubling food production to feed the 9 billion: a critical perspective on a key discourse of food security in the UK." *Journal of rural studies* 29 (2013): 81-90.

Palladino, Santiago, and Zeppelin Solutions. "The parity wallet hack explained." *Zeppelin Blog* 19 (2017).

Apte, Shireesh, and Nikolai Petrovsky. "Will blockchain technology revolutionize excipient supply chain management?." *Journal of Excipients and Food Chemicals* 7, no. 3 (2016).

Fisher, S. "Gartner Hype Cycle 2016: blockchain, no big data." *Accessed on* 2 (2017).

Thavanathan, Jenitha. "Process Innovation with Blockchain in Banking-A case study of how Blockchain can change the KYC process in banks." Master's thesis, NTNU, 2017.

Vest, Charles M. "Open content and the emerging global meta-university." *EDUCAUSE review* 41, no. 3 (2006): 18.

Tapscott, Don, and Anthony D. Williams. "Innovating the 21st-century university: It's time." *Educause review* 45, no. 1 (2010): 16-29.

Cachin, Christian. "Architecture of the Hyperledger blockchain fabric." In *Workshop on Distributed Cryptocurrencies and Consensus Ledgers*. 2016.

Tapscott, Don, and Alex Tapscott. "The impact of the blockchain goes beyond financial services." *Harvard Business Review* 10 (2016).

Shelkovnikov, Alexander. "Blockchain applications in the public sector." *Deloitte, available at: https://www2. deloitte. com/.../ch-en-innovation-deloitte-blockchain (accessed 3 August 2016).[Google Scholar]* (2016).

Benchoufi, Mehdi, and Philippe Ravaud. "Blockchain technology for improving clinical research quality." *Trials* 18, no. 1 (2017): 335.

Ray, Deepak K., Nathaniel D. Mueller, Paul C. West, and Jonathan A. Foley. "Yield trends are insufficient to double global crop production by 2050." *PloS one* 8, no. 6 (2013): e66428.

Shukla, A. K., M. C. Meena, P. K. Tiwari, C. Prakash, P. Singh, G. S. Tagore, H. K. Rai, and A. K. Patra. "Current status of micronutrient deficiencies in soils and crop-specific recommendations for different agro-climatic zones of Madhya Pradesh." *Indian J Fert* 12 (2016): 26-35.

Appendix A

Interview questions- State functionaries at the block level

Q.1- NITI Aayog is planning to operationalize IndiaChain. Have you heard of blockchain technology before and if so in what context? (if the response is NO, skip to Q.3)

Q.2- Do you think the plan is ambitious? Do we have the infrastructure in place to launch such an ambitious policy?

Q.3- What do you think are the major issues and challenges perplexing the Indian agricultural sector?

Q.4- What role do you think ICT is playing or could play in reforming the agricultural sector in India?

Q.5- Has the number of people claiming benefits of the government schemes increased over the years?

Q.6-Do you feel the need to associate private sector in the agricultural sector? If yes, how can private sector contribute towards agricultural reforms?

Q.7-Do you believe the trinity of Jan Dhan, Aadhar and Mobile has started showing its promise? What are the major challenges?

Q.8- Do you want to share anything insightful based on your personal belief and experiences?

Q.9- Do you have any questions for me?

Appendix B

Interview questions- village heads

Q.1- What are your primary responsibilities as a village head?

Q.2- What are some of the key government policies in the agricultural sector that materialize under your supervision?

Q.3- What percentage of the village population comes under the category of marginal farmers? Do you fall in that category too?

Q.4- Do you think after the introduction of *Jan Dhan* scheme the number of people owning bank accounts has increased in the village?

Q.5- What percentage of the village population has AADHAR number?

Q.6- What according to you are the major challenges faced by farmers in the village?

Q.7- Do you feel the need to associate private sector in the agricultural sector? If yes, how can private sector contribute towards agricultural reforms?

Q.8- What is the role of the government in reforming the agricultural sector according to you? What do you think are the key issues with the governance currently?

Q.9- Do you want to share anything insightful based on your personal belief and experiences?

Q.10- Do you have any questions for me?

Appendix C

Interview questions- Blockchain Expert

Q.1- NITI Aayog is rolling out IndiaChain to deliver public policy through blockchain. What is the potential in the idea according to you?

Q.2- Is India ready for such a policy intervention? Do you think we have the requisite infrastructure?

Q.3- How can blockchain reform policy implementation in India?

Q.4- Do we have examples from other countries that we could follow here?

Q.5- What role do you believe private sector can play in this entire plan?

Q.6- This is going to be a hefty investment. What are your ideas about the funding?

Q.7- What do you think about the scalability of the project? Should it be chalked out as a pan-India project from the very beginning?

Q.8- Do you want to share anything insightful based on your personal belief and experiences?

Q.9- Do you have any questions for me?

Appendix D

Interview questions-   General Manager, Magicagro Biotech Private Limited

Q.1- Are you aware about blockchain technology?

Q.2- What according to you are the key issues in the agricultural sector currently?

Q.3- What are the key issues with agricultural supply chain currently?

Q.3- If agricultural supply chain is harmonized what gains do you expect for your organization?

Q.4- How often do you interact with the government functionaries in course of your operations?

Q.5- Could you comment on the attitude of farmers towards technology in agricultural sector?

Appendix E

List of villages visited for data collection:

1) District Hoshangabad:

Bhatki Alias Iklani

Bhamedi

2) District Raisen:

Sagoni

Dhwaaj

3) District Burhanpur:

Adhari

Bada Buzurg

4) District Gwalior:

Amarol

Akbai Badi

5) District Vidisha:

Basiya Gajar

Dhamnod

6)District Dewas:

Khedi

Chichli